Table of Contents

I. Executive Summary of the Self-Study Report ................................................................. 1
   A. Message from the Department Head and Graduate Program Adviser .......................... 1
   B. Charge to the External Review Team ............................................................................ 2

II. Introduction to Department ............................................................................................ 3
   A. Brief departmental history ............................................................................................. 3
   B. Mission and goals .......................................................................................................... 3
   C. Administrative structure ............................................................................................... 4
   D. Advisory Council ......................................................................................................... 7
   E. Department and program resources .............................................................................. 8
      1. Facilities .................................................................................................................... 8
      2. Institutes and Centers ............................................................................................. 11
      3. Finances .................................................................................................................. 13
   F. External program accreditations .................................................................................. 13
   G. Date of last APR external review ............................................................................... 13
   H. Analysis ...................................................................................................................... 13

III. Academic Programs and Curricula .............................................................................. 15
   A. Programs offered ......................................................................................................... 15
   B. Program curricula ....................................................................................................... 15
      1. Master of Science in Nuclear Engineering ............................................................... 15
      2. Master of Engineering in Nuclear Engineering ........................................................ 19
      3. Ph.D. in Nuclear Engineering .................................................................................. 19
   C. Admissions criteria (doctoral students) ....................................................................... 20
   D. Number of degrees awarded per year (most recent five years) ................................. 23
   E. Average time to degree (most recent five years) ......................................................... 24
   F. Academic enhancements / high-impact opportunities for students ............................ 25
   G. Assessment of student learning outcomes ................................................................ 25
   H. Analysis ...................................................................................................................... 26

IV. Faculty Profile ............................................................................................................. 28
   A. Core faculty .................................................................................................................. 28
      1. Number .................................................................................................................... 28
Table of Tables

Table 1. Requirements for the Ph.D. degree plan (for students without Master’s degree)* ........ 19
Table 2. Requirements for the Ph.D. degree plan (for students with Master’s degree)* ........ 19
Table 3. Number of Earned Degrees by Academic Year ........................................................ 24
Table 4. Doctoral Graduation Data .......................................................................................... 24
Table 5. Master’s Graduation Data ....................................................................................... 25
Table 6. Texas A&M Nuclear Engineering Graduate Program Rankings .................................. 27
Table 7. Core Faculty to Graduate Enrollment Ratio .............................................................. 28
Table 8. Faculty Publications .................................................................................................. 29
Table 9. Faculty Research Expenditures .................................................................................. 29
Table 10. Faculty Other Than Core to Graduate Enrollment Ratio .......................................... 30
Table 11. Core Faculty Diversity ............................................................................................ 31
Table 12. Faculty Other Than Core Diversity ......................................................................... 31
Table 13. Faculty Awards and Honors .................................................................................... 32
Table 14. Ph.D. Time to Graduation ...................................................................................... 42
Table 15. Student Publications/Presentations ....................................................................... 44
Table 16. Post-Graduation Employment of Ph.D. Nuclear Engineering Graduates ................. 44
Table 17. Degrees Awarded .................................................................................................... 50
Table 18. Time to Degree ....................................................................................................... 50
Table 19. Post-Graduation Employment of Master’s Nuclear Engineering Graduates .......... 51
Table 20. Student Awards ...................................................................................................... 55
Table 21. Student Financial Awards ..................................................................................... 58
# Table of Figures

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Organizational Chart</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>Self-Defined Metrics Standards of Measure</td>
<td>36</td>
</tr>
<tr>
<td>3</td>
<td>Total M.S./Ph.D. Enrollment</td>
<td>38</td>
</tr>
<tr>
<td>4</td>
<td>Doctoral Enrollment</td>
<td>39</td>
</tr>
<tr>
<td>5</td>
<td>Ph.D. Full-time Enrollment</td>
<td>39</td>
</tr>
<tr>
<td>6</td>
<td>Ph.D. Ethnicity/Race Enrollment</td>
<td>40</td>
</tr>
<tr>
<td>7</td>
<td>Ph.D. Domestic/International Enrollment</td>
<td>41</td>
</tr>
<tr>
<td>8</td>
<td>Ph.D. Retention Rate</td>
<td>41</td>
</tr>
<tr>
<td>9</td>
<td>Ph.D. Graduation Rate</td>
<td>42</td>
</tr>
<tr>
<td>10</td>
<td>Ph.D. Institutional Support</td>
<td>43</td>
</tr>
<tr>
<td>11</td>
<td>Ph.D. Full-Time Support Percentage</td>
<td>43</td>
</tr>
<tr>
<td>12</td>
<td>Ph.D. Post Graduate Appointment</td>
<td>46</td>
</tr>
<tr>
<td>13</td>
<td>Master’s Post Graduate Appointment</td>
<td>47</td>
</tr>
<tr>
<td>14</td>
<td>Master’s Ethnicity/Race Enrollment</td>
<td>48</td>
</tr>
<tr>
<td>15</td>
<td>Master’s Ethnicity/Race Percentage</td>
<td>48</td>
</tr>
<tr>
<td>16</td>
<td>Master’s Retention Rate</td>
<td>49</td>
</tr>
<tr>
<td>17</td>
<td>Master’s Graduation Rate</td>
<td>49</td>
</tr>
</tbody>
</table>
Supplemental Material

Book 1. Faculty Curricula Vitae
1. Marvin L. Adams
2. Gamal Akabani
3. Frederick Best
4. Leslie A. Braby
5. William S. Charlton
6. Sunil S. Chirayath
7. John Ford
8. Stephen Guetersloh
9. Yassin A. Hassan
10. W. Wayne Kinnison
11. Cable Kurwitz
12. William H. Marlow
13. Craig Marianno
14. Ryan G. McClarren
15. Sean M. McDeavitt
16. Jim E. Morel
17. Kenneth L. Peddicord
18. John W. Poston, Sr.
19. Jean C. Ragusa
20. W. Daniel Reece
21. Lin Shao
22. Pavel Tsvetkov
23. Galina Tsvetkova
24. Karen Vierow

Book 2. Graduate Course Syllabi
1. NUEN 601, Nuclear Reactor Theory
2. NUEN 604, Radiation Interactions and Shielding
3. NUEN 605, Radiation Detection and Nuclear Materials Measurement
4. NUEN 606, Nuclear Reactor Analysis and Experimentation
5. NUEN 609, Nuclear Reactor Safety
6. NUEN 610, Nuclear Reactor Design and Critical Analysis
7. NUEN 612, Radiological Safety and Hazards Evaluation
8. NUEN 613, Principles of Radiological Safety
9. NUEN 618, Multiphysics Computations in Nuclear Science and Engineering
10. NUEN 623, Nuclear Engineering Heat Transfer and Fluid Flow
11. NUEN 624, Nuclear Thermal Hydraulics and Stress Analysis
12. NUEN 625, Neutron Transport Theory
13. NUEN 627, Radiation-Hydrodynamics
14. NUEN 629, Numerical Methods in Reactor Analysis
15. NUEN 630, Monte Carlo Computational Particle Transport (Fall 2013)
16. NUEN 633, Radiation Measurements and Calibrations
17. NUTR/NUEN/KINE 646, Fundamentals of Space Life Sciences
18. NUEN 650, Nuclear Nonproliferation and Arms Control
19. NUEN 651, Nuclear Fuel Cycles and Nuclear Material Safeguards
20. NUEN 656, Critical Analysis of Nuclear Security Data
21. NUEN 661, Nuclear Fuel Performance
22. NUEN 662, Nuclear Materials under Extreme Conditions
23. NUEN 663, Fundamentals of Ion Solid Interactions
24. NUEN/BMEN 673, Radiation Biology
25. NUEN 674, Radiation Carcinogenesis
26. NUEN 675, Internal Dose Techniques
27. NUEN 676, Radiation Dosimetry Laboratory (2012)
28. NUEN 678, Waste Management in the Nuclear Industry
29. NUEN 685, Special Topics in Internal Dose Assessment
30. NUEN 689, Introduction to Diagnostic Radiology Physics
31. NUEN 689, Introduction to Radionuclide Production and Separation Methods
32. NUEN 689, Nuclear Emergency Response and Dose Assessment
33. NUEN 689, Severe Accident Analysis of Nuclear Facilities
34. NUEN 689, Introduction to GEANT4 Monte Carlo Transport
35. NUEN 689, Special Topics in Uncertainty Quantification in Nuclear Science and Engineering
I. Executive Summary of the Self-Study Report

A. Message from the Department Head and Graduate Program Adviser

The Department of Nuclear Engineering at Texas A&M University welcomes the review team to Texas A&M University and thanks you for your service as external reviewers of our academic program. We are pleased to have this opportunity for you to assess our academic program and look forward to implementing improvements and enhancements. We realize that strong academic programs, and in particular a strong doctoral program, are a key part of creating and maintaining an excellent department and in establishing and enhancing our academic reputation. Thus, we are grateful for your help in this process.

This self-study report was prepared specifically for the graduate program review. It includes background information, including departmental history, administrative structure, resources and facilities. The report presents specifics about our graduate program, ranging from admission to graduation. The faculty profile is presented, including faculty research concentration areas and activities. The student profile section emphasizes the doctoral students.

The Department of Nuclear Engineering has the largest student population of any nuclear engineering department in the United States. The department is nationally ranked second in public schools by *U.S. News and World Report* in both undergraduate and graduate programs. The department currently confers five degrees: B.S. degrees in nuclear engineering and radiological health engineering; M.S. degree in nuclear engineering; M.E. degree in nuclear engineering; and Ph.D. degree with specialization options in nuclear engineering, nonproliferation and health physics.

Departmental faculty includes a wide spectrum of expertise and research interests:

- Reactor physics
- Neutron transport
- Radiation hydrodynamics
- Computational methods
- Nuclear safety
- Transport phenomena
- Fuel management
- Nuclear safeguards
- Nuclear security
- Proliferation and terrorism risk analysis
- Heat transfer and two-phase flow
- Flow visualization
- Plutonium disposition
- Radionuclide transport in the environment
- Ion beam interactions with materials
- Materials engineering
- Radiation shielding
- Safety systems analysis
- Environmental aspects of nuclear power
- Direct energy conversion
- Radiation effects on materials
- Radiation dosimetry
- Medical radionuclides
- Radiation biology

The department is central to meeting industrial needs for the State of Texas and the nation in the safe and secure application of nuclear technology and the usage of radionuclides. These industries include major electric power utilities which operate nuclear power plants, numerous chemical process and petrochemical industries which use radionuclides for precision...
measurements, and a large medical community which uses nuclear radiation and radionuclides for both diagnostic and therapeutic health treatments.

The Academic Program Review (APR) process at Texas A&M University provides the occasion for academic units to plan strategically, assess the quality and efficacy of their programs, and determine the best courses of action for ongoing improvement. The APR is at the heart of our institutional commitment to excellence. Thank you in advance for playing such an important role in this process and we look forward to your visit in early February 2015.

Yassin A. Hassan  Karen Vierow  
Department Head  Graduate Program Adviser

B. Charge to the External Review Team

The Office of the Provost requests that the External Review Team examines the Department of Nuclear Engineering and its programs and make recommendations that will help in planning improvements. The resources for this review are a self-study report prepared by the department, copies of materials from the program’s last review, appendixes, information you gain through personal interactions while visiting Texas A&M University, and any additional information requested by you. Within the broad charge of recommending ways the department can continue to improve are some specific questions for the review team to address:

- Based on the data/information provided in the self-study report or gathered by the review team, what are the department’s overall strengths and weaknesses?
- How well do the department’s strategic goals align with those of its college and with those of Texas A&M University?
- What improvements (including student learning and faculty development) has the department made since the previous program review?
- How would you compare this department with its peers?
- What practices, resources and facilities do you have at your home institution which could benefit the Department of Nuclear Engineering if implemented/acquired here?
- Within the context of a rapidly changing national research environment, is the research of the department sufficiently robust? If not, what capabilities and facilities are most urgently needed?
- Vibrant nuclear research in today’s funding environment often requires extensive collaboration across the college and university as well as across institutional and international boundaries. What is your assessment of the department’s level of involvement in multidisciplinary team projects and in interdisciplinary research?
- The university and the College of Engineering emphasize the value of diversity among students, the staff, and the faculty. Are these values adequately reflected in the programs and practices of the department?
- With only current resources or a modest infusion of new ones, what specific recommendations could improve the department’s performance, marginally or significantly?
II. Introduction to Department

A. Brief departmental history

The Department of Nuclear Engineering at Texas A&M University was founded in 1958. Initially it offered only a graduate program; however, in 1975 an undergraduate program was added. Significant milestones during the first 30 years after the founding include:

- 1967 – first Ph.D. graduate;
- 1969 – AGN-201 low-power teaching reactor first criticality;
- 1971 – TRIGA research reactor first criticality;
- 1978 – first B.S. graduates;
- 1981 – nuclear engineering program accredited by ABET (Accreditation Board for Engineering and Technology); and
- 1987 – radiological health engineering program accredited by ABET.

Significant milestones during the last 25 years include:

- 1997 to 2010 – Texas A&M College of Engineering commits to retaining and strengthening the Department of Nuclear Engineering;
- 1998 – undergraduate enrollment declines to low of 55 in fall term;
- 2006 – TRIGA reactor core converted from HEU to LEU fuel;
- 2013 – the department celebrated its 55th anniversary;
- 2014 – undergraduate enrollment rises to high of 225 and graduate enrollment rises to 157; and
- 2015 – the Department of Nuclear Engineering is assigned its own building.

At the beginning of the fall semester of 2012, 18 tenured/tenure-track faculty members were administratively located in the department. On January 23, 2013, Dean M. Katherine Banks announced the 25 by 25 Initiative, with one of the many goals being to increase engineering enrollment to 25,000 students by 2025.

B. Mission and goals

The department has defined its vision “To develop and maintain a nationally and internationally recognized program that promotes a passion for understanding and applying the knowledge of nuclear science and engineering to support the nation's alternative energy, national security and healthcare missions.”

Our mission is to “serve our state, our nation and our global community by nurturing future nuclear engineering professionals and leaders who are:

- instilled with the highest standards of professional and ethical behavior
- prepared to meet the complex challenges associated with sustainably expanding peaceful uses of nuclear energy
- enhancing global nuclear security and avoiding the dangers of nuclear proliferation”

The Department of Nuclear Engineering’s strategic plan has been developed with input from both the department’s External advisory council and the departmental faculty. The plan supports and is complementary to the Texas A&M University Vision 2020: Creating a Culture of Excellence and the university’s Quality Enhancement Plan 2002 (QEP), both of which were
published in 2002. The priority themes of the QEP for excellence development in student learning are research, diversity, internationalization, and technology. The department’s strategic plan also supports the institutional priority imperatives stated in 2003: (1) to elevate faculty, (2) to improve the graduate and undergraduate programs, (3) to diversify and to globalize programs, and (4) to improve the use of space.

The department’s current strategic plan continues to focus on improvements in the following eight strategic areas:

- recognition;
- undergraduate enrollment;
- graduate enrollment;
- research focus;
- faculty development;
- research funding;
- student funding; and
- support from the college.

The adequacy of the defined strategic areas is evaluated at least semi-annually. Four strategic areas were recently added:

- academic standards;
- organization;
- development; and
- facilities.

The Texas A&M Engineering Experiment Station (TEES, the engineering research agency of the university) established research thrust areas to include energy systems and services; safety and security; health care; materials and manufacturing; information systems and sensors; industry outreach; and education and training. The department’s research core competencies are aligned with several of the thrust areas, in addition to education and training.

C. Administrative structure

The department administrative organization is shown on the next page. The organization assigns responsibility to the department head or a faculty member for each major department administrative activity. The following administrative functions are also each supported by one or more full-time staff members: general administration, business administration, computer systems and network, safety and laboratory management, undergraduate programs, and graduate programs.

Faculty members also serve on the following department committees, which enhance the educational experience of both undergraduate and graduate students:

- Graduate Admissions Committee
- Undergraduate Programs and Policies Committee
- Scholarships and Fellowship Committee
- Ph.D. Qualifying Examination Committee
- Growth Committee
- Space Committee
• Honors & Awards Committee

All tenured faculty serve on:

• Tenure & Promotion Committee
• Post Tenure Review Committee
Figure 1. Organizational Chart
D. Advisory Council

The department is advised by an external advisory council that was formed in 1998. The council is currently composed of seventeen senior executives from a broad spectrum of utilities, nuclear industry companies, national laboratories, and academia. The council meets twice annually, once during the fall semester and once during the spring semester, for a full day.

Current membership of the advisory council:

1. Carol Berrigan, Nuclear Energy Institute
2. Rafael Flores, Luminant Power
3. Thomas Geer, Westinghouse, Chair
4. Timothy Hurst, Hurst Technologies Corporation
5. Dr. Regis Matzie, Westinghouse-retired, Co-Chair
6. Evelyn Mullen, Los Alamos National Laboratory
7. Dr. James Peery, Sandia National Laboratory
8. Tim Powell, South Texas Project
9. Sandra Sloan, B&W mPower, Inc.
10. Dr. Russell Stachowski, Global Nuclear Fuel
11. Ron Stinson, Emeritus, Atlas Consulting Group
12. Richard Wolters, Emeritus, General Electric-retired
13. Dr. Finis Southworth, Areva, Inc.
14. Tom Hannigan, Zachry Nuclear, Inc.
15. Rube Williams, Jet Learning Laboratory
16. G.R. “Ross” Frazer, Helix Well Containment Group, LLC
17. Dr. J. Wesley Hines, Head of Nuclear Engineering, University of Tennessee

Each meeting of the advisory council is preceded by an informal dinner to which faculty, staff and students are invited. The dinner is preceded by a brief program, which has traditionally been recognition of students’ scholarship and fellowship awards at the fall meeting and a special topic discussion, such as new nuclear power plant construction, at the spring meeting. During the dinner, council members each have a designated table at which students may gather and discuss the organization represented by that member as well as internship and job opportunities.

Each meeting of the advisory council follows a similar agenda including: an update from the department head of events having a significant impact on the department, the financial status of the department, and progress on each of the areas of the department’s strategic plan; reports from the undergraduate coordinator, the graduate coordinator, and the Faculty Search Committee chair (if appropriate); reports from one or more faculty members on either a research topic or a teaching improvement topic; response to feedback from the council at its previous meeting; and generally a special report requested by the council, such as the department’s plans for the college’s 25 by 25 Initiative and its impact on the department.

During each meeting the council has lunch with a group of student leaders, generally the officers of the American Nuclear Society (ANS), Women in Nuclear (WIN), Institute of Nuclear Materials Management (INMM) and the Health Physics Society (HPS) student sections to obtain feedback about the department’s programs. This feedback is reported to the department head by the council at the close of its meeting and is a significant source of input to making improvements to the department’s education programs and facilities.
The advisory council had a significant role in developing and monitoring progress toward
departmental goals. Likewise, the council participated in several aspects of the department’s
preparations for an ABET accreditation review in 2010 including developing program
educational objectives and program educational outcomes and administering assessments of
results.

E. Department and program resources

1. Facilities

The Department of Nuclear Engineering has extensive facilities and laboratories that are used in
support of both the teaching and research missions. Summary descriptions of each are provided
below.

The primary mission of the **Accelerator Laboratory** is to study ion beam-solid interactions.
Primary research in the Accelerator Laboratory includes measuring ion-stopping powers;
measuring transmitted energy and angular distributions of ions channeled through thin films;
studying lattice damage and self-annealing phenomena; studying low-energy ion implantations
and film deposition; studying semiconductor alloys produced by ion beam synthesis; and
investigating masked ion-beam lithography. The laboratory has two primary accelerators with
maximum voltages of 200 kV and 160 kV, a secondary accelerator, plus two Tandetron
accelerators (1.0 MV and 1.7 MV).

The **AGN-201M Nuclear Reactor Laboratory** has a 5 W AGN-201M nuclear reactor used
primarily in undergraduate and graduate laboratory courses, which teaches fundamentals of
nuclear reactor operations and interactions of neutrons with matter. The AGN-201M lets students
conduct experiments on basic reactor physics parameters. In addition, the laboratory has a
subcritical assembly for studying the neutron flux profile in a nuclear system and a graphite pile
for examining the neutron thermalization process. The laboratory facilities are used nearly
exclusively to support education programs rather than research.

The **Fuel Cycle and Materials Laboratory** (FCML) was established to study current issues in
the nuclear fuel cycle, including materials and chemical processing, advanced fuels and
materials, and waste immobilization. Equipment in FCML includes high temperature furnaces,
two inert atmosphere gloved boxes, and a 90-ton hydraulic press. These may be configured for
casting, instrumented sintering, cold or hot pressing, and hot extrusion. Further, the laboratory is
equipped and has been approved for the handling, testing and characterization of radioactive
materials. Currently funded projects from the U.S. Department of Energy include materials
processing activities to develop advanced nuclear fuels for burning transuranic radionuclides and
radioactive waste forms for isolating fission products.

The **Interphase Transport Phenomena Laboratory** (ITP) conducts research in the area of
interphase heat, mass and momentum transfer. Most recently, the ITP group has worked
on modeling and measurement of zero gravity, two-phase flow systems. The laboratory builds
research hardware and conducts experimental programs in the NASA zero gravity aircraft.

The mission of the **Laser Diagnostics Multiphase Flow Laboratory** is to investigate the
complex, multiphase flow of multi-scale, multi-physics flow phenomena using non-intrusive
global field measurement techniques. The laboratory provides the ability to use state-of-the art
particle image velocimetry techniques to study these flows. The laboratory is equipped with fast-
pulsed, high-energy lasers and fast high-resolution cameras. Data are analyzed using in-house developed tracking, imaging and pattern recognition routines. The combination of instantaneous measurements of full-fields of velocity and laser-induced temperature measurements enables a multitude of interesting studies of single and multiphase flows.

The **Micro-Beam Cell Irradiation Facility** provides specialized irradiation capabilities needed to implement radiation biology experiments to understand the cellular and molecular mechanisms controlling the risk of long-term health effects related to low doses of ionizing radiation. Radiation sources include a 250 kV x-ray machine, an 80 kV electron microbeam, and a 3 MeV tandem electrostatic accelerator with single particle microbeam capability. The microbeam facilities can reproduce most of the range of charged particles that are found in environmental and industrial settings, and are designed to facilitate study of effects in bystander cells and other biological phenomena that are found at low doses.

The **Microdosimetry Laboratory** is used to assemble and to test microdosimetry detectors. Special equipment for assembling, filling, and sealing detectors makes it possible to build detectors that operate for five years or longer without need for maintenance. Prototype detectors can be built and evaluated in relatively little time. This facility is used to produce detectors used by NASA in a variety of past and future space missions.

The **Neutron Counting Laboratory** is used to teach fundamental neutron detection science, neutron coincidence counting, counting of special nuclear materials, neutron detector array technologies, and nonproliferation applications of neutron counting. The laboratory is equipped with He-3, BF3, fission chamber, and self-powered neutron detectors. Electronics include traditional NIMbin electronics as well as digital electronics and LIST mode data acquisitions systems for coincidence and multiplicity counting. Several neutron sources ($^{252}$Cf, PuBe, and AmLi) as well as neutron shielding materials are available.

The **Nuclear Heat Transfer Systems Laboratory** was established with the initial goals of investigating condensation heat transfer mechanisms, developing new reactor designs and safety systems, and advancing the field of reactor safety analysis. Later efforts focused on developing analysis methods for high-temperature, gas-cooled reactors and improving best estimate analysis with PRA methodologies. Recent sponsored projects performed experimental investigations of reactor safety systems such as the BWR Mark I Reactor Core Isolation Cooling (RCIC) System in the Fukushima Dai-ichi reactors and to use the data to validate theoretical models that the lab members have developed for system performance and for fundamental phenomena. The lab is equipped with a 150 kW steam supply, a high-speed camera, extensive thermal hydraulic instrumentation and a state-of-the-art data acquisition system. The lab also has two test facilities to investigate countercurrent flow limitation (CCFL) and is extending one of the facilities to allow for testing at higher pressures and temperatures.

The **Nuclear Science Center** (NSC) reactor is a “swimming pool” type research facility operating with FLIP TRIGA fuel. The reactor core was converted from HEU to LEU fuel in 2006. The core consists of cylindrical fuel elements reflected with graphite. It is positioned about 26 feet below the pool surface and is cooled by natural convection. While the reactor is generally operated in the stall area of the pool, the reactor can be positioned anywhere along the centerline of the pool if desired. The reactor has a variety of features to support experiments including a large irradiation cell, beam ports, thermal column, and a pneumatic “rabbit” system. The NSC
The reactor is licensed to operate at a maximum steady state power level of 1 MW and can be pulsed to 500 MW with a pulse half-width of 50 msec.

The **Radiation Biology Laboratory** is next to the Micro-Beam Cell Irradiation Facility (described previously) in a 2,500 square-foot laboratory building located next to the Nuclear Science Center (above). Space is provided for cell and tissue culture work on a 2,000 square-foot platform equipped with four CO₂ incubators, two laminar flow clean hoods, microscopes and other equipment necessary to maintain and work with human and other mammalian cells in culture. A 250 kV x-ray machine for reference radiation exposures is located on the ground level, in close proximity to the cell culture facilities. A second set of labs is comprised of a cell culture lab and microinjection lab. The cell culture lab has a dual chamber incubator and a clean hood, along with refrigerators for sample and reagent storage.

The **Radiation Detection and Measurement Laboratory** is based around five Canberra counting systems and five alpha spectrometers with PIPS detectors. Additionally available are two HPGe detection systems, seven data acquisition cards with software, a portable Canberra Ge(Li) detector, a Canberra Series SL Si(Li) low-energy x-ray detector, two pressurized ion-chambers, two PERALS alpha spectrometers, a Gamma Products alpha/beta counting station and a Rad Elec (Electret) detection system. The laboratory has three TLD readers, one Bonner Sphere system, three NaI(Tl) scintillation detectors, six gas-flow proportional detectors, six end-window GM detectors, six flat-area, high-efficiency gas-flow proportional counters, three 4π gas-flow proportional counters, a Canberra Planchet counter, and a LKB 1219 rack beta liquid scintillation counter. In addition, six Ludlum Model 2200 ratemeters, four digital air samplers, a Nomad NaI(Tl) detection system, a Scout Detection system, a Ludlum Model 19 Micro R meter, a Bicron Micro Rem meter, six oscilloscopes (one digital), and a gamma tracer system are available. These systems are used in both undergraduate and graduate courses to teach students the fundamentals of radioactive sample characterization and radiation detection.

The **Spectroscopy Laboratory** includes two stationary and two portable HPGe detectors, eight NaI(Tl) detectors, one SiLi detector, and two photon-electron rejecting alpha liquid scintillation (PERALS) spectrometers. The laboratory also has portable and stationary 4096- and 8192-channel computer-based spectrometry systems, which can be used for both time-domain (multichannel scaling) and energy-spectra measurements (pulse height analysis) and portable and stationary detector shields. These computer systems are used for all of the solid-state detectors, including the alpha PIPS detectors in the Radiation Detection and Measurement Laboratory (above), and the scintillation detectors. Additionally, they are used for pulse shape analysis with the PERALS systems.

The **Tandem Accelerator Laboratory** hosts a 3 MeV Pelletron accelerator which provides charged particle beams for radiation biology and dosimetry studies. Beam lines for single particle microbeam biology studies and for charged particle track structure studies are available. The accelerator provides particles in the energy range typical of proton recoils from neutron irradiation and alpha particles from radioactive sources.

The **Nuclear Forensics and Radiochemistry Laboratory** includes a glove box and fume hood for handling radioactive materials, NaI and HPGe detectors for gamma-radiation spectroscopy, PIPS detectors for alpha-radiation spectroscopy, electrochemical setup for radioactive material sample preparation, centrifuges to separate organic and aqueous phases, vortex mixer to mix
different chemical phases, heating mantle for chemical dissolution of uranium dioxide, and a bench-scale setup for analyzing the PUREX chemical process.

In addition to the physical facilities mentioned above, the department provides a computer laboratory to students for their instructional needs as well as research. Faculty and students have access to multiple high performance computing systems in the Texas A&M Supercomputing Facility. Along with hundreds of desktop computers available for student use, the department has multiprotocol file servers as well as its own computational servers.

2. Institutes and Centers

The Department of Nuclear Engineering has a number of affiliated institutes and centers that are focused on specific mission areas that overlap with the department’s mission space. These centers are directed by faculty members in the department.

The objective of the Center for Large-Scale Scientific Simulations (CLASS) is to advance the state of the art in large-scale scientific simulations. This means developing numerical methods and computational strategies that enable more efficient solutions of large problems on the latest massively parallel computer platforms. CLASS strives to achieve this objective through research and development performed by collaborative multidisciplinary teams including faculty from the colleges of engineering and science at Texas A&M University as well as key researchers from national laboratories. CLASS also strives to lead the development of educational programs whose participants will be exceptionally well qualified for careers in scientific computation. CLASS is working toward this objective by bringing together key faculty members from several departments (including mathematics, computer science, and nuclear engineering) and key national lab practitioners to collaboratively design a graduate program that will provide the broad range of skills and knowledge that is needed by tomorrow’s experts in scientific simulation.

CLASS has several large multidisciplinary projects under its purview. For instance, CLASS manages the Support of Stockpile Stewardship Program, which is funded at a level of roughly $1M per year by Lawrence Livermore National Laboratory, and has professors and students participating from Nuclear Engineering, Computer Science and Engineering, Material Science and Engineering, and Mathematics.

CLASS also manages the Center for Exascale Radiation Transport (CERT), which was established in 2014 as one of six national “predictive science” centers created by the National Nuclear Security Administration. It includes participation by professors and students from Nuclear Engineering and Computer Science and Engineering as well as as professors and students from the Statistics Department at Simon Fraser University in Canada and the Applied Mathematics Department at the University of Colorado. The purpose of the predictive science centers is to perform research in the areas of interest to the NNSA weapons science laboratories and to produce graduates who can contribute to the national security missions. CERT performs research in several areas including the use of uncertainty quantification coupled with experiments relating to large multi-scale radiation transport problems, and the development of transport and basic computer science methods for petascale and exascale computing. CERT is funded at $2M per year.

The Nuclear Security Science and Policy Institute (NSSPI) is a university-based entity that focuses on graduate education, research, and service on a variety of topics related to the safeguarding of nuclear materials and the reduction of nuclear threats. NSSPI works in
collaboration with national laboratories and other partners to develop technological solutions to problems associated with the malicious use of nuclear materials and to study policy issues related to nuclear security.

The **Institute for National Security Education and Research (INSER)** develops and implements graduate-level education programs targeted at national security professionals. For example, it currently works with Texas A&M's Bush School of Government and Public Service to provide a Graduate Certificate program in National Security Affairs to selected employees from Lawrence Livermore National Laboratory and Sandia National Laboratories. INSER also organizes and implements multidisciplinary research and development programs that are relevant to national security. Current programs include those targeted at nuclear nonproliferation, scientific simulation relevant to national security, and homeland and international security. For instance, the Support of Stockpile Stewardship Program, which is managed and executed by CLASS on behalf of INSER, arose from INSER interactions with the University of California and Lawrence Livermore National Laboratory.

The **Nuclear Power Institute (NPI)** was the result of a request by the nuclear utilities to assist in the development of the nuclear workforce for the nuclear power plants. The focus is on the technical workforce in fields other than nuclear engineering, including at the technician level. An active outreach program was developed as well to inform younger students about nuclear energy and to attract them into courses of studies leading to careers in the nuclear industry. To carry out this mission, NPI developed a partnership in industry, several universities and community colleges, high schools and junior highs, teachers, students, and community and elected leaders. NPI is now utilized for training programs by the International Atomic Energy Agency in Vienna, Austria for “nuclear newcomer” countries to support their human resource development for emerging nuclear power programs.

The Department of Nuclear Engineering also participates in several research centers hosted by other departments or colleges:

- The **Cyclotron Institute** has an 88-inch single-D, variable energy cyclotron capable of accelerating protons and deuterons to 60 MeV, alpha particles to 135 MeV, and heavier ions to energies of 300 MeV. A complete research facility exists with on-line data acquisition capabilities coupled to an IBM 7094 computer system. A cryogenic K-500 has been installed. Injection into the current machine allows heavy ion energies to about 600 MeV. The department has most recently used this facility in studies of direct energy conversion phenomena.

- Researchers in the **National Center for Electron Beam Food Research**, which has been recently designated as a National Research Center, use high- and low-energy electron beams to reduce the number of bacteria and other pathogens in and on food and other materials. The work is primarily directed at spontaneous, food-borne illness but is also relevant to bioterrorism issues.

- The **Texas A&M Institute for Preclinical Studies (TIPS)** was established in 2007 to serve the preclinical needs of academic researchers and industry. TIPS is uniquely qualified and positioned to conduct medical device and combination product safety studies in large animal models in compliance with the U.S. Food and Drug Administration's (FDA) Good Laboratory Practice (GLP) regulations because of this direct association with the College of Veterinary Medicine and Biomedical Sciences.
3. Finances

The Department of Nuclear Engineering is supported by state appropriated funds, student fees, sponsored research income, grants and gifts. The dean of engineering determines the department’s portion of state appropriated funds. These funds are based on historical statistics, new authorizations, faculty and staff merit increases, and related adjustments. Nuclear engineering also receives a historically set amount of operating funds from the college. Other sources of income include indirect cost returns based on sponsored research expenditures, externally (industry and federal) and internally (state agency) funded grants and gifts.

Expenditures include faculty and staff salaries, faculty travel and professional activities, general operating expenditures, graduate student support, student projects and travel, classroom and laboratory equipment purchases and maintenance.

F. External program accreditations

The department’s undergraduate program undergoes ABET accreditation every six years. The department undertook and passed the last ABET review in 2010. In addition, in 2012 Texas A&M University was reviewed by the Southern Association of Colleges and Schools (SACS). The department provided information for the College of Engineering input to SACS. The university’s accreditation by SACS was renewed.

G. Date of last APR external review

The department’s most recent Academic Program Review (APR) was in 2007, with a four-year update provided in 2011.

H. Analysis

The Department of Nuclear Engineering is one of the highest ranked nuclear engineering departments in the U.S. as well as one of the highest ranked departments across all of Texas A&M University (see Chapter III, Section H). We are nationally and internationally recognized as one of the leading academic units in the field with vibrant research and education programs focused on areas critical to the safe and secure application of nuclear energy. We continually strive to improve programs and drive toward excellence. Since the last review, a number of noteworthy developments have taken place in the graduate program in the Department of Nuclear Engineering. Three examples of these are given below.

Perhaps the most dramatic development has been the growth in the graduate enrollment. In 2007, the total number of graduate students in the department was 104. By the fall semester of 2014, this has increased to 157. Within this group, the increase in the number of Ph.D. students has been especially important for the department. In 2007, this number was 32, but by fall 2014 it was 87 (a 170% increase). It also represents an increase in the fraction of the graduate enrollment that is at the Ph.D. level (from 30% to 50%). The department has also increased its emphasis on the graduate program. In 2011, Dr. Karen Vierow became the graduate adviser. Following this action, Mr. Robb Jenson joined the department as the graduate program coordinator. This has led to an increased emphasis on graduate student recruiting, with more active identification and engagement of potential applicants to the department.

Since 2007, the department has moved strongly to increase its emphasis and capabilities in the area of materials. In 2006, Dr. Sean McDeavitt from Purdue University joined the department. His expertise is in nuclear fuels and materials. He has worked previously at Argonne National
Laboratory. Dr. McDeavitt established the Fuel Cycle and Materials Laboratory, which has a full range of nuclear fuels capabilities. It is one of the most extensive labs in this field at any university. Shortly after Dr. McDeavitt, Dr. Lin Shao also joined the faculty. He had held a post-doctoral appointment at the Los Alamos National Laboratory. His field of expertise is interaction of radiation with matter. He took over the suite of particle accelerators previously developed by Dr. Ron Hart. Dr. Shao has expanded the capabilities of his laboratory so that it now consists of five accelerators with the capability to deliver a large range of ions with energies ranging from a few keV to a few MeV per nucleon. The accelerators are used for a wide variety of applications and basic research including the following: accelerator based ion beam mixing, ion beam assisted film deposition, ion doping, Rutherford Back Scattering (RBS) spectrometry, elastic recoil detection analysis, and particle induced X-ray emission analysis.

The Dwight Look College of Engineering is encouraging departments to invite individuals to take part in the educational programs as a “Professor of Practice.” This position makes it possible to expand the breadth of expertise and bring new perspectives to the academic program. Typically those serving in this capacity have decades of experience in the field. Beginning with the 2012-2013 academic year, Richard Schultz from Idaho National Laboratory has served as Professor of Practice in the Department of Nuclear Engineering. His area of expertise is reactor safety and thermal hydraulics, and he taught NUEN 485/609, “Nuclear Reactor Safety,” NUEN 623, “Nuclear Engineering Heat Transfer and Fluid Flow,” and NUEN 624, “Nuclear Thermal Hydraulics and Stress Analysis.” During the 2014-15 academic year, Ernest Kee is serving as Associate Professor of Practice in the department. Mr. Kee is retired from the South Texas Project Nuclear Operating Company. His activities have been in the use of probabilistic risk analysis as applied to non-safety related operating functions in a nuclear power plant. In this role in the department, he introduced a new course related to risk informed analysis and PRA in nuclear application taught as a new course NUEN 689/489 “Probability and Risk Assessment in Nuclear Power.”
III. Academic Programs and Curricula

A. Programs offered

The Department of Nuclear Engineering offers Master of Science (M.S.), Master of Engineering (M.E.), and Doctorate of Philosophy (Ph.D.) degrees. Until recently, the department offered separate M.S. degrees in Nuclear Engineering and Health Physics; however, beginning in the fall 2014 semester, the department has not been admitting new M.S. in Health Physics students and a new consolidated M.S. curriculum in Nuclear Engineering is being offered that provides a balance between safety, safeguards, and security while still offering specialization options for students in reactor engineering, health physics, computational sciences, nuclear materials, and nuclear nonproliferation. This new consolidated degree program is described in some detail below.

B. Program curricula

Students enrolled in either Master of Science or Ph.D. programs are required to file a degree plan with the Office of Graduate and Professional Studies. This degree plan is put together by the student in consultation with the student’s Research Advisory Committee (RAC). The plan requires the approval of all the RAC members and must be approved by the department head. To facilitate this process the department has recommended typical degree plans posted on the website. In some cases, the degree plan may deviate from the recommended plan with appropriate justification made by the student and the student’s faculty research adviser to the department head. The minimum requirement for the M.S. degree is 32 semester credit hours (SCH). The university requires a minimum of 30 SCH for the Master of Engineering degree, but the department has imposed additional requirements such that the minimum requirement for this degree is 36 SCH.

Individuals with an M.S. degree and pursuing a Ph.D. are required to complete an additional 64 SCH. However, a student with a B.S. degree may enter the Ph.D. program upon approval of the department’s Graduate Admissions Committee, but the requirements for their degree plan are 96 SCH.

1. Master of Science in Nuclear Engineering

For over 20 years, the department has offered individual M.S. degrees in Nuclear Engineering (NUEN) and Health Physics (HLPH). In the last 10 years, specializations were added in nuclear nonproliferation and nuclear materials. In addition, the core M.S. NUEN degree had become essentially a specialization in reactor engineering (with no radiation safety or radiation detection being taught). This has effectively led to the existence of four highly specialized M.S. options each with separate approved degree plans: reactor engineering, nuclear nonproliferation, nuclear materials, and health physics. These specialized M.S. options created two issues that were recognized by the NUEN faculty: (1) the specialization options do not contain a common core body of knowledge (making them relatively unbalanced) and (2) it could be challenging for individual courses to achieve a large enough enrollment to be offered, given the effectively separate degree programs and recent increases in minimum course enrollments. To resolve both of the issues, the NUEN faculty collectively developed a consolidated Master of Science in Nuclear Engineering (MSNE) degree plan that includes a set of common courses defining a core body of knowledge and allowing for multiple specialization options through overlapping elective options.
courses (i.e., each elective course will be used for more than one specialization option). The specialization options are reactor engineering, health physics, nuclear nonproliferation, nuclear materials, and computational radiation transport.

This consolidated MSNE degree program is designed to produce leaders in the development and application of technological solutions to problems involving nuclear and radiological materials and sources of radiation. The degree program has a set of common learning objectives as well as learning objectives specific to each specialization option. All graduates from this program should be able to:

1. apply engineering techniques to design and analyze systems and facilities that use nuclear and radiological materials and other sources of radiation,
2. synthesize and critically evaluate technical data from diverse sources to aid in solving nuclear science and engineering problems,
3. understand the importance of safety and security to the nuclear field,
4. perform quantitative measurements of nuclear and radiological materials,
5. apply science and engineering in a safe and secure manner that forwards the responsible development of nuclear technologies,
6. perform fundamental and applied research independently and in small multidisciplinary groups that can lead to the creation of new knowledge in the field of nuclear science and engineering, and
7. communicate technical issues to both professionals and non-professionals in an effective, coherent manner.

The faculty established that the following topics represent a core body of knowledge, which should be mastered by all Master of Science nuclear engineering graduates (regardless of specialization):

- Basic nuclear and atomic physics
- Interactions of radiation with matter
- Physics of nuclear reactions (including fission)
- Radiation detection
- Radiation safety and protection
- Radiation shielding
- Transport of radiation through matter
- Nuclear criticality
- Kinetics of nuclear systems
- Nuclear fuel cycles
- Fundamentals of materials to nuclear and radiological fields
- Fundamentals of heat transfer, fluid flow, and thermodynamics
- Nuclear safety
- Safeguards and security
- Regulations in the nuclear and radiological fields
- Statistics, linear algebra, and numerical methods
- Solution methods for ODE’s and PDE’s
- Uncertainty quantification
- Risk fundamentals and assessment
• Critical thinking and analysis
• Systems analysis
• Effective communication of technical material (including to non-tech audiences)
• Application of science and engineering to solve problems and make decisions under uncertainty
• Research fundamentals and the ability to work independently

The MSNE degree consists of a minimum of 32 credit hours of coursework including seven formal courses, two seminar courses, and approximately eight hours of research coursework. The faculty has reformulated the syllabi and topics in several courses and has established that this core body of knowledge can be effectively covered in the following courses (with the individual topics for these courses shown in the sub-bullets):

NUEN 601 Nuclear Reactor Theory (three-hour lecture course)

• Physics of nuclear fission, the nuclear chain reaction, and criticality
• Neutron cross sections, cross section energy dependence, and cross section processing
• Neutron transport and diffusion theory
• Diffusion theory applied to bare homogeneous reactors and reflected reactors, one-group solutions for bare and reflected homogeneous reactors
• Neutron slowing down and energy spectra
• Energy-dependent diffusion and the multigroup approximation to the diffusion equation, two-group solutions for bare and reflected homogeneous reactors
• Time-dependent diffusion solutions and kinetic behavior of reactor systems
• Buildup and depletion calculations, fission product poisoning
• Nuclear fuels and material performance under irradiation, heat, and stress
• Fundamentals of heat transfer, fluid flow, and thermodynamics
• Reactivity feedback
• Nuclear fuel cycles
• Assembly and full core neutronic design and analysis methods

NUEN 604 Radiation Interaction and Shielding (three-hour lecture course)

• Review of basic nuclear and atomic physics, radioactive decay, and radioactivity
• Sources of radiation (alpha, beta, x-rays)
• Sources of radiation (gamma, neutron)
• Interactions of gamma rays with matter and transport of gamma rays through matter
• Interactions of charged particles with matter and transport of charged particles through matter
• Interactions of neutrons with matter and neutron activation
• Radiation dose and dosimetry
• External exposure
• Internal exposure
• Radiation safety
• The shielding of radiation and buildup factors
• The point kernel method
• The Monte Carlo method for calculating dose through a shield
NUEN 611 Radiation Detection and Measurement (three-hour lecture, three-hour lab course)

- Counting statistics and propagation of variance
- Basic detector electronics, radiation dose and basic radiation safety
- Gas-filled detectors (ion chambers, proportional counters, and Geiger-Mueller detectors) and basic detector properties (efficiency, dead time, etc.)
- Gamma spectroscopy and scintillation detectors (NaI and LaBr)
- Semiconductor gamma-ray detectors (HPGe and silicon diode detectors)
- Alpha spectroscopy
- Neutron detection (He-3, BF3, and fission chambers)
- Cavity theory, dosimetry, calibration, and thermoluminescent detectors
- Dosimetry by pulse mode detection
- Uranium enrichment measurement
- Rutherford Backscattering Spectroscopy experiment
- Calorimetry
- Gamma coincidence counting

NUEN 606 Nuclear Engineering Experiments and Simulations (three-hour lecture, three-hour lab course)

- Model validation and uncertainty quantification
- Monte Carlo modeling (geometry, sources, tallies, and variance estimates)
- Dosimetry and shielding experiment
- Monte Carlo simulation of reactor systems to predict critical rod heights
- Subcritical multiplication and the I/M method to measure critical rod heights
- Simulations for predicting neutron energy spectra
- Foil activation and neutron spectrum unfolding
- Rod worth simulations
- Rod worth measurements and inverse reactivity
- Predicting fuel burnup and irradiated fuel isotopic content
- Irradiated fuel measurement for fission product inventory
- Radiation damage
- Nuclear materials lab

NUEN 681 Seminar (one-hour lecture course)

- Systems analysis
- Critical thinking and critical analysis
- Additional topics vary by semester

All M.S. students regardless of specialization will complete these five courses. In addition, the students will complete two elective courses and a capstone course. For the reactor engineering and nonproliferation students, a common capstone course will be used. The other specializations may make use of a common capstone or they may have an additional elective course.

By establishing this consolidated MSNE program, the faculty has effectively eliminated the separate M.S. in Health Physics and has established a well-balanced, broad-based nuclear engineering M.S. degree that still retains the flexibility to allow for student specialization.
2. Master of Engineering in Nuclear Engineering

Requirements for the Master of Engineering degree are similar to those above. The departmental requirement is that the student completes 36 SCH of courses. No thesis is required for this degree; however, the university rules do require a comprehensive final examination. Under university rules, this examination may be waived at the discretion of the faculty, based on extraordinary academic performance.

3. Ph.D. in Nuclear Engineering

A Ph.D. candidate, together with his/her graduate committee, must develop a degree plan that upon completion will demonstrate mastery of advanced knowledge and skills in the chosen area of emphasis. Typical degree requirements for the Ph.D. degree in nuclear engineering are shown below. A dissertation and a final oral examination are required.

<table>
<thead>
<tr>
<th>Table 1. Requirements for the Ph.D. degree plan (for students without Master’s degree)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>NUEN and Supporting Course Work[2] Strongly recommended: 15 graduate courses or more</td>
</tr>
<tr>
<td>Research (NUEN 691)[3] Number of credit hours determined by student’s graduate committee</td>
</tr>
<tr>
<td>Seminar (NUEN 681) Up to 4 hours</td>
</tr>
<tr>
<td>Total 96 hours</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 2. Requirements for the Ph.D. degree plan (for students with Master’s degree)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>NUEN[1] and Supporting Course Work[2] Strongly recommended: 8 graduate courses or more</td>
</tr>
<tr>
<td>Research (NUEN 691)[3] Number of credit hours determined by student’s graduate committee</td>
</tr>
<tr>
<td>Seminar (NUEN 681) Up to 4 hours</td>
</tr>
<tr>
<td>Total 64 hours</td>
</tr>
</tbody>
</table>

No undergraduate courses can be listed on a Ph.D. degree plan in Nuclear Engineering.

* For students who have passed the departmental Ph.D. Qualifying Examination and have been admitted to candidacy.

1 Chosen from NUEN graduate courses that were not included on the student’s master’s degree plan.

2 Chosen from graduate courses in other departments, usually in a science or engineering subject area.

3 The balance among NUEN courses, other courses, and NUEN 691 research hours is up to the student’s Graduate Committee.
There is no state-approved degree program in health physics at the doctoral level. Candidates for the Ph.D. degree with a specialization in health physics receive the Ph.D. degree in nuclear engineering.

The duration of programs and requirements are similar to those of the program’s peers. Student credit hours have been detailed earlier in this section as 32 credit hours (with seven being thesis research hours) for the MSNE and 45 credit hours of coursework plus additional research hours for the Ph.D. when the student has not already earned an M.S. degree. As will be seen in the Student Profile section, Ph.D. students typically take between four to five years to graduate and MSNE students require two to three years.

As a sample comparison against a peer program, from the North Carolina State University Department of Nuclear Engineering’s website for the MSNE program:

“The MS degree requirements include 15 credit hours of graduate courses in nuclear engineering, 9 credit hours in an interdisciplinary breadth area, and six credit hours of research, for a total requirement of 30 credit hours.” (http://www.ne.ncsu.edu/academics/#!ms)

For the Ph.D. program:

“The Ph.D. program typically contains 50 hours of graduate course credits, excluding research credits, and typically requires four to five years beyond the B.S. degree for completion, including dissertation.” (http://www.ne.ncsu.edu/academics/#!phd)

As a second comparison against a peer program, from Georgia Tech’s Nuclear & Radiological Engineering website, 30 credits, with 9 of those credits being for “thesis”, are required for the MSNE degree. For the Ph.D., 42 hours of coursework are required. (http://nremp.gatech.edu/academics/grad/nre/curriculum)

C. Admissions criteria (doctoral students)

Admission to all graduate programs at Texas A&M University is coordinated by the Office of Graduate Admissions in conjunction with the respective departments. Common requirements for admission are specified in the Texas A&M University Graduate Catalog and on the website. These requirements include:

- holding an accredited baccalaureate degree (of at least three years) from a college, institution or university of recognized standing, or its equivalent, guarantees consideration for admission;
- GRE, MAT or GMAT scores (evaluated in a manner which complies with Chapter 51, Subchapter W of the Texas Education Code, Admissions and Scholarship Policies for Graduate and Professional Programs, House Bill 1641);
- transcripts;
- GPA (grade point average) in the last 60 hours of course work;
- letters of recommendation;
- professional and/or academic experience;
- promise of ability to pursue advanced study and research satisfactorily;
- resume or curriculum vitae;
- adequate preparation to enter graduate school in the specific discipline or field of study; and
• Statement of Purpose essay.

All candidates for admission to the graduate program must submit a completed State of Texas Common Application. Applicants to the Department of Nuclear Engineering are evaluated by the Graduate Admissions Committee chaired by the graduate coordinator. This committee makes recommendations on students to be admitted and recommends the appropriate levels of financial support, etc. The committee has one member from each research group on its roster. This allows the faculty to determine the interests of applicants in order to recognize where they potentially fit with the department’s research activities.

The committee also evaluates the sufficiency of each applicant’s academic preparation by comparison of their transcript(s) to the appropriate undergraduate curriculum available in the department. If the applicant has not completed the equivalent of the department’s undergraduate curriculum, the Graduate Admissions Committee may recommend that when the applicant enrolls he/she be required to take specified undergraduate course(s) as remediation without credit on their degree plan.

Students who enter the department with a Master of Science degree may apply to move directly into the Ph.D. program.

Students wishing to pursue the Ph.D. degree in the Department of Nuclear Engineering must follow the procedure outlined below:

1. Establish credentials for entering the Ph.D. program via successful completion of the departmental Qualifying Examination (QE). The QE tests whether or not the student is qualified academically to enter the Ph.D. program. It represents one part of an evaluation by the faculty as a whole on the qualifications of each student to enter the program. Also included in the decision on whether to allow the student entry into the Ph.D. program are recommendations from the student’s M.S. committee on the independent research qualifications of the student; the student’s grades; etc. These all go into a package to the department head.

2. The student should complete the required Office of Graduate and Professional Studies form (called Letter of Intent) indicating the student desires to continue for the Ph.D. degree. This form should be submitted to the department head.

3. In addition, the student should solicit a letter from a faculty member willing to serve as the student’s adviser. The letter should indicate that the faculty member will serve as the adviser and the possible source of funding for the student. (It is recognized that the faculty member may not be able to guarantee support for a number of years. The letter should indicate that funding is available, funding to support the student is being sought, or that funding does not exist.)

4. The student should ensure that an evaluation form has been completed by each member of the M.S. research committee and submitted to the department head’s administrative assistant. Normally, it is the responsibility of the committee chair to ensure that these forms are completed and submitted at the end of the oral defense.

5. Once these materials have been submitted, the package will be submitted to department head.

6. The department head will use this information in making the decision to approve/deny the student’s request.
The Qualifying Examination is a departmental examination to help establish a student’s credentials for entering the Ph.D. program. It also serves as part of the examination required for the Ph.D. degree. It is in the student’s best interest to take the Qualifying Examination early in graduate school to help him/her decide whether or not to invest the considerable effort required to pursue a doctoral degree from the Department of Nuclear Engineering. Following successful completion of the Qualifying Examination plus completion of essentially all course work, the student takes the Preliminary Examination (see graduate catalog for details).

With the growing number of Ph.D. students and research groups, the department has modified the Ph.D. Qualifying Examination. This is addressed in more detail below. Given the breadth of research options, the format for the Qualifying Exam now provides a wider choice of topics that the student can choose for the exam. As before, a student must pass three sections of the exam, including a written portion on each section, and an oral exam subsequent to the written exam for any subject in which the faculty determine that the student’s performance on the written exam did not clearly demonstrate the level of expertise expected in a Ph.D. student. The goal of the new approach is to assure that the successful candidates are well prepared for their Ph.D. studies. The overall performance is reviewed and voted upon by the entire faculty.

The Preliminary Examination is administered solely by the doctoral student’s graduate committee in accordance with the policies stated in the graduate catalog.

The QE is a written exam and, in some cases, may include an oral exam. To pass the written exam, the student must pass the required section, Interactions, Measurement and Theory of Radiation, as well as select and pass two additional sections of their choice out of the remaining five sections. The first attempt for all three sections must occur during the same week.

The following six sections are available:

1. Interactions, Measurement and Theory of Radiation (required section)
2. Fission Engineering
3. Reactor Theory and Experimentation
4. Nuclear Materials Engineering
5. Theoretical Health Physics
6. Applied Health Physics

Those students who clearly pass the written exam are judged as qualified academically to enter the Ph.D. program. The faculty may convene an oral exam for any student whose written exam result is marginal.

Examinees must announce their intentions to take the written examination no later than by the end of the semester preceding the semester when examination is planned to occur. The examination period is three consecutive days, early in fall/spring semesters. The duration of each section is three hours.

Permitted number of attempts (excluding summers):

- two times in three semesters for students with M.S. degrees in nuclear engineering or
- two times in five semesters for students without M.S. degrees in nuclear engineering

Students are expected to pass all three sections on their first attempt. However, if this doesn’t happen a second chance will be given the next time the exams are offered, as described below:
If two of three sections are passed on the first attempt, the remaining section must be passed on second attempt. If only one section is passed on the first attempt, the entire examination must be repeated.

Written exam results are delivered within one month. Oral exam results are given within one month of the written exam results.

The exams are graded following the double blind anonymous grading procedure; students will not be identifiable by name in the grading process until the final stage of the exam results review process. Arbitrary alphabetic identifiers will be used during grading and evaluation. The connection between identifiers and students will be unknown to both students and faculty.

The purpose of the oral exam is to examine those students whose performance on the written exam is weak such that a clear “pass” or “fail” outcome is difficult to declare. Students who clearly pass or clearly fail the written portion will not be examined orally.

An oral assessment exam will be convened at the discretion of the faculty for cases where the student’s performance on the written exam is marginal. The examining committee will be seeking to evaluate the student’s understanding of the material from the written exam. Failure of the exam component being assessed is a viable option. The student will have the option to decline the oral assessment, thus opting to retake the exam at the next available opportunity (if eligible). However, failure of an oral exam does not preclude taking the exam again if the student remains eligible under the current eligibility policy.

Those students who clearly pass all written exams are well qualified for the Ph.D. track and the oral exam is not necessary.

D. Number of degrees awarded per year (most recent five years)

The table below shows the total number of degrees granted in the department for students in the given academic year. The department has been graduating a consistent number of doctoral students each year except for the 2012-2013 academic year when the department saw a large increase in the number of doctoral graduates.

As can be seen, the total number of degrees per year has fluctuated. However, the department is consistently awarding over 20 degrees per year. The graduation rates are relatively consistent with moderate growth and increase in the number of degrees is expected to continue due to the growth program and larger enrollment numbers the department has achieved in the last three years.
Table 3. Number of Earned Degrees by Academic Year

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ph.D. NUEN</td>
<td>8</td>
<td>7</td>
<td>5</td>
<td>6</td>
<td>18</td>
<td>8</td>
<td>52</td>
</tr>
<tr>
<td>M.S. NUEN</td>
<td>11</td>
<td>19</td>
<td>15</td>
<td>23</td>
<td>28</td>
<td>18</td>
<td>114</td>
</tr>
<tr>
<td>M.S. HLPH</td>
<td>2</td>
<td>7</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>24</td>
</tr>
<tr>
<td>Total Master’s</td>
<td>13</td>
<td>26</td>
<td>20</td>
<td>27</td>
<td>31</td>
<td>21</td>
<td>138</td>
</tr>
<tr>
<td>Overall Total</td>
<td>21</td>
<td>33</td>
<td>25</td>
<td>33</td>
<td>49</td>
<td>29</td>
<td>190</td>
</tr>
</tbody>
</table>

E. Average time to degree (most recent five years)

The table below shows the time to degree data breaking it down by fall semester term entered. The trending data in this table shows that doctoral students are graduating faster, however, this data may be skewed for the last few years, given that some of the students are still enrolled in the program. This data, though, is encouraging to the department and the faculty as it suggests that many students are graduating in a reasonable time of four to five years.

Table 4. Doctoral Graduation Data

<table>
<thead>
<tr>
<th>First Entered</th>
<th>Term</th>
<th>Number of Ph.D. Grads</th>
<th>Average Time to Graduation (Years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall 2004</td>
<td>7</td>
<td>5.09</td>
<td></td>
</tr>
<tr>
<td>Fall 2005</td>
<td>6</td>
<td>4.48</td>
<td></td>
</tr>
<tr>
<td>Fall 2006</td>
<td>8</td>
<td>3.96</td>
<td></td>
</tr>
<tr>
<td>Fall 2007</td>
<td>7</td>
<td>3.58</td>
<td></td>
</tr>
<tr>
<td>Fall 2008</td>
<td>7</td>
<td>3.56</td>
<td></td>
</tr>
<tr>
<td>Fall 2009</td>
<td>5</td>
<td>3.50</td>
<td></td>
</tr>
<tr>
<td>Grand Total</td>
<td>40</td>
<td>4.08</td>
<td></td>
</tr>
</tbody>
</table>

The table below represents master’s students’ time to degree data breaking it down by fall semester term entered. Currently, the data in this table shows that master’s students are graduating faster than those of previous years. However, not all of the students from these cohorts have graduated, thus skewing the data some and indicating that they are graduating faster with each passing semester. Other encouraging news is that most of the students are graduating within a reasonable time of two to two and one-half years.
Table 5. Master’s Graduation Data

<table>
<thead>
<tr>
<th>First Term Entered</th>
<th>Number of Master’s Grads</th>
<th>Average Time to Graduation (Years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall 2006</td>
<td>16</td>
<td>2.78</td>
</tr>
<tr>
<td>Fall 2007</td>
<td>12</td>
<td>2.81</td>
</tr>
<tr>
<td>Fall 2008</td>
<td>14</td>
<td>2.43</td>
</tr>
<tr>
<td>Fall 2009</td>
<td>23</td>
<td>2.31</td>
</tr>
<tr>
<td>Fall 2010</td>
<td>21</td>
<td>2.20</td>
</tr>
<tr>
<td>Fall 2011</td>
<td>15</td>
<td>1.74</td>
</tr>
<tr>
<td>Grand Total</td>
<td>101</td>
<td>2.37</td>
</tr>
</tbody>
</table>

F. Academic enhancements / high-impact opportunities for students

The graduate students have a wide range of professional development opportunities leading toward establishing their professional careers. Their professional life begins when students decide to join one of the faculty research groups. Through their participation in research projects, the students are given exposure to national research laboratories, industry, federal agencies and international organizations. Either integrated with research efforts or independently, professional internships are encouraged and facilitated by faculty mentors. Typical professional internships occur during summer months, however, once required courses completed, students have an opportunity to join industry or national labs for a year-round internships. Often, internship opportunities facilitate thesis and dissertation efforts and lead to post-graduation employment. Students are encouraged and provided with opportunities to join research organizations abroad to gain international experience. Nuclear Engineering graduate students join research groups in Europe, Russia, Japan, China and other foreign locations.

Lastly, tours are organized for the students of national and international facilities. Regular tours include nuclear power plants, national laboratories (Sandia National Laboratory and Oak Ridge National Laboratory), Waste Isolation Pilot Plant, enrichment facilities. Funded by Department of Energy and Department of Education, students have also visited nuclear facilities and organizations in Europe, Russia and Japan. The department continuously tries to develop new opportunities to facilitate international experiences for the students.

G. Assessment of student learning outcomes

Learning objectives and outcomes are documented in a university-wide assessment website known as Weave Online; (Appendix B). The assessment of master’s students’ learning outcomes is primarily carried out through examinations. In addition to tests in regular courses, all M.S. students are required to undergo a final exam with his/her committee.

Ph.D. students undergo a much more rigorous assessment process. The details are given in Chapter III, Section B.2. Generally speaking, a Ph.D. student’s assessment has the following components: (a) regular course assessments; (b) Ph.D. qualifying exam; (3) preliminary exam; (4) dissertation proposal; and (5) final exam (including dissertation defense).
The assessment of student learning outcomes is entered annually (in the summer of each year) through Weave Online. In addition, the Southern Association of Colleges and Schools Commission (SACS) and the Texas Higher Education Coordinating Board (THECB) assess the quality of Texas A&M University as a whole.

The department’s peer group is considered to be other public universities with nuclear engineering programs that are within the top ranking according to *U.S. News & World Report* rankings. These universities include, in alphabetical order:

- North Carolina State University
- University of California -Berkeley
- University of Michigan
- University of Tennessee
- University of Wisconsin -Madison

H. Analysis

It is the department’s belief that by providing a quality nuclear engineering education, advancing the engineering and science knowledge through graduate student research and serving the nuclear engineering profession through leadership, the Department is achieving its goals. The Nuclear Engineering Graduate Program supports the University mission and Vision 2020 objectives by providing a highly educated workforce, new knowledge and future leadership, which play an important role in the financial health of the state of Texas and the Nation.

*U.S. News and World Report* is the only source of nuclear engineering graduate program rankings that has been available for over ten years. The National Research Council (NRC) last ranked nuclear engineering graduate programs in 1995 and has defined nuclear engineering to be an “emerging field” in its 2006 Assessment of Research Doctorate Programs. The more recent 2011 study did not rank nuclear engineering programs either. Neither organization ranks health physics graduate programs.

The rankings of the Texas A&M University Nuclear Engineering graduate program reported by *U.S. News and World Report* for the past five years are given below.
Unfortunately, the *U.S. News and World Report* rankings are not based on a rigorous set of weighted metrics, such as student enrollment, number of faculty, faculty scholarship, research expenditures, or placement of graduates. The rankings are, in fact, based on a survey of nuclear engineering department chairs/heads (formerly of engineering college deans), which simply asks for opinions. Nevertheless, the rankings in the table show that the Texas A&M University Nuclear Engineering graduate program is highly regarded by its peers. In the most recent rankings, Texas A&M University Nuclear Engineering graduate program’s ranking has improved slightly over its peers.
IV. Faculty Profile

A. Core faculty

Core faculty are defined as full-time, tenured and tenure-track, with 50% or more doctoral instruction.

1. Number

The Department of Nuclear Engineering faculty is currently composed of 16 tenure-tenure track (TT) and seven non-TT positions. In 2011, Dr. Frederick Best retired and in 2014, Dr. William Marlow retired, bringing the number of core faculty to 16. Two additional tenure-tenure track positions at the Assistant Professor rank are scheduled to be added in fiscal year 2015 (FY15).

Abbreviated curriculum vitae for all faculty are provided in the supplemental materials.

2. Core faculty / student ratio

The Department currently has a core faculty-to-graduate student ratio of 10:1 and has historically maintained a core faculty-to-graduate student ratio of about 8:1. When the two open positions are filled in FY15, the ratio will decrease to 9:1.

<table>
<thead>
<tr>
<th>Table 7. Core Faculty to Graduate Enrollment Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year</td>
</tr>
<tr>
<td>------</td>
</tr>
<tr>
<td>2010</td>
</tr>
<tr>
<td>2011</td>
</tr>
<tr>
<td>2012</td>
</tr>
<tr>
<td>2013</td>
</tr>
<tr>
<td>2014</td>
</tr>
</tbody>
</table>

3. Publications (most recent five years)

The faculty in the Department of Nuclear Engineering are heavily active in scholarly research and publish their work in the top archival journals and at the premier scholarly conferences. The table below lists the publication data for the faculty for the past five years.

28
Table 8. Faculty Publications

<table>
<thead>
<tr>
<th>Year</th>
<th>Journal Articles</th>
<th>Conference Presentations</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>60</td>
<td>85</td>
</tr>
<tr>
<td>2011</td>
<td>52</td>
<td>63</td>
</tr>
<tr>
<td>2012</td>
<td>60</td>
<td>53</td>
</tr>
<tr>
<td>2013</td>
<td>62</td>
<td>73</td>
</tr>
<tr>
<td>2014</td>
<td>Not yet available</td>
<td></td>
</tr>
</tbody>
</table>

4. External grants (most recent five years)
The faculty in the Department of Nuclear Engineering believe that a well-funded research program is essential to the success of research programs and the department. Research expenditures have been around $18M per year for the last five years.

Table 9. Faculty Research Expenditures

<table>
<thead>
<tr>
<th>Fiscal Year</th>
<th>New Awards</th>
<th>Total Expenditures</th>
<th>Federal Expenditures</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>$17,451,832</td>
<td>$18,534,709</td>
<td>$14,854,731</td>
</tr>
<tr>
<td>2011</td>
<td>8,053,270</td>
<td>18,332,397</td>
<td>13,356,777</td>
</tr>
<tr>
<td>2012</td>
<td>15,352,571</td>
<td>17,393,664</td>
<td>7,906,193</td>
</tr>
<tr>
<td>2013</td>
<td>10,959,840</td>
<td>19,594,219</td>
<td>9,845,905</td>
</tr>
<tr>
<td>2014</td>
<td>6,066,653</td>
<td>17,353,102</td>
<td>8,125,311</td>
</tr>
</tbody>
</table>

5. Teaching load
All tenure-tenure track faculty members and several non-TT faculty members have teaching assignments in the department. The standard teaching load of the core faculty is three courses per year. New hires usually receive a one course reduction per year for the first two years. All tenure/tenure-track faculty have nine-month academic appointments with separate three-month research appointments in the summer.

B. Faculty other than core
1. Number
The department employs faculty in addition to core to assist in teaching and/or research missions. These include TEES Research Professors and Professors of Practice. Further, emeritus professors and otherwise retired faculty continue to contribute to the department.

• Professors of Practice: 2
• Lecturers: 2
• Emeritus Professors: 1
• Retired Professors: 1 (non-teaching)
• Visiting Professors: 2
• Research Professors: 2 (non-teaching)

2. Faculty / student ratio

Table 10. Faculty Other Than Core to Graduate Enrollment Ratio

<table>
<thead>
<tr>
<th>Year</th>
<th>Faculty other than core (teaching-engaged)</th>
<th>Graduate Enrollment (Ratio)</th>
<th>Graduate Ratio including Core</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>5</td>
<td>131 (1:26)</td>
<td>1:5</td>
</tr>
<tr>
<td>2011</td>
<td>5</td>
<td>134 (1:27)</td>
<td>1:5</td>
</tr>
<tr>
<td>2012</td>
<td>6</td>
<td>144 (1:24)</td>
<td>1:6</td>
</tr>
<tr>
<td>2013</td>
<td>6</td>
<td>147 (1:24)</td>
<td>1:6</td>
</tr>
<tr>
<td>2014</td>
<td>7</td>
<td>157 (1:22)</td>
<td>1:6</td>
</tr>
</tbody>
</table>

3. Publications
Publications by faculty other than core typically include core faculty and are included in the core faculty publications count.

4. External grants
Awards received by faculty other than core are included in the core faculty research funding totals.

5. Teaching load
Teaching loads for faculty other than core varies considerably. A full load is six courses per year. The other-than-core teaching-engaged faculty members have various percentages of appointment from 33% to 100%. The average is 50%. Teaching assignments for these faculty are made on an as-needed basis and their total level of effort is either adjusted to accommodate their teaching load or their level of effort is offset by research funding.

C. Faculty diversity
The following table shows the diversity of the core faculty by ethnicity and gender in fall 2013.
Table 11. Core Faculty Diversity

<table>
<thead>
<tr>
<th>Category</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>White Non-Hispanic</td>
<td>12</td>
<td>1</td>
</tr>
<tr>
<td>Black Non-Hispanic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hispanic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>American Indian, Alaskan</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Asian</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>International</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>15</td>
<td>1</td>
</tr>
</tbody>
</table>

The following table shows the diversity of the teaching-engaged faculty (other than core) by ethnicity and gender.

Table 12. Faculty Other Than Core Diversity

<table>
<thead>
<tr>
<th>Category</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>White Non-Hispanic</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Black Non-Hispanic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hispanic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>American Indian, Alaskan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asian</td>
<td></td>
<td></td>
</tr>
<tr>
<td>International</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>6</td>
<td>1</td>
</tr>
</tbody>
</table>

D. Faculty qualifications and recognitions

As specified previously, the Department of Nuclear Engineering faculty consist of core (tenure/tenure-track) faculty, teaching faculty (i.e., lecturers whose primary responsibility is teaching), and research faculty (whose primary responsibility is research and teach only on an as needed basis). Our current faculty are highly qualified and nationally recognized (as can be seen by their extensive curriculum vitae provided in the appendix). The core faculty are expected to all maintain some balance between teaching, research, and service activities for the department. Therefore, when hiring faculty candidates are sought who have demonstrated the potential for these areas including publishing in high-quality scholarly journals, ability to independently fund research activities, ability to communicate technical material before professional audiences, and a history of service to their organization beyond their own personal benefit. We look for
candidates who have been recognized by their employers and professional peers for the quality of their work and who are internally driven to succeed.

Table 13. Faculty Awards and Honors

<table>
<thead>
<tr>
<th>Faculty Member</th>
<th>Honors/Awards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marvin Adams</td>
<td>Texas A&amp;M Association of Former Students, Distinguished Service Award for Teaching, 2010</td>
</tr>
<tr>
<td></td>
<td>Texas A&amp;M, HTRI Endowed Professorship, 2008-present</td>
</tr>
<tr>
<td></td>
<td>Texas A&amp;M, George Armistead, Jr. ’23 Faculty Fellow, 2006</td>
</tr>
<tr>
<td></td>
<td>Texas A&amp;M, TEES Fellow, 2003</td>
</tr>
<tr>
<td></td>
<td>American Nuclear Society, Fellow, 2001</td>
</tr>
<tr>
<td></td>
<td>American Nuclear Society, Best Paper, Reactor Physics, 2001</td>
</tr>
<tr>
<td>William Charlton</td>
<td>Texas A&amp;M, Barbara and Ralph Cox ’53 Faculty Fellow for Outstanding Engineering Contributions, 2013</td>
</tr>
<tr>
<td></td>
<td>Special Service Award, Institute of Nuclear Materials Management, 2010</td>
</tr>
<tr>
<td></td>
<td>Texas A&amp;M, Advisor of the Year Award, Division of Student Affairs, 2009-2010</td>
</tr>
<tr>
<td></td>
<td>Texas A&amp;M, College of Engineering Faculty Fellow, 2007</td>
</tr>
<tr>
<td></td>
<td>Texas A&amp;M, George Armistead, Jr. ’23 Faculty Fellow, 2005-2006</td>
</tr>
<tr>
<td>John Ford</td>
<td>ARRO Educator of the Year Award, 2013</td>
</tr>
<tr>
<td></td>
<td>Registered Student Organization Advisor of the Year, 2008</td>
</tr>
<tr>
<td></td>
<td>BP Award for Teaching Excellence, 2007</td>
</tr>
<tr>
<td>Yassin Hassan</td>
<td>Fellow of American Association for the Advancement of Science</td>
</tr>
<tr>
<td></td>
<td>Fellow of the American Nuclear Society</td>
</tr>
<tr>
<td></td>
<td>Fellow of the American Society of Mechanical Engineers</td>
</tr>
<tr>
<td></td>
<td>American Nuclear Society Seaborg Medal, 2008</td>
</tr>
<tr>
<td></td>
<td>Best Paper at Thermal Hydraulic Session of Young Professionals, ANS Winter Meeting, (advisee Steve Fortenberry), Nov. 2008</td>
</tr>
<tr>
<td></td>
<td>Thermal Hydraulics Tech. Achievement Award, ANS, Significant Contributions in Thermal Hydraulics &amp; Reactor Safety, 2004</td>
</tr>
<tr>
<td></td>
<td>Arthur Holly Compton Award, 2003</td>
</tr>
<tr>
<td></td>
<td>Glenn Murphy Award of the Am. Assoc. for Eng. Education, 2001</td>
</tr>
<tr>
<td></td>
<td>Texas Engineering Experiment Station Senior Fellow, 1992</td>
</tr>
<tr>
<td></td>
<td>Texas Engineering Experiment Station Fellow, 1991</td>
</tr>
<tr>
<td></td>
<td>Texas Engineering Experiment Station Fellow, 1990</td>
</tr>
<tr>
<td>Faculty Member</td>
<td>Honors/Awards</td>
</tr>
<tr>
<td>---------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Certificate of Recognition from the French Nuclear Society for Managing as US Technical Chair, 9th International Conference on Nuclear Engineering (ICONE-9), April 2001</td>
<td></td>
</tr>
<tr>
<td>Certificate of Appreciation at ICONE-7, Tokyo, Japan, April 1999</td>
<td></td>
</tr>
<tr>
<td>Certificate of Appreciation at ICONE-6, May 1998</td>
<td></td>
</tr>
<tr>
<td>Cable Kurwitz</td>
<td>Excellent Undergraduate Student Research Advisor, Harbin Engineering University, China, 2014</td>
</tr>
<tr>
<td>Craig Marianno</td>
<td>Inducted into the Oregon State University Council of Outstanding Early Career Engineers, 2005</td>
</tr>
<tr>
<td>William Marlow</td>
<td>Japan Society for the Promotion of Science Fellow, Chemical Engineering Department, University of Hiroshima, Japan, 2000</td>
</tr>
<tr>
<td>Wenner Gren Visiting Professor of Solid State Physics, Ångstrom Lab. of Materials Science, Uppsala Univ., Uppsala, Sweden, 2000</td>
<td></td>
</tr>
<tr>
<td>Texas A&amp;M, Faculty Fellow of the College of Engineering, 1996</td>
<td></td>
</tr>
<tr>
<td>Ryan McClarren</td>
<td>Mathematics and Computation Best Paper/Presentation Award, American Nuclear Society Winter Meeting, 2012</td>
</tr>
<tr>
<td>Texas A&amp;M, Institute for Applied Mathematics and Computational Science Fellow, 2009-2011</td>
<td></td>
</tr>
<tr>
<td>Los Alamos Awards Program, Team Award Recipient, 2007</td>
<td></td>
</tr>
<tr>
<td>Department of Energy, National Undergraduate Research Fellow, 2002</td>
<td></td>
</tr>
<tr>
<td>Department of Energy, Energy Research Undergraduate Fellow, 2001</td>
<td></td>
</tr>
<tr>
<td>National Academy for Nuclear Training, Undergraduate Scholarship, 2000-2003</td>
<td></td>
</tr>
<tr>
<td>Sean McDeavitt</td>
<td>TEES Faculty Fellow, Texas A&amp;M Experiment Station, 2014</td>
</tr>
<tr>
<td>ANS, Materials Science and Technology Division, “2010 Significant Contribution Award”</td>
<td></td>
</tr>
<tr>
<td>Charles H. Barclay Jr. ’45 Faculty Fellow from Texas A&amp;M University College of Engineering, 2010</td>
<td></td>
</tr>
<tr>
<td>American Nuclear Society, Materials Science and Technology Division, “2002 Significant Contribution Award”</td>
<td></td>
</tr>
<tr>
<td>“Outstanding Mentor Award” from 2002 U.S Department of Energy education programs</td>
<td></td>
</tr>
<tr>
<td>Faculty Member</td>
<td>Honors/Awards</td>
</tr>
<tr>
<td>---------------</td>
<td>--------------</td>
</tr>
<tr>
<td></td>
<td>Argonne National Laboratory, “Critical Skills” Award, 2002</td>
</tr>
<tr>
<td></td>
<td>American Nuclear Society Literary Award (“Best Paper”)</td>
</tr>
<tr>
<td></td>
<td>from the ANS Materials Science and Technology Division, 1996</td>
</tr>
<tr>
<td></td>
<td>Argonne National Laboratory Pacesetter Award, 1995</td>
</tr>
<tr>
<td>Jim Morel</td>
<td>Fellow, American Nuclear Society, 2010</td>
</tr>
<tr>
<td></td>
<td>DOE Weapons Program Award of Excellence, 1994</td>
</tr>
<tr>
<td></td>
<td>LANL Distinguished Performance Award, 1992</td>
</tr>
<tr>
<td>Kenneth Peddicord</td>
<td>Fellow, American Nuclear Society</td>
</tr>
<tr>
<td>John Poston</td>
<td>Fellow, American Association for the Advancement of Science</td>
</tr>
<tr>
<td></td>
<td>Fellow, American Nuclear Society</td>
</tr>
<tr>
<td></td>
<td>Fellow, Health Physics Society</td>
</tr>
<tr>
<td></td>
<td>Professional Excellence Award, ANS Radiation Protection and Shielding Division, 2014</td>
</tr>
<tr>
<td>Jean Ragusa</td>
<td>TEES Faculty Fellow, Texas A&amp;M Engineering</td>
</tr>
<tr>
<td></td>
<td>Experiment Station (TEES), 2009</td>
</tr>
<tr>
<td></td>
<td>Excellence in Research Award, Department of Nuclear Engineering, Texas A&amp;M University, 2012</td>
</tr>
<tr>
<td>W. Daniel Reece</td>
<td>Concepts in Engineering (Holtzapple and Reece, 2004) won</td>
</tr>
<tr>
<td></td>
<td>McGraw-Hill’s Science, Eng. and Math. group's first edition of the year award</td>
</tr>
<tr>
<td></td>
<td>AFS Distinguished Teaching Award, 1997</td>
</tr>
<tr>
<td></td>
<td>Induction into Phi Kappa Phi. April, 1998</td>
</tr>
<tr>
<td></td>
<td>Sigma Xi, Induction to membership, 1992</td>
</tr>
<tr>
<td></td>
<td>ASEE- Best Session Paper Award, June 1991</td>
</tr>
<tr>
<td></td>
<td>TEES Fellow, 1991</td>
</tr>
<tr>
<td>Lin Shao</td>
<td>The BP Teaching Award, Texas A&amp;M, 2012</td>
</tr>
<tr>
<td></td>
<td>TEES Selected Young Faculty Award, Texas A&amp;M, 2011</td>
</tr>
<tr>
<td></td>
<td>NSF Career Award, US National Science Foundation, 2009</td>
</tr>
<tr>
<td></td>
<td>IBMM 2008 Prize (inaugural), Dresden, Germany, 2008</td>
</tr>
<tr>
<td>Pavel Tsvetkov</td>
<td>2008-2009 Caterpillar Teaching Excellence, Texas A&amp;M</td>
</tr>
<tr>
<td></td>
<td>Phi Kappa Phi, National Interdisciplinary Honor Society, 2004-present</td>
</tr>
<tr>
<td></td>
<td>Alpha Nu Sigma, National Nuclear Engineering Honor Society, 2001-present</td>
</tr>
</tbody>
</table>
### Faculty Member

<table>
<thead>
<tr>
<th>Honors/Awards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outstanding Reviewer, Elsevier, Nuclear Engineering &amp; Design, 2014</td>
</tr>
<tr>
<td>International Peer Reviewer Certificate, Shota Rustaveli National Science Foundation, 2013-2014</td>
</tr>
<tr>
<td>Karen Vierow</td>
</tr>
<tr>
<td>Texas Engineering Experiment Station (TEES) Select Young Faculty Award, 2007</td>
</tr>
<tr>
<td>Dwight Look College of Engineering Faculty Fellow, 2008</td>
</tr>
</tbody>
</table>

To participate in the graduate program, faculty must be admitted to the graduate faculty. This approval process adds an additional assurance of the qualifications of the faculty. Faculty members are admitted to the graduate faculty following review by the Office of Graduate and Professional Studies and approval by the Dean of Graduate Programs. As a member of the Graduate Faculty, one of the most important responsibilities of faculty members is to serve on graduate students’ Research Advisory Committees (RACs). Most faculty members serve as the chair of several students’ committees and as a member of many other students’ committees, both within the department and in other departments. The major roles of the RAC chair are to advise the student in preparation of his/her degree plan, to mentor the student’s preparation for admission to the Ph.D. program, to advise and to assist the student in determining his/her research topic, to provide financial support through a sponsored research project, to advise the student in conduct of his/her research, and to mentor the student’s preparation for preliminary and final examinations. The major roles of RAC committee members, including the chair, are to review and to approve the student’s degree plan, thesis or dissertation proposal, and thesis or dissertation and to examine the student during the preliminary and final examinations.

**E. Metrics**

The figure on the next page describes the self-defined metrics standards of measure for the department, which is approved by the Provost.
<table>
<thead>
<tr>
<th>Dwight Look Engineering</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Nuclear Engineering</td>
<td>Student evaluations mean score &gt;4.0</td>
<td>6 Graduate students enrolled/TTF</td>
<td>$250K/year in research expenditures and/or 5 funded graduate students/TTF/year</td>
</tr>
<tr>
<td></td>
<td>10% Undergraduate involvement in research</td>
<td>Meet or exceed national average for diversity in nuclear engineering</td>
<td>4 externally funded graduate students/TTF/year</td>
</tr>
<tr>
<td></td>
<td>&gt;90% domestic undergraduate students with &gt;20% female</td>
<td>100% Achievement of outcomes per ABET and SACS standards</td>
<td>Goal: Strengthen departmental national ranking</td>
</tr>
<tr>
<td></td>
<td>18 Undergraduates per TTF</td>
<td>Goal: Strengthen departmental national ranking</td>
<td>Goal: Strengthen departmental national ranking</td>
</tr>
<tr>
<td></td>
<td>75% Undergraduate graduation rate (U2 to graduation)</td>
<td>90% Graduate graduation rate</td>
<td>50% TTF serving on national technical committees</td>
</tr>
<tr>
<td></td>
<td>&gt;15 Graduate degrees/year</td>
<td>&gt;50 Graduate degrees/year</td>
<td>Goal: Strengthen departmental national ranking</td>
</tr>
<tr>
<td></td>
<td>Goal: Strengthen departmental national ranking</td>
<td>Goal: Strengthen departmental national ranking</td>
<td>100% TTF serving on department/college/university committees</td>
</tr>
<tr>
<td></td>
<td>20 Undergraduate students /TTF ratio (lower is better)</td>
<td>200 BS/50MS/20 MEN/20 PhD degrees awarded by level per year</td>
<td>$300K Research expenditures/TTF per year</td>
</tr>
<tr>
<td></td>
<td>20 Days of industry interaction/TTF per year</td>
<td>8 Editorships per year</td>
<td>25% National Academy of Engineers members</td>
</tr>
<tr>
<td></td>
<td>20 Goals: Strengthen national ranking</td>
<td>50% Professional society fellows for full professors</td>
<td>50% Participation in reviews of scholarly publications and research proposals</td>
</tr>
<tr>
<td></td>
<td>50% TTF serving on national technical committees</td>
<td>50% Participation in reviews of scholarly publications and research proposals</td>
<td>50% Participation in reviews of scholarly publications and research proposals</td>
</tr>
</tbody>
</table>

**Figure 2. Self-Defined Metrics Standards of Measure**
F. Analysis

Faculty members interact with students through the activities of student sections of the following four professional societies: the American Nuclear Society (ANS), the Health Physics Society (HPS), the Institute of Nuclear Materials Management (INMM), and Women in Nuclear (WIN). Each of these sections is advised by a tenured/tenure-track faculty member. Each of the sections meets several times each semester, and faculty members attend periodically. The meetings usually involve a speaker who enhances the students’ professional development. One of the most important professional development activities of the student sections is to sponsor students’ attendance at the national meetings of their respective professional societies. Numerous faculty members also attend these national meetings and thus enhance the students’ professional development by mentoring the students during the meeting and introducing the students to professionals in the field.

The faculty is engaged in a wide spectrum of service activities at the department, college, university, state, national, and international levels as illustrated by the curriculum vitae provided in the appendix. Most faculty members are affiliated with more than one professional society; some are a member of several. Nearly all faculty members have held or currently hold positions in their professional societies as officers, on national committees or on technical program committees. As shown by the curriculum vitae in the appendix, seven faculty members are fellows in their respective professional societies. The extent and level of influence of the faculty’s service activities is illustrated by the listing of noteworthy committees on which faculty members currently serve or have recently served and are provided in the curriculum vitae in the appendix.

Evaluating the faculty’s performance against the metrics in Figure 2 that pertain to the Graduate Program, the faculty are doing well overall. Conclusions for each Standard of Measure, as defined in the table, are summarized below.

- Teaching productivity metrics are mostly satisfied. The master’s student graduation rate is in some years below the goal of 90% (refer to Figure 17).
- Under Teaching Excellence, the amount of diversity within the faculty and the graduate students could be improved, although there is some diversity.
- On Research Productivity, all of the metrics are being met for the Departmental averages. Most faculty, but not every individual, meet or exceed the goals set. Having about 30% of the current faculty not involved in viable research is an area for improvement.
- For Research Excellence, all metrics are being met except for the goal of having 25% National Academy of Engineers members for full professors. Tables of the faculty publications (Table 8) verify this conclusion.
- Service Productivity and Excellence metrics are satisfied in large part. Areas for improvement are with respect to the amount of faculty involvement with industry and the number of editorships per year.
V. Student Profile

Graduate student enrollment has seen significant growth in the past five years:

![Graph showing student enrollment growth](image)

**Figure 3. Total M.S./Ph.D. Enrollment**

A. Doctoral students

1. Enrollment, including percentage of full-time students

In the Department of Nuclear Engineering, doctoral student enrollment has experienced significant growth over the last five years. Since the fall 2010 semester, the department has seen an astonishing 89.1% increase in enrollment numbers. The figures below show the history of this growth for the doctoral students and the percentage of the doctoral students enrolled full-time. The percentage of full-time enrollees has stayed relatively the same over the past five years although the department experienced tremendous growth during this period. The constant percentage is a desirable trend because it indicates that students are on-campus and pursuing their doctorate as a primary occupation, as opposed to off-campus students who are more likely to have longer times to graduation.
2. Student diversity / demographics
The department has made a concerted effort to increase the diversity profile within the program and has expanded its outreach efforts to help us in this regard. The figure below provides numbers with respect to race/ethnicity. There was a significant jump with the number of white students in the fall 2012 semester, but this growth can be contributed to the sudden rise in doctoral numbers.
As a side note, this fall 2012 increase in doctoral students is in part due to a change in which new doctoral students are classified upon enrollment. Until this semester, incoming graduate students who did not hold a previous M.S. degree were instructed to register as an M.S. student (G7) and transition to doctoral classification (G8) upon completion of the M.S. degree. With encouragement from the Dean’s office to increase the number of Ph.D. students, the department now instructs new students who do not hold an M.S. degree but have the intention to pursue a Ph.D. to register as a doctoral student upon matriculation into the Nuclear Engineering graduate program.

Also shown below is the breakdown of students into three categories: white, domestic under-represented and international students. This graph does well to show the percentage of growth within the domestic under-represented student base, which from the fall 2010 semester was at 8.7% and increased to 20.7% this fall 2014 semester. Also evident is the trend that the fraction of white students has remained mostly the same and the percentage of international students has diminished over the past five years. From these numbers, the department is encouraged by the progress and hopes that the continued outreach efforts will yield similar results.

Figure 6. Ph.D. Ethnicity/Race Enrollment
3. Retention rates

The data presented in the chart below represents the percentage of doctoral students who entered into the department in a given fall semester and were still enrolled two years later. This data is from the most recent five years.

![Figure 7. Ph.D. Domestic/International Enrollment](image)

4. Graduation rates

The data below shows the graduation rate of doctoral students, who have been graduating at a high percentage. The fall semesters of 2008 and 2009 are currently lower than the previous years.

![Figure 8. Ph.D. Retention Rate](image)
because of a few students who enrolled in these semesters remain enrolled in the doctoral program.

Figure 9. Ph.D. Graduation Rate

5. Average time to degree (most recent five years)

The table below does well to represent time to degree data breaking it down by fall semester term entered. The trending data in this table shows that doctoral students are graduating faster, however, this data may be skewed for the last few years, given that some of the students are still enrolled in the program. This data, though, is encouraging to the department and the faculty as it suggests that many students are graduating in a reasonable time of four to five years.

Table 14. Ph.D. Time to Graduation

<table>
<thead>
<tr>
<th>First Term Entered</th>
<th>Number of Ph.D. Grads</th>
<th>Average Time to Graduation (Years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall 2004</td>
<td>7</td>
<td>5.09</td>
</tr>
<tr>
<td>Fall 2005</td>
<td>6</td>
<td>4.48</td>
</tr>
<tr>
<td>Fall 2006</td>
<td>8</td>
<td>3.96</td>
</tr>
<tr>
<td>Fall 2007</td>
<td>7</td>
<td>3.58</td>
</tr>
<tr>
<td>Fall 2008</td>
<td>7</td>
<td>3.56</td>
</tr>
<tr>
<td>Fall 2009</td>
<td>5</td>
<td>3.50</td>
</tr>
<tr>
<td>Total</td>
<td>40</td>
<td>4.08</td>
</tr>
</tbody>
</table>
6. Average institutional financial support provided

The department has done very well in providing support to doctoral students as the dollars have continued to grow each year. The figure below shows a significant jump in financial support (stipends only) from the fall 2010 semester to fall 2011. This increase can be attributed to a change in the method of the payment of tuition and fees.

![Figure 10. Ph.D. Institutional Support](image)

7. Percentage of full-time students with institutional financial support

Despite the growth in the Ph.D. program, the department remains able to provide the overwhelming majority of the full-time doctoral students some form of financial support.

![Figure 11. Ph.D. Full-Time Support Percentage](image)
8. Student publications / presentations (most recent five years)

Students are encouraged to publish with their faculty members. The department has expectations of at least one archival journal publication for each Ph.D. student. M.S. students are expected to make at least one professional presentation and many of them also publish at least once refereed full conference paper or archival journal paper.

Table 15. Student Publications/Presentations

<table>
<thead>
<tr>
<th>Year</th>
<th>Journal Articles</th>
<th>Conference Presentations</th>
<th>Summaries/Abstracts</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>26</td>
<td>35</td>
<td>19</td>
</tr>
<tr>
<td>2011</td>
<td>20</td>
<td>31</td>
<td>20</td>
</tr>
<tr>
<td>2012</td>
<td>32</td>
<td>25</td>
<td>13</td>
</tr>
<tr>
<td>2013</td>
<td>42</td>
<td>39</td>
<td>16</td>
</tr>
<tr>
<td>2014</td>
<td>36</td>
<td>18</td>
<td>13</td>
</tr>
</tbody>
</table>

9. Employment profile (in field within one year of graduation; most recent five years)

Graduates from the department are employed at a diverse number of institutions including universities, national laboratories, industry, and government. The table below lists the post-graduation employment of nearly all of the recent graduates with a Ph.D. Nuclear Engineering degree.

Table 16. Post-Graduation Employment of Ph.D. Nuclear Engineering Graduates

<table>
<thead>
<tr>
<th>Full Name</th>
<th>Graduation</th>
<th>Degree</th>
<th>Employer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ahmad Al Rashdan</td>
<td>December 2014</td>
<td>Ph.D.</td>
<td></td>
</tr>
<tr>
<td>Di Chen</td>
<td>December 2014</td>
<td>Ph.D.</td>
<td></td>
</tr>
<tr>
<td>Marc Delchini</td>
<td>December 2014</td>
<td>Ph.D.</td>
<td></td>
</tr>
<tr>
<td>Royal Elmore</td>
<td>December 2014</td>
<td>Ph.D.</td>
<td>Los Alamos National Laboratory</td>
</tr>
<tr>
<td>Jesse Johns</td>
<td>December 2014</td>
<td>Ph.D.</td>
<td>Nimbus Innovations, LLC</td>
</tr>
<tr>
<td>Saya Lee</td>
<td>December 2014</td>
<td>Ph.D.</td>
<td>Post-Doc at Texas A&amp;M University</td>
</tr>
<tr>
<td>Grant Spence</td>
<td>December 2014</td>
<td>Ph.D.</td>
<td>Zel Technologies, Inc.</td>
</tr>
<tr>
<td>Jessica Feener</td>
<td>August 2014</td>
<td>Ph.D.</td>
<td>Defense Threat Reduction Agency</td>
</tr>
<tr>
<td>David Sweeney</td>
<td>August 2014</td>
<td>Ph.D.</td>
<td>University of California -Berekeley</td>
</tr>
<tr>
<td>Yunhuang Zhang</td>
<td>August 2014</td>
<td>Ph.D.</td>
<td>Post-Doc at Texas A&amp;M University</td>
</tr>
<tr>
<td>Full Name</td>
<td>Graduation</td>
<td>Degree</td>
<td>Employer</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>--------------</td>
<td>--------</td>
<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Damien Thomas Lebrun-Grandié</td>
<td>May 2014</td>
<td>Ph.D.</td>
<td>Oak Ridge National Lab</td>
</tr>
<tr>
<td>Megan Pritchard</td>
<td>May 2014</td>
<td>Ph.D.</td>
<td>Nuclear Safety Associates</td>
</tr>
<tr>
<td>Jarrod Edwards</td>
<td>December 2013</td>
<td>Ph.D.</td>
<td>Sandia National Laboratories</td>
</tr>
<tr>
<td>Zachary Kulage</td>
<td>December 2013</td>
<td>Ph.D.</td>
<td>Texas A&amp;M Engineering Extension Service (TEES)</td>
</tr>
<tr>
<td>Rodolfo Vaghetto</td>
<td>December 2013</td>
<td>Ph.D.</td>
<td>Research Engineer at Texas A&amp;M University</td>
</tr>
<tr>
<td>Sangjoon Ahn</td>
<td>August 2013</td>
<td>Ph.D.</td>
<td>Korea Atomic Energy Research Institute</td>
</tr>
<tr>
<td>Shaoyong Feng</td>
<td>August 2013</td>
<td>Ph.D.</td>
<td></td>
</tr>
<tr>
<td>Sandeep Irukuvarghula</td>
<td>August 2013</td>
<td>Ph.D.</td>
<td>Post-Doc at Texas A&amp;M University</td>
</tr>
<tr>
<td>Michael Martin</td>
<td>August 2013</td>
<td>Ph.D.</td>
<td>Shear Form Inc.</td>
</tr>
<tr>
<td>James Miller</td>
<td>August 2013</td>
<td>Ph.D.</td>
<td>National Nuclear Security Administration</td>
</tr>
<tr>
<td>Jeremy Northum</td>
<td>August 2013</td>
<td>Ph.D.</td>
<td>Facility for Rare Isotope Beams</td>
</tr>
<tr>
<td>Adam Parkison</td>
<td>August 2013</td>
<td>Ph.D.</td>
<td>Los Alamos National Laboratory</td>
</tr>
<tr>
<td>Hayes Stripling</td>
<td>August 2013</td>
<td>Ph.D.</td>
<td>ExxonMobil Upstream Research Company</td>
</tr>
<tr>
<td>Braden Goddard</td>
<td>May 2013</td>
<td>Ph.D.</td>
<td>Khalifa University of Science, Technology &amp; Research (KUSTAR)</td>
</tr>
<tr>
<td>Matthew Grypp</td>
<td>May 2013</td>
<td>Ph.D.</td>
<td>U.S. Department of Defense</td>
</tr>
<tr>
<td>Adam Hetzler</td>
<td>May 2013</td>
<td>Ph.D.</td>
<td>Sandia National Laboratories</td>
</tr>
<tr>
<td>Michael Myers</td>
<td>May 2013</td>
<td>Ph.D.</td>
<td>Intel Corporation</td>
</tr>
<tr>
<td>Angelo Frisani</td>
<td>December 2012</td>
<td>Ph.D.</td>
<td>AREVA</td>
</tr>
<tr>
<td>Christopher Myers</td>
<td>December 2012</td>
<td>Ph.D.</td>
<td>Y-12 National Security Complex</td>
</tr>
<tr>
<td>Tara Pandya</td>
<td>December 2012</td>
<td>Ph.D.</td>
<td>Oak Ridge National Lab</td>
</tr>
<tr>
<td>Matthew Sternat</td>
<td>December 2012</td>
<td>Ph.D.</td>
<td>Sandia National Laboratories</td>
</tr>
<tr>
<td>Bruno Turcksin</td>
<td>December 2012</td>
<td>Ph.D.</td>
<td>Post-Doc at Texas A&amp;M University</td>
</tr>
<tr>
<td>Hong-Chan Wei</td>
<td>December 2013</td>
<td>Ph.D.</td>
<td>GL Noble Denton</td>
</tr>
<tr>
<td>Luigi Capone</td>
<td>August 2012</td>
<td>Ph.D.</td>
<td></td>
</tr>
<tr>
<td>Fada Guan</td>
<td>May 2012</td>
<td>Ph.D.</td>
<td>MD Anderson Cancer Center</td>
</tr>
<tr>
<td>Haifeng Liu</td>
<td>May 2012</td>
<td>Ph.D.</td>
<td></td>
</tr>
<tr>
<td>Valentin Zingan</td>
<td>May 2012</td>
<td>Ph.D.</td>
<td>University of Alberta</td>
</tr>
<tr>
<td>Richard Metcalf</td>
<td>December 2011</td>
<td>Ph.D.</td>
<td>Idaho National Laboratory</td>
</tr>
<tr>
<td>Bradley Cox</td>
<td>August 2011</td>
<td>Ph.D.</td>
<td>Oak Ridge National Lab</td>
</tr>
<tr>
<td>Adrienne Lafleur</td>
<td>August 2011</td>
<td>Ph.D.</td>
<td>Los Alamos National Laboratory</td>
</tr>
<tr>
<td>Joshua Jarrell</td>
<td>December 2010</td>
<td>Ph.D.</td>
<td>Oak Ridge National Lab</td>
</tr>
<tr>
<td>Shin Kyu Kang</td>
<td>December 2010</td>
<td>Ph.D.</td>
<td>Post-Doc at Texas A&amp;M University</td>
</tr>
<tr>
<td>Zeyun Wu</td>
<td>December 2010</td>
<td>Ph.D.</td>
<td>Post-Doc at North Carolina State University</td>
</tr>
<tr>
<td>Full Name</td>
<td>Graduation</td>
<td>Degree</td>
<td>Employer</td>
</tr>
<tr>
<td>-------------------</td>
<td>------------</td>
<td>--------</td>
<td>-----------------------------------------</td>
</tr>
<tr>
<td>David Ames</td>
<td>August 2010</td>
<td>Ph.D.</td>
<td>Sandia National Laboratories</td>
</tr>
<tr>
<td>Jun Geng</td>
<td>August 2010</td>
<td>Ph.D.</td>
<td>Louisiana State University</td>
</tr>
<tr>
<td>Tom Lewis</td>
<td>August 2010</td>
<td>Ph.D.</td>
<td>Sandia National Laboratories</td>
</tr>
<tr>
<td>Vijay Mahadevan</td>
<td>August 2010</td>
<td>Ph.D.</td>
<td>Argonne National Laboratory</td>
</tr>
<tr>
<td>Ayodeji Alajo</td>
<td>May 2010</td>
<td>Ph.D.</td>
<td>Missouri University of Science and Technology</td>
</tr>
<tr>
<td>Karen Miller</td>
<td>May 2010</td>
<td>Ph.D.</td>
<td>Los Alamos National Laboratory</td>
</tr>
<tr>
<td>Andrew Goldman</td>
<td>December 2009</td>
<td>Ph.D.</td>
<td>Sandia National Laboratories</td>
</tr>
</tbody>
</table>

Many of the nuclear engineering Ph.D. graduates start their professional careers in academia, with postdoctoral or faculty positions, or at national laboratories, as seen in the figure above. The laboratory connections are often made during the course of their Ph.D. research years. The most common avenue for M.S. students is that of continued studies within the Ph.D. program. The second most frequently observed path is with either industry or private employers, as seen in the figure below.
B. All other students
This section addresses all graduate students, excluding Ph.D. students

1. Student diversity / demographics
The largest enrollment increase was seen with Hispanics, while all other underrepresented groups experienced some modest gains. The figure below shows the percentage of students within the three different categories: White, Domestic Underrepresented, and International students. The percentage of white students has remained relatively the same hovering around the 60% benchmark. This graph also shows that the domestic underrepresented group has increased about seven percent over the last five years and international student enrollment has decreased about 10%.
2. Retention Rates

The department has been successful in guiding the majority of the master’s students to graduation. The figure below shows the percentage to be in the mid to high eighties. Retention is defined as the return of a master’s student for the following year. This past year, the number was lower due to a few students who were pursuing health physics degrees (M.S. HLPH and Ph.D. HP option) deciding to no longer pursue a degree after learning of the discontinuation of the
health physics program. Overall, the program has done well to retain students and expects the progress to continue.

![Figure 16. Master’s Retention Rate](image1)

Shown below are the graduation rates for students who enter in the fall semesters. The numbers for the last two years are lower than they should be due to some students from those cohorts still working on their master’s degrees.

![Figure 17. Master’s Graduation Rate](image2)

3. Graduation Rates

Shown below are the numbers of degrees awarded by the department in the past six academic years. As can be seen, the total number of degrees per year has fluctuated. However, the
department is consistently awarding over 20 degrees per year. The graduation rates are relatively consistent with moderate growth and the number of degrees is expected to increase due to the larger enrollment numbers the department has achieved the last three years.

Table 17. Degrees Awarded

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>M.S. NUEN</td>
<td>11</td>
<td>19</td>
<td>15</td>
<td>23</td>
<td>28</td>
<td>18</td>
<td>114</td>
</tr>
<tr>
<td>M.S. HLPH</td>
<td>2</td>
<td>7</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>24</td>
</tr>
<tr>
<td>Totals</td>
<td>13</td>
<td>26</td>
<td>20</td>
<td>27</td>
<td>31</td>
<td>21</td>
<td>138</td>
</tr>
</tbody>
</table>

The table below represents master’s students’ time to degree data and breaking it down by fall semester term entered. Currently, the data in this table shows that master’s students are graduating faster than those of previous years. However, not all of the students from these cohorts have graduated, thus skewing the data some and indicating that they are graduating faster with each passing semester. The encouraging news is that most of the students are graduating within a reasonable time of two to two and one-half years.

Table 18. Time to Degree

<table>
<thead>
<tr>
<th>First Entered</th>
<th>Term Entered</th>
<th>Number of Master's Grads</th>
<th>Average Time to Graduation (Years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall 2006</td>
<td></td>
<td>16</td>
<td>2.78</td>
</tr>
<tr>
<td>Fall 2007</td>
<td></td>
<td>12</td>
<td>2.81</td>
</tr>
<tr>
<td>Fall 2008</td>
<td></td>
<td>14</td>
<td>2.43</td>
</tr>
<tr>
<td>Fall 2009</td>
<td></td>
<td>23</td>
<td>2.31</td>
</tr>
<tr>
<td>Fall 2010</td>
<td></td>
<td>21</td>
<td>2.20</td>
</tr>
<tr>
<td>Fall 2011</td>
<td></td>
<td>15</td>
<td>1.74</td>
</tr>
<tr>
<td>Grand Total</td>
<td></td>
<td>101</td>
<td>2.37</td>
</tr>
</tbody>
</table>

C. Graduate placement / employment

Graduates from the department are employed at a diverse number of institutions including universities, national laboratories, industry, and government. The list below shows the post-graduation employment of nearly all of the recent graduates from the nuclear engineering and health physics master’s graduate programs, respectively. As can be seen, a significant fraction of
the master’s level graduates continue on for a Ph.D.; however, many also leave the program and enter into employment at national laboratories or in industry.

**Table 19. Post-Graduation Employment of Master’s Nuclear Engineering Graduates**

<table>
<thead>
<tr>
<th>Full Name</th>
<th>Graduation</th>
<th>Degree</th>
<th>Major</th>
<th>Employer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chia-Ying Chang</td>
<td>December 2014</td>
<td>M.Eng.</td>
<td>NUEN</td>
<td></td>
</tr>
<tr>
<td>Chase Gilmore</td>
<td>December 2014</td>
<td>M.Eng.</td>
<td>NUEN</td>
<td>South Texas Power Nuclear Operating Company</td>
</tr>
<tr>
<td>Tariq Yaqoob Sayed Alhashimi</td>
<td>December 2014</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Emirates Nuclear Energy Corporation</td>
</tr>
<tr>
<td>Christopher Chance</td>
<td>December 2014</td>
<td>M.S.</td>
<td>NUEN</td>
<td></td>
</tr>
<tr>
<td>William Cook</td>
<td>December 2014</td>
<td>M.S.</td>
<td>NUEN</td>
<td></td>
</tr>
<tr>
<td>Daniel Galicki</td>
<td>December 2014</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Pursuing Ph.D., University of Tennessee - Knoxville</td>
</tr>
<tr>
<td>Daniel Holladay</td>
<td>December 2014</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Pursuing Ph.D., Texas A&amp;M University</td>
</tr>
<tr>
<td>Jijie Lou</td>
<td>December 2014</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Pursuing Ph.D., Texas A&amp;M University</td>
</tr>
<tr>
<td>Connor Woolum</td>
<td>December 2014</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Idaho National Laboratory</td>
</tr>
<tr>
<td>Alice Dale</td>
<td>August 2014</td>
<td>M.S.</td>
<td>HLPH</td>
<td>The University of Kansas</td>
</tr>
<tr>
<td>Nischal Kafle</td>
<td>August 2014</td>
<td>M.S.</td>
<td>NUEN</td>
<td></td>
</tr>
<tr>
<td>Trevor Lancon</td>
<td>August 2014</td>
<td>M.S.</td>
<td>HLPH</td>
<td>FEI Company</td>
</tr>
<tr>
<td>Jeremy Osborn</td>
<td>August 2014</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Pursuing Ph.D., Texas A&amp;M University</td>
</tr>
<tr>
<td>Micheal Smith</td>
<td>August 2014</td>
<td>M.S.</td>
<td>HLPH</td>
<td>Nuclear Regulatory Commission</td>
</tr>
<tr>
<td>Merinda Volia</td>
<td>August 2014</td>
<td>M.S.</td>
<td>HLPH</td>
<td>Pursuing Ph.D., Texas A&amp;M University</td>
</tr>
<tr>
<td>Paul Ward</td>
<td>August 2014</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Argonne National Laboratory</td>
</tr>
<tr>
<td>Ethan Windsor</td>
<td>August 2014</td>
<td>M.S.</td>
<td>NUEN</td>
<td></td>
</tr>
<tr>
<td>Suhaeb Abdulsattar</td>
<td>May 2014</td>
<td>M.S.</td>
<td>NUEN</td>
<td></td>
</tr>
<tr>
<td>Jeffrey Clemens</td>
<td>May 2014</td>
<td>M.S.</td>
<td>NUEN</td>
<td>DNV-GL</td>
</tr>
<tr>
<td>Taylor Coles</td>
<td>May 2014</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Entergy</td>
</tr>
<tr>
<td>Chad Garcia</td>
<td>May 2014</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Pursuing Ph.D., University of Wisconsin</td>
</tr>
<tr>
<td>Jon Hansen</td>
<td>May 2014</td>
<td>M.S.</td>
<td>NUEN</td>
<td></td>
</tr>
<tr>
<td>Benjamin Larsen</td>
<td>May 2014</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Nuclear Waste Partnership</td>
</tr>
<tr>
<td>Dean Mathis</td>
<td>May 2014</td>
<td>M.S.</td>
<td>NUEN</td>
<td>US Army</td>
</tr>
<tr>
<td>Jacob Peterson</td>
<td>May 2014</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Pursuing Ph.D., Texas A&amp;M University</td>
</tr>
<tr>
<td>Andrew Till</td>
<td>May 2014</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Pursuing Ph.D., Texas A&amp;M University</td>
</tr>
<tr>
<td>Abdulla Al Kathiri</td>
<td>December 2013</td>
<td>M.Eng.</td>
<td>NUEN</td>
<td>Emirates Nuclear Energy Corporation</td>
</tr>
<tr>
<td>Full Name</td>
<td>Graduation</td>
<td>Degree</td>
<td>Major</td>
<td>Employer</td>
</tr>
<tr>
<td>-------------------</td>
<td>------------</td>
<td>--------</td>
<td>-------</td>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td>Abdulla Al Nuaimi</td>
<td>December 2013</td>
<td>M.Eng.</td>
<td>NUEN</td>
<td>Emirates Nuclear Energy Corporation</td>
</tr>
<tr>
<td>Jinyong Feng</td>
<td>December 2013</td>
<td>M.Eng.</td>
<td>NUEN</td>
<td>Pursuing Ph.D., North Carolina State University</td>
</tr>
<tr>
<td>Kristina Yancey</td>
<td>December 2013</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Pursuing Ph.D., Texas A&amp;M University</td>
</tr>
<tr>
<td>Weixiong Zheng</td>
<td>December 2013</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Pursuing Ph.D., Texas A&amp;M University</td>
</tr>
<tr>
<td>Brian Barnhart</td>
<td>August 2013</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Global Nuclear Fuel/GE Hitachi Nuclear Energy</td>
</tr>
<tr>
<td>Tianyi Chen</td>
<td>August 2013</td>
<td>M.S.</td>
<td>NUEN</td>
<td></td>
</tr>
<tr>
<td>Kevin Dugan</td>
<td>August 2013</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Universite de Paris Sud XI</td>
</tr>
<tr>
<td>Daniel Eichel</td>
<td>August 2013</td>
<td>M.S.</td>
<td>NUEN</td>
<td></td>
</tr>
<tr>
<td>Annabelle Le Coq</td>
<td>August 2013</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Areva</td>
</tr>
<tr>
<td>Jonathan Madsen</td>
<td>August 2013</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Pursuing Ph.D., Texas A&amp;M University</td>
</tr>
<tr>
<td>Scott Stewart</td>
<td>August 2013</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Oak Ridge National Lab</td>
</tr>
<tr>
<td>Huali Wu</td>
<td>August 2013</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Pursuing Ph.D. – University of Wisconsin – Madison</td>
</tr>
<tr>
<td>Jennifer Erchinger</td>
<td>May 2013</td>
<td>M.S.</td>
<td>HLPH</td>
<td>Pacific Northwest National Laboratory</td>
</tr>
<tr>
<td>Jordan Evans</td>
<td>May 2013</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Pursuing Ph.D., Texas A&amp;M University</td>
</tr>
<tr>
<td>Michael Hackemack</td>
<td>May 2013</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Pursuing Ph.D., Texas A&amp;M University</td>
</tr>
<tr>
<td>Joshua Hansel</td>
<td>May 2013</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Pursuing Ph.D., Texas A&amp;M University</td>
</tr>
<tr>
<td>Matthew Johnson</td>
<td>May 2013</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Bechtel Marine Propulsion Corporation</td>
</tr>
<tr>
<td>Ryan Kelly</td>
<td>May 2013</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Pursuing Ph.D., Texas A&amp;M University</td>
</tr>
<tr>
<td>Alexandra Khudoleeva</td>
<td>May 2013</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Booz Allen Hamilton</td>
</tr>
<tr>
<td>Akansha Kumar</td>
<td>May 2013</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Pursuing Ph.D., Texas A&amp;M University</td>
</tr>
<tr>
<td>Sergiy Manolov</td>
<td>May 2013</td>
<td>M.S.</td>
<td>NUEN</td>
<td></td>
</tr>
<tr>
<td>Eowyn Pedicini</td>
<td>May 2013</td>
<td>M.S.</td>
<td>NUEN</td>
<td>U.S. Navy</td>
</tr>
<tr>
<td>James Uhlemeyer</td>
<td>May 2013</td>
<td>M.S.</td>
<td>HLPH</td>
<td>Pursuing Ph.D., Texas A&amp;M University</td>
</tr>
<tr>
<td>Bradley Beeny</td>
<td>December 2012</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Pursuing Ph.D., Texas A&amp;M University</td>
</tr>
<tr>
<td>Yuan Di</td>
<td>December 2012</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Pursuing Ph.D., Texas A&amp;M University</td>
</tr>
<tr>
<td>Matthew Fitzmaurice</td>
<td>December 2012</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Pursuing Ph.D., Texas A&amp;M University</td>
</tr>
<tr>
<td>Evans Kitcher</td>
<td>December 2012</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Pursuing Ph.D., Texas A&amp;M University</td>
</tr>
<tr>
<td>Michael Leimon</td>
<td>December 2012</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Numerical Applications</td>
</tr>
<tr>
<td>Patrick McDermott</td>
<td>December 2012</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Bechtel Marine Propulsion Corporation (KAPL)</td>
</tr>
<tr>
<td>Jeremy Rogers</td>
<td>December 2012</td>
<td>M.S.</td>
<td>HLPH</td>
<td>Remote Sensing Laboratory</td>
</tr>
<tr>
<td>Joshua Smith</td>
<td>December 2012</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Duke Energy</td>
</tr>
<tr>
<td>Full Name</td>
<td>Graduation</td>
<td>Degree</td>
<td>Major</td>
<td>Employer</td>
</tr>
<tr>
<td>---------------------------</td>
<td>------------</td>
<td>--------</td>
<td>----------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>Matthew Solom</td>
<td>December 2012</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Pursuing Ph.D., Texas A&amp;M University</td>
</tr>
<tr>
<td>Chad Thompson</td>
<td>December 2012</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Duke Energy</td>
</tr>
<tr>
<td>Huhu Wang</td>
<td>December 2012</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Pursuing Ph.D., Texas A&amp;M University</td>
</tr>
<tr>
<td>Bradley Appel</td>
<td>August 2012</td>
<td>M.S.</td>
<td>NUEN</td>
<td>SpaceX</td>
</tr>
<tr>
<td>Marie Arrieta</td>
<td>August 2012</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Pursuing Ph.D., Texas A&amp;M University</td>
</tr>
<tr>
<td>Nandan Chandregowda</td>
<td>August 2012</td>
<td>M.S.</td>
<td>NUEN</td>
<td>PDPU</td>
</tr>
<tr>
<td>Di Chen</td>
<td>August 2012</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Pursuing Ph.D., Texas A&amp;M University</td>
</tr>
<tr>
<td>Curtis Conchewski</td>
<td>August 2012</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Defense Intelligence Agency</td>
</tr>
<tr>
<td>Wes Cullum</td>
<td>August 2012</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Southern Company</td>
</tr>
<tr>
<td>Alison Goodsell</td>
<td>August 2012</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Los Alamos National Laboratory</td>
</tr>
<tr>
<td>Gentry Hearn</td>
<td>August 2012</td>
<td>M.S.</td>
<td>HLPH</td>
<td>Texas Department of State Health Services</td>
</tr>
<tr>
<td>Joe Justina</td>
<td>August 2012</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Altran Technologies</td>
</tr>
<tr>
<td>Abdul Khan</td>
<td>August 2012</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Pursuing Ph.D. – Tokyo Institute of Technology</td>
</tr>
<tr>
<td>Samuel Kuhr</td>
<td>August 2012</td>
<td>M.S.</td>
<td>NUEN</td>
<td>US Navy</td>
</tr>
<tr>
<td>Thomas Martin</td>
<td>August 2012</td>
<td>M.S.</td>
<td>NUEN</td>
<td></td>
</tr>
<tr>
<td>Marie-Hermine Cuvelier</td>
<td>May 2012</td>
<td>M.S.</td>
<td>NUEN</td>
<td></td>
</tr>
<tr>
<td>Donald Bruss</td>
<td>May 2012</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Pursuing Ph.D., Texas A&amp;M University</td>
</tr>
<tr>
<td>Laura Holewa</td>
<td>May 2012</td>
<td>M.S.</td>
<td>NUEN</td>
<td>RadiaBeam Technologies</td>
</tr>
<tr>
<td>Carissa Humrickhouse</td>
<td>May 2012</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Epic</td>
</tr>
<tr>
<td>Sathish Lakshmipathy</td>
<td>May 2012</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Lattice Engines</td>
</tr>
<tr>
<td>Dapeng Lao</td>
<td>May 2012</td>
<td>M.S.</td>
<td>HLPH</td>
<td></td>
</tr>
<tr>
<td>Vishal Patel</td>
<td>May 2012</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Pursuing Ph.D., Texas A&amp;M University</td>
</tr>
<tr>
<td>Stephen Revis</td>
<td>May 2012</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Knolls Atomic Power Laboratory</td>
</tr>
<tr>
<td>Paul Rodi</td>
<td>May 2012</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Southern Company</td>
</tr>
<tr>
<td>Cheyn Worn</td>
<td>May 2012</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Airdyne Inc</td>
</tr>
<tr>
<td>Ruoming Bi</td>
<td>December 2011</td>
<td>M.S.</td>
<td>HLPH</td>
<td></td>
</tr>
<tr>
<td>John Creasy</td>
<td>December 2011</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Y-12 National Security Complex</td>
</tr>
<tr>
<td>Jeffrey Hausaman</td>
<td>December 2011</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Entergy</td>
</tr>
<tr>
<td>Nathaniel Fredette</td>
<td>December 2011</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Knolls Atomic Power Laboratory</td>
</tr>
<tr>
<td>Dongyoul Lee</td>
<td>December 2011</td>
<td>M.S.</td>
<td>NUEN</td>
<td></td>
</tr>
<tr>
<td>Grant Spence</td>
<td>December 2011</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Zel Technologies, Inc.</td>
</tr>
<tr>
<td>Full Name</td>
<td>Graduation</td>
<td>Degree</td>
<td>Major</td>
<td>Employer</td>
</tr>
<tr>
<td>---------------------------</td>
<td>------------</td>
<td>--------</td>
<td>-------</td>
<td>-----------------------------------------</td>
</tr>
<tr>
<td>Viharkumar Bhakta</td>
<td>August 2011</td>
<td>M.S.</td>
<td>HLPH</td>
<td>University of Houston</td>
</tr>
<tr>
<td>Michael Butkus</td>
<td>August 2011</td>
<td>M.S.</td>
<td>HLPH</td>
<td>Pursuing Ph.D., Oregon State University</td>
</tr>
<tr>
<td>Lillian Marie Cronholm</td>
<td>August 2011</td>
<td>M.S.</td>
<td>HLPH</td>
<td></td>
</tr>
<tr>
<td>Alex Chambers</td>
<td>August 2011</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Bechtel Marine Propulsion Corporation</td>
</tr>
<tr>
<td>Di Chen</td>
<td>August 2011</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Pursuing Ph.D., Texas A&amp;M University</td>
</tr>
<tr>
<td>Andrew Dercher</td>
<td>August 2011</td>
<td>M.S.</td>
<td>NUEN</td>
<td>ERIN Engineering</td>
</tr>
<tr>
<td>Roushan Ghanbari</td>
<td>August 2011</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Sandia National Laboratories</td>
</tr>
<tr>
<td>Ernest Gitau</td>
<td>August 2011</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Pacific Northwest National Laboratory</td>
</tr>
<tr>
<td>Donghoon Kim</td>
<td>August 2011</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Pursuing Ph.D., Texas A&amp;M University</td>
</tr>
<tr>
<td>Jingjie Zhou</td>
<td>May 2011</td>
<td>M.S.</td>
<td>HLPH</td>
<td>United Imaging Healthcare</td>
</tr>
<tr>
<td>Anthony Barbu</td>
<td>May 2011</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Pursuing Ph.D., Texas A&amp;M University</td>
</tr>
<tr>
<td>Michael Mella</td>
<td>May 2011</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Entergy Nuclear</td>
</tr>
<tr>
<td>Christopher Ryan</td>
<td>May 2011</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Lawrence Livermore National Lab</td>
</tr>
<tr>
<td>Rodolfo Vaghetto</td>
<td>May 2011</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Pursuing Ph.D., Texas A&amp;M University</td>
</tr>
<tr>
<td>Keel Curtis</td>
<td>December 2010</td>
<td>M.S.</td>
<td>HLPH</td>
<td>State of Texas Department of State Health Service</td>
</tr>
<tr>
<td>Grant Helmreich</td>
<td>December 2010</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Pursuing Ph.D., Texas A&amp;M University</td>
</tr>
<tr>
<td>Thomas Hogelin</td>
<td>December 2010</td>
<td>M.S.</td>
<td>NUEN</td>
<td></td>
</tr>
<tr>
<td>Grant Hundley</td>
<td>December 2010</td>
<td>M.S.</td>
<td>NUEN</td>
<td>US Marine Corp.</td>
</tr>
<tr>
<td>Peter Maginot</td>
<td>December 2010</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Pursuing Ph.D., Texas A&amp;M University</td>
</tr>
<tr>
<td>Hayes Stripling</td>
<td>December 2010</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Pursuing Ph.D., Texas A&amp;M University</td>
</tr>
<tr>
<td>Gary Chen</td>
<td>August 2010</td>
<td>M.S.</td>
<td>HLPH</td>
<td>Naval Research Laboratory</td>
</tr>
<tr>
<td>Shaoyong Feng</td>
<td>August 2010</td>
<td>M.S.</td>
<td>HLPH</td>
<td>Pursuing Ph.D., Texas A&amp;M University</td>
</tr>
<tr>
<td>David Wagoner</td>
<td>August 2010</td>
<td>M.S.</td>
<td>HLPH</td>
<td>Pursuing Ph.D., Francis Marion University</td>
</tr>
<tr>
<td>Changwoo Kang</td>
<td>August 2010</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Korean Military</td>
</tr>
<tr>
<td>Michael Naramore</td>
<td>August 2010</td>
<td>M.S.</td>
<td>NUEN</td>
<td>GE Hitachi</td>
</tr>
<tr>
<td>Adam Redwine</td>
<td>August 2010</td>
<td>M.S.</td>
<td>NUEN</td>
<td>The Shaw Group Incorporated</td>
</tr>
<tr>
<td>Alissa Stafford</td>
<td>August 2010</td>
<td>M.S.</td>
<td>NUEN</td>
<td>ICF International</td>
</tr>
<tr>
<td>Jeremy Northum</td>
<td>May 2010</td>
<td>M.S.</td>
<td>HLPH</td>
<td>Pursuing Ph.D., Texas A&amp;M University</td>
</tr>
<tr>
<td>Alisha Stallard</td>
<td>May 2010</td>
<td>M.S.</td>
<td>HLPH</td>
<td>Texas Commission on Environmental Quality</td>
</tr>
<tr>
<td>Daniel Strohmeyer</td>
<td>May 2010</td>
<td>M.S.</td>
<td>HLPH</td>
<td>U.S. Nuclear Regulatory Commission</td>
</tr>
<tr>
<td>James Corson</td>
<td>May 2010</td>
<td>M.S.</td>
<td>NUEN</td>
<td>U.S. Nuclear Regulatory Commission</td>
</tr>
<tr>
<td>Marc Delchini</td>
<td>May 2010</td>
<td>M.S.</td>
<td>NUEN</td>
<td>Pursuing Ph.D., Texas A&amp;M University</td>
</tr>
</tbody>
</table>
D. Student awards
The tables below demonstrate the success of students obtaining research, academic and financial awards.

<table>
<thead>
<tr>
<th>Name</th>
<th>Received</th>
<th>Award Name</th>
<th>Faculty Member</th>
</tr>
</thead>
<tbody>
<tr>
<td>J. Miller</td>
<td>2008</td>
<td>Robert J. Sorenson Memorial Scholarship, Institute of Nuclear Materials Management</td>
<td>Charlton</td>
</tr>
<tr>
<td>A. LaFleur</td>
<td>2008</td>
<td>Best Student Paper Award, 8th International Conference on Facility Operations-Safeguards Interface</td>
<td>Charlton</td>
</tr>
<tr>
<td>M. Martin</td>
<td>2009</td>
<td>CONTACT Program Travel Grant</td>
<td>Shao</td>
</tr>
<tr>
<td>A. Aitkaliyeva</td>
<td>2009</td>
<td>CONTACT Program Travel Grant</td>
<td>Shao</td>
</tr>
<tr>
<td>SEI PEM Fuel Cell Team</td>
<td>2009</td>
<td>First Place Student Research Week, Two Phase Flow Instabilities in Parallel Channels of a Proton Exchange Membrane Fuel Cell</td>
<td>Kurwitz</td>
</tr>
<tr>
<td>SEI South Texas Nuclear Project Team</td>
<td>2009</td>
<td>Second Place Student Research Week, Time Domain Analysis of Temperatures in an Electrical Auxiliary Building Room</td>
<td>Kurwitz</td>
</tr>
<tr>
<td>B. Goddard</td>
<td>2009</td>
<td>J.D. Williams Student Paper Award, INMM Annual Meeting</td>
<td>Charlton</td>
</tr>
<tr>
<td>Name</td>
<td>Received</td>
<td>Award Name</td>
<td>Faculty Member</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>----------</td>
<td>-----------------------------------------------------------------------------</td>
<td>----------------</td>
</tr>
<tr>
<td>M. Myers</td>
<td>2010</td>
<td>Lawrence Scholar, Lawrence Livermore National Lab</td>
<td>Shao</td>
</tr>
<tr>
<td>M. Hackemack</td>
<td>2010</td>
<td>First Place Student Research Week, Vortex Separator Interfacial Stability in Microgravity</td>
<td>Kurwitz</td>
</tr>
<tr>
<td>SEI ITEMS Team</td>
<td>2010</td>
<td>First Place Student Research Week, Integrated Thermal Energy Management System</td>
<td>Kurwitz</td>
</tr>
<tr>
<td>SEI South Texas Nuclear Project Team</td>
<td>2010</td>
<td>First Place Student Research Week, Mitigation of Temperature Rise in an Electrical Auxiliary Building Room</td>
<td>Kurwitz</td>
</tr>
<tr>
<td>K. Miller</td>
<td>2010</td>
<td>J.D. Williams Student Paper Award, INMM Annual Meeting</td>
<td>Charlton</td>
</tr>
<tr>
<td>B. Goddard</td>
<td>2010</td>
<td>Roy G. Post Foundation Scholarship</td>
<td>Charlton</td>
</tr>
<tr>
<td>J. McNeal, J. Grice, R. Gener, M. Yameogo, and J. Issa</td>
<td>2011</td>
<td>Best Student Paper, South Texas Chapter of the Health Physics Society</td>
<td>Kurwitz</td>
</tr>
<tr>
<td>W. Deason, D. Eichel, J. Hansel, and W. Sames</td>
<td>2011</td>
<td>First Place American Nuclear Society 2011 Undergraduate Design Competition</td>
<td>Kurwitz</td>
</tr>
<tr>
<td>SEI ITEMS Team</td>
<td>2011</td>
<td>Second Place Student Research Week, Integrated Thermal Energy Management System</td>
<td>Kurwitz</td>
</tr>
<tr>
<td>SEI South Texas Nuclear Project Team</td>
<td>2011</td>
<td>First Place Student Research Week, Analysis of RHR Heat Exchanger for a Interfacing Systems LOCA</td>
<td>Kurwitz</td>
</tr>
<tr>
<td>J. Zhoul</td>
<td>2011</td>
<td>Honorable Mention, Society of Nuclear Medicine (SNM) 2011</td>
<td>Akabani</td>
</tr>
<tr>
<td>J. Zhoul</td>
<td>2011</td>
<td>South West Chapter of the American Association of Physicists in Medicine (SWAAPM)</td>
<td>Akabani</td>
</tr>
<tr>
<td>J. Zhoul</td>
<td>2011</td>
<td>South Texas Chapter of the Health Physics Society (STC-HPS)</td>
<td>Akabani</td>
</tr>
<tr>
<td>A. Goodsell</td>
<td>2012</td>
<td>Isotopes and Radiation Session Best Paper Award, American Nuclear Society Student Conference</td>
<td>Charlton</td>
</tr>
<tr>
<td>J. Feener</td>
<td>2012</td>
<td>Robert J. Sorenson Memorial Scholarship, Institute of Nuclear Materials Management</td>
<td>Charlton</td>
</tr>
<tr>
<td>M. Grypp</td>
<td>2012</td>
<td>Best Student Paper Award, South Texas Chapter of the Health Physics Society</td>
<td>Charlton</td>
</tr>
<tr>
<td>J. Evans</td>
<td>2012</td>
<td>First Place, Student Research Week, Texas A&amp;M University</td>
<td>Akabani</td>
</tr>
<tr>
<td>M. Shah, C. Marianno, S. Khatri, D. Boyle</td>
<td>2012</td>
<td>Best student paper in the Nonproliferation and Arms Control Division, 55th Annual Meeting of the International Nuclear Materials Management</td>
<td>Marianno, Boyle</td>
</tr>
<tr>
<td>Name</td>
<td>Received</td>
<td>Award Name</td>
<td>Faculty Member</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>----------</td>
<td>-----------------------------------------------------------------------------</td>
<td>----------------</td>
</tr>
<tr>
<td>K. Yancey</td>
<td>2013</td>
<td>Dwight Look College of Engineering Outstanding Engineering Student Award of 2013</td>
<td>Tsvetkov</td>
</tr>
<tr>
<td>N. P. Mondrik</td>
<td>2013</td>
<td>First Prize for Undergraduate Student Poster, IBA-2013 International Conference</td>
<td>Shao</td>
</tr>
<tr>
<td>M. Martin</td>
<td>2013</td>
<td>Silver Award for Best Poster, TMS Conference</td>
<td>Shao</td>
</tr>
<tr>
<td>C. Chapeaux, J. Skloss, ZhiXuan Tang, and E. Tindle</td>
<td>2013</td>
<td>Best Student Paper, Second place, Health Physics-South Texas Annual Meeting</td>
<td>Kurwitz</td>
</tr>
<tr>
<td>M. Ghrist</td>
<td>2013</td>
<td>First Place Student Research Week, Phase Separation in Microgravity</td>
<td>Kurwitz</td>
</tr>
<tr>
<td>J. Erchinger</td>
<td>2013</td>
<td>2012-2013 Robert S. Landauer, Sr. Memorial Fellowship, Health Physics Society</td>
<td>Charlton</td>
</tr>
<tr>
<td>J. Madsen</td>
<td>2013</td>
<td>Best Student Paper, South Texas Chapter of the Health Physics Society (STC-HPS)</td>
<td>Akabani</td>
</tr>
<tr>
<td>M. Martin</td>
<td>2013</td>
<td>Best Student Paper, Second Place, South Texas Chapter of the Health Physics Society (STC-HPS)</td>
<td>Akabani</td>
</tr>
<tr>
<td>J. Wallace</td>
<td>2014</td>
<td>Lawrence Scholar, Lawrence Livermore National Lab</td>
<td>Shao</td>
</tr>
<tr>
<td>A. Till</td>
<td>2014</td>
<td>Best Student Paper, PHYSOR 2014 International Conference</td>
<td>Morel, Adams</td>
</tr>
<tr>
<td>M. Shah</td>
<td>2014</td>
<td>J.D. Williams Student Paper Award, INMM Annual Meeting</td>
<td>Charlton</td>
</tr>
<tr>
<td>H. F. Stripling, IV</td>
<td>2014</td>
<td>Frederick A Howes Scholar in Computational Science</td>
<td>Adams</td>
</tr>
<tr>
<td>R. Vega</td>
<td>2014</td>
<td>First Place, Science and Engineering Outstanding Thesis Award, Texas A&amp;M Undergraduate Honors and Research Program</td>
<td>Akabani</td>
</tr>
<tr>
<td>M. Carson</td>
<td>2014</td>
<td>Third Place, Undergraduate Summer Research Grant (USRG) Program, Texas A&amp;M University</td>
<td>Akabani</td>
</tr>
<tr>
<td>T. Crook</td>
<td>2014</td>
<td>Best Student Paper-North America, Sensitivity analysis of a PWR response during a loss of coolant accident under a hypothetical core blockage scenario Using RELAP5-3D, ICONE-22</td>
<td>Hassan</td>
</tr>
<tr>
<td>S. Lee</td>
<td>2014</td>
<td>Best Student Paper-North America, Head loss through fibrous beds generated on different types of containment sump strainers, ICONE-22</td>
<td>Hassan</td>
</tr>
<tr>
<td>Semester Received</td>
<td>Name</td>
<td>Fellowship/Scholarship Award</td>
<td></td>
</tr>
<tr>
<td>-------------------</td>
<td>--------------------</td>
<td>-------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Fall 2008</td>
<td>Adam Bingham</td>
<td>(INPO) Institute of Nuclear Power Operations</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Adam Hetzler</td>
<td>ANS Graduate Scholarship Award</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Joshua Jarrell</td>
<td>Robert A. Dannels Memorial Scholarship</td>
<td></td>
</tr>
<tr>
<td></td>
<td>James Miller</td>
<td>DHS (DND) Domestic Nuclear Detection Office</td>
<td></td>
</tr>
<tr>
<td></td>
<td>James Miller</td>
<td>(INMM) Robert J. Sorenson Memorial Scholarship</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Alissa Stafford</td>
<td>ANS Graduate Scholarship Award</td>
<td></td>
</tr>
<tr>
<td>Fall 2009</td>
<td>Joshua Jarrell</td>
<td>ANS Everitt P. Blizard Scholarship</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Zachary Kulage</td>
<td>DHS Nuclear Forensics</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hayes Stripling</td>
<td>DOE Computational Science Graduate</td>
<td></td>
</tr>
<tr>
<td>Fall 2010</td>
<td>Bradley Appel</td>
<td>(NSF) National Science Foundation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Marie Arrieta</td>
<td>Sandia National Lab (TEES)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Andrew Dercher</td>
<td>DOE (NEUP) Nuclear Energy University Programs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Jessica Feener</td>
<td>(NNIS) Nuclear Nonproliferation International Safeguards</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Braden Goddard</td>
<td>DOE (NNSA) National Nuclear Security Administration</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hayes Stripling</td>
<td>ANS Robert A. Dannels Memorial Scholarship</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Andrew Till</td>
<td>DOE Computational Science Graduate</td>
<td></td>
</tr>
<tr>
<td>Fall 2011</td>
<td>Michael Hackemack</td>
<td>MUSC Rickover</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ryan Kelly</td>
<td>MUSC Rickover</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ryan Kelly</td>
<td>ANS Vern R. Dapp Scholarship</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cheuk Lau</td>
<td>National Excellence Fellowship</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vishal Patel</td>
<td>DOE (NEUP) Nuclear Energy University Programs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Jeremy Rogers</td>
<td>HPS Richard J. Burke, Jr. Fellowship</td>
<td></td>
</tr>
<tr>
<td></td>
<td>William Sames</td>
<td>ANS Graduate Scholarship Award</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hayes Stripling</td>
<td>ANS Robert A. Dannels Memorial Scholarship</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Andrew Till</td>
<td>ANS Graduate Scholarship Award</td>
<td></td>
</tr>
<tr>
<td></td>
<td>James Uhlemeyer</td>
<td>HPS Burton J. Moyer Fellowship</td>
<td></td>
</tr>
<tr>
<td>Fall 2012</td>
<td>Royal Elmore</td>
<td>DOE (NNSA) National Nuclear Security Administration</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Jennifer Erchinger</td>
<td>HPS Robert S. Landauer, Sr. Memorial Fellowship</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Jennifer Erchinger</td>
<td>HPS Robert S. Landauer, Sr. Memorial Fellowship</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Claudio Gariazzo</td>
<td>(NNIS) Nuclear Nonproliferation International Safeguards</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Arnulfo Gonzalez</td>
<td>OGS Diversity Fellowship</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Joshua Hansel</td>
<td>DOE (NEUP) Nuclear Energy University Programs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Jon Hansen</td>
<td>(NRC) Nuclear Regulatory Commission</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ryan Kelly</td>
<td>ANS Graduate Scholarship Award</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sarah Over</td>
<td>(NSBRI) National Space Biomedical Research Institute</td>
<td></td>
</tr>
<tr>
<td></td>
<td>William Sames</td>
<td>DOE (NEUP) Nuclear Energy University Programs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>William Sames</td>
<td>ANS James F. Schumar Scholarship</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Charles Stratton</td>
<td>DOE (NEUP) Nuclear Energy University Programs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Andrew Till</td>
<td>ANS Saul Levine Memorial Scholarship</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Jose Trevino</td>
<td>OGS Pathway to Doctorate Fellowship</td>
<td></td>
</tr>
<tr>
<td>Semester Received</td>
<td>Name</td>
<td>Fellowship/Scholarship Award</td>
<td></td>
</tr>
<tr>
<td>-------------------</td>
<td>--------------------</td>
<td>------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Merinda Volia</td>
<td>Fulbright Fellowship</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Kristina Yancey</td>
<td>(NSF) National Science Foundation</td>
<td></td>
</tr>
<tr>
<td>Fall 2013</td>
<td>Robert Zedric</td>
<td>(NNIS) Nuclear Nonproliferation International Safeguards</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Simon Bolding</td>
<td>DOE (NEUP) Nuclear Energy University Programs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tyler Cantrell</td>
<td>HPS J. Newell Stannard Fellowship</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lane Carasik</td>
<td>DOE (NEUP) Nuclear Energy University Programs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Timothy Jacomb-Hood</td>
<td>DHS Nuclear Forensics</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Corey Keith</td>
<td>HPS Robert Gardner Fellowship</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ryan Kelly</td>
<td>ANS Everitt P. Blizard Scholarship</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lloyd Price, Jr.</td>
<td>DOE (NEUP) Nuclear Energy University Programs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>William Sames</td>
<td>ANS Graduate Scholarship Award</td>
<td></td>
</tr>
<tr>
<td></td>
<td>William Sames</td>
<td>DOE (NEUP) Nuclear Energy University Programs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Jonathan Scherr</td>
<td>DOE (NEUP) Nuclear Energy University Programs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Micheal Smith</td>
<td>DOE (NEUP) Nuclear Energy University Programs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Karyn Stern</td>
<td>OGS Diversity Fellowship</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Jose Trevino</td>
<td>HPS Richard J. Burke, Jr. Fellowship</td>
<td></td>
</tr>
<tr>
<td>Fall 2014</td>
<td>James Uhlemeyer</td>
<td>(NSBRI) National Space Biomedical Research Institute</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Kristina Yancey</td>
<td>Texas A&amp;M Outstanding Graduate Student (Master's)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Yuriy Ayzman</td>
<td>OGS Diversity Fellowship</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bradley Beeny</td>
<td>Texas A&amp;M Energy Institute Fellowships</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Marlene Bencomo</td>
<td>Louis Stokes Alliance for Minority Participation (LSAMP)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Landon Brockmeyer</td>
<td>OGS Merit Fellowship</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Elizabeth Castanon</td>
<td>OGS Diversity Fellowship</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lainy Dromgoole</td>
<td>OGS Diversity Fellowship</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lainy Dromgoole</td>
<td>HPS Robert S. Landauer, Sr. Memorial Fellowship</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Grant Emery</td>
<td>(NRC) Nuclear Regulatory Commission</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Matthew Garza</td>
<td>(INPO) Institute of Nuclear Power Operations</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Clifford Hart</td>
<td>Roy G. Post scholarship</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mary Johansen</td>
<td>(NRC) Nuclear Regulatory Commission</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ryan Kelly</td>
<td>Allan F. Henry/Paul A. Grecbler Memorial Scholarship Award</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Yesenia Salazar</td>
<td>OGS Diversity Fellowship</td>
<td></td>
</tr>
<tr>
<td></td>
<td>William Sames</td>
<td>ANS Walter Meyer Memorial Scholarship Award</td>
<td></td>
</tr>
<tr>
<td></td>
<td>David Saucier</td>
<td>(NRC) Nuclear Regulatory Commission</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Jonathan Scherr</td>
<td>DOE (NEUP) Nuclear Energy University Programs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Richard Vega</td>
<td>DOE Stewardship Sciences</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Richard Vega</td>
<td>ANS Graduate Scholarship Award</td>
<td></td>
</tr>
</tbody>
</table>

E. Student professional development
See section II.F.
VI. Concluding Observations

The Department of Nuclear Engineering at Texas A&M University is putting great effort forth to grow and improve its already vibrant graduate program. As described in this self-study report, several changes have been and are being implemented in pursuit of the department’s vision “to develop and maintain a nationally and internationally recognized program that promotes a passion for understanding and applying the knowledge of nuclear science and engineering to support the nation's alternative energy, national security and healthcare missions.”

With respect to the growth of the student population, one of the many goals of the college’s 25 by 25 Initiative, put simply, is to increase the college’s student body (B.S., M.S., and Ph.D.) from 11,281 in 2012 to 25,000 in 2025. Dean M. Katherine Banks asked that each department form a growth committee in order to discuss whether that department has room to grow, and if so, by how much and by what means.

For the faculty, the first question for consideration was whether the department has room to grow; the student body has grown significantly since 2007 from 104 graduate students to 157 students in the fall 2014 semester. The number of Ph.D. students in 2007 was 32 and by fall 2014 it was 87 (a 170% increase). During the same time period, the number of tenured/tenure-track faculty decreased to 15, two less than the 17 faculty in 2007 (Dr. Marlow retired at beginning of the fall 2014 semester). Since the announcement of the 25 by 25 Initiative, the college has approved two positions to be filled. The department’s Growth Committee has taken a very detailed look, including building a year-by-year growth model, to guide the efforts in student population growth.

The department’s current plan is to grow graduate enrollment by 7.5% per year to reach a projected enrollment goal of 579 by the year 2025. This growth will be largely through distance learning for the Master of Engineering degree, which is earned primarily through classwork and does not require a research thesis.

Such growth in size and teaching capabilities will position the department at the forefront of undergraduate and graduate education and research, to achieve a preeminent program. While this high growth rate could seem unsustainable, and in some aspects risky, the faculty have prepared the plan with careful consideration to current and future practices for efficient instruction techniques. The faculty are firmly committed to strengthening the nuclear engineering graduate program during this period of growth and to maintaining the department’s high ranking.

The department’s graduate program, particularly the Ph.D. program, is critical to our mission because it produces the most highly trained nuclear engineers for placement as researchers in national laboratories, professors and researchers at competitive universities and within industry. The department will continue to further enhance course offerings at the cutting edge of technology, as evidenced by the recent addition of new topics needed by nuclear industry such as risk-informed analysis. Course instruction of these topics can be offered by professionals in industry and laboratories through the use of the Professor of Practice positions, which are currently encouraged by the college.

In the years ahead, there will be a greater emphasis on the department’s Ph.D. program. Currently, the Ph.D. student to tenured/tenure-track faculty ratio is 4:1. Having about 30% of the current faculty not involved in viable research is an area for improvement.
The Ph.D. student population is expected to grow in proportion to the increase in number of tenured/tenure-track faculty. An important goal is to ensure that all full-time Ph.D. students are fully funded and advised by tenured/tenure-track faculty, which will require ventures into new funding areas, including emerging areas of multidisciplinary research. The collaboration of the department with other nuclear engineering departments and national laboratories to pursue new research areas, such as currently done within the CASL program, will be encouraged. The climate that the growth plan provides is favorable to the hiring of new faculty to pursue these funding opportunities.

Beginning in the fall 2014 semester, new M.S. in health physics applicants are not being admitted and the new consolidated M.S. curriculum in nuclear engineering is being offered. This curriculum provides a balance between safety, safeguards, and security while still offering specialization options for students in nuclear engineering, health physics, computational sciences, nuclear materials, and nuclear nonproliferation. This new consolidated degree will enhance our growth while effectively making use of budget constraints. The department’s goal is to maintain a curriculum that is responsive to industrial and research needs. Hence our new goals are focused on taking advantage of the expected growth to enhance the undergraduate and graduate degree programs. We will continuously strive to increase student and faculty diversity among women and underrepresented groups.

The department recognizes that we are not alone in facing these challenges, as nuclear engineering programs across the country are encountering similar challenges. The department looks forward to the External Review Team’s advice and counsel as it endeavors to elevate the graduate and research programs in Nuclear Engineering at Texas A&M University.
Appendix A. 18 Characteristics of Texas Public Doctoral Programs (2012)
Texas A&M University

18 Characteristics of Texas Public Doctoral Programs

Programs included only if in existence 3 or more years. Program is defined at the 8-digit CIP code level.

<table>
<thead>
<tr>
<th>Department</th>
<th>Nuclear Engineering</th>
</tr>
</thead>
<tbody>
<tr>
<td>Doctoral Degree Program</td>
<td>Nuclear Engineering</td>
</tr>
<tr>
<td>Contact Name</td>
<td>Yassin Hassan</td>
</tr>
<tr>
<td>Contact Phone Number</td>
<td>845-4161</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Number of Degrees Per Year</th>
<th>2010-2011</th>
<th>2011-2012</th>
<th>2012-2013</th>
<th>3 Year Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average, 2010-2013</td>
<td>6</td>
<td>18</td>
<td>8</td>
<td>10.7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Graduation Rates</th>
<th>% Graduating within 10 Years</th>
<th>Years with Cohort greater than 0</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Average Time to Degree</th>
<th>5.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students Starting 2002-2004</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Employment Profile</th>
<th>Employed</th>
<th>Still Seeking Employment</th>
<th>Unknown</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Percent</td>
<td>Number</td>
</tr>
<tr>
<td>2011-2012</td>
<td>5</td>
<td>72%</td>
<td>1</td>
</tr>
<tr>
<td>2012-2013</td>
<td>16</td>
<td>88%</td>
<td>1</td>
</tr>
<tr>
<td>2013-2014</td>
<td>7</td>
<td>88%</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Admissions Criteria</th>
<th>Description of admission factors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Standard admission criteria to Graduate Program and successfully passing the Doctoral Qualifying Exam administered by the department.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Percentage Full-time Students</th>
<th>Fall 2011</th>
<th>Fall 2012</th>
<th>Fall 2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>FTS/number of students enrolled for the last three fall semesters.</td>
<td>81.6%</td>
<td>79.6%</td>
<td>81.0%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Average Institutional Financial Support Provided</th>
<th>$28,200</th>
</tr>
</thead>
<tbody>
<tr>
<td>For those receiving financial support, the average monetary institutional financial support provided per full-time graduate student for the prior year, from assistantships, scholarships, stipends, grants, and fellowships. Does not include tuition or benefits.</td>
<td></td>
</tr>
</tbody>
</table>
### Percentage Full-Time Students with Institutional Financial Support

In the prior year, the number of full-time students with at least $1,000 of annual support/the number of full-time students

92.6%

### Number of Core Faculty

Number of core faculty in the prior year

17

### Student-Core Faculty Ratio

Three-year average of full-time student equivalent (FTSE)/three-year average of full-time faculty equivalent (FTFE) of core faculty. Core Faculty: Full-time tenured and tenure-track faculty who teach 50 percent or more in the doctoral program or other individuals integral to the doctoral program who can direct dissertation research.

4.0

### Core Faculty Publications

Three-year average of the number of discipline-related refereed papers/publications, books/book chapters, juried creative/performance accomplishments, and notices of discoveries filed/patents issued per year per core faculty member.

7.1

### Core Faculty External Grants

Three-year average of the number of core faculty receiving external funds, average external funds per faculty, and total external funds per program per academic year. All external funds received from any source including research grants, training grants, gifts from foundations, etc., reported as expenditures.

| Average of the Number of Core Faculty receiving | 17 |
| Average External Funds per Faculty | $635,000 |
| Total External Funds | $10,800,000 |

### Faculty Teaching Load

Total number of semester credit hours in organized teaching courses taught per academic year by core faculty divided by the number of core faculty in the prior year

29.3

### Faculty Diversity

Core faculty by ethnicity (White, Black, Hispanic, Other) and gender, updated when changed

<table>
<thead>
<tr>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>16</td>
</tr>
<tr>
<td>Black</td>
<td>0</td>
</tr>
<tr>
<td>Hispanic</td>
<td>0</td>
</tr>
<tr>
<td>Other</td>
<td>3</td>
</tr>
</tbody>
</table>

### Student Diversity

Enrollment headcount by ethnicity (White, Black, Hispanic, Other) and gender in program in the prior year

<table>
<thead>
<tr>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>41</td>
</tr>
<tr>
<td>Black</td>
<td>1</td>
</tr>
<tr>
<td>Hispanic</td>
<td>4</td>
</tr>
<tr>
<td>Other</td>
<td>24</td>
</tr>
</tbody>
</table>

### Date of Last External Review

Date of last formal external review, updated when changed

2011-2012

### External Program Accreditation

Name of body and date of last program accreditation review, if applicable, updated when changed

SACS-COC

### Student Publications/Presentations

For the three most recent years, the number of discipline-related refereed papers/publications, juried creative/performance accomplishments, book chapters, books, and external presentations per year by student FTE

3.00
Appendix B. Weave Online Entries
Texas A&M University

Detailed Assessment Report
As of: 1/09/2015 03:02 PM CENTRAL
2014-2015 Health Physics, MS
(Includes those Action Plans with Budget Amounts marked One-Time, Recurring, No Request.)

Mission / Purpose

To enable students to successfully perform as professional health physicists with an initial level of expertise appropriate to a Master's program, and to prepare them for further graduate study.

Goals and Student Learning Outcomes/Objectives, with Any Associations and Related Measures, Targets, Findings, and Action Plans

G 1:Recruitment
Recruit highly qualified graduate students and work to achieve greater diversity in the department.

SLO 1:Enrollees - High Quality
Enrollees will be of high quality.

Relevant Associations:

Strategic Plan Associations:
Executive Vice President for Academics and Provost
1.1 Accountability: Establish structures, processes, and policies that hold the unit accountable and eligible for rewards for demonstrating their current standing, plans, and progress in creating an environment where the diversity of individual identities and ideas are treated equitably in a climate that fosters success and achievement by all.

Texas A&M University
2 Strengthen our graduate programs.
6 Diversify and globalize the A&M community.
7 Increase access to intellectual resources.
8 Enrich our campus.

Related Measures:

M 1:GRE Scores
GRE Scores - Common indicator of the quality of the graduate student's preparation. GRE scores will be compared to the program and the College.

Source of Evidence: Administrative measure - other

Target:
Quantitative Average: 161 (770 on previous scale) Verbal Average: 155 (530 on previous scale)
M 2:Prospectives GPA
GPA Average - Incoming students will possess a competitive GPA.

Source of Evidence: Performance (recital, exhibit, science project)

Target:
Our departmental goal is that incoming students average a 3.4

SLO 2:Enrollees - Achieve Diversity
Enrollees will help us achieve our diversity goals.

Relevant Associations:

Strategic Plan Associations:
Executive Vice President for Academics and Provost
1.1 Accountability: Establish structures, processes, and policies that hold the unit accountable and eligible for rewards for demonstrating their current standing, plans, and progress in creating an environment where the diversity of individual identities and ideas are treated equitably in a climate that fosters success and achievement by all.

Texas A&M University
2 Strengthen our graduate programs.
6 Diversify and globalize the A&M community.
8 Enrich our campus.

Related Measures:

M 3:Program Diversity - Race/Ethnicities
Student Program Diversity - The program has and will continue to strive for a diverse program of students and meet the University's initiative to increase our under-represented groups. Fall 2012 - 13.7%

Source of Evidence: Existing data

Target:
Increase domestic race/ethnic groups of under-represented students to 16%.

M 4:Program Diversity – Females
Increase our female representation to 19.1%.

Source of Evidence: Existing data

G 2:Academic & Professional Excellence
Active and productive graduate students who will contribute to the overall excellence of the department.

SLO 4:Apply Knowlege
Apply subject matter knowledge in a range of contexts to solve problems and make decisions.

Relevant Associations:

Graduate Outcome Associations:
1.2 Apply subject matter knowledge in a range of contexts to solve problems and make decisions.

**Strategic Plan Associations:**
Texas A&M University
2 Strengthen our graduate programs.

**Related Measures:**

**M 6:NUEN 604 Report**
NUEN 604 Oral and Written Report - This is an excellent course to help us measure the effectiveness of our student's to meet these learning outcomes. One, this course is in the majority of the student's degree plans, so it will do well to capture a large response from our base. Second, this course is typically taken in the second semester of their graduate coursework. This allows our students to acclimate to rigor of graduate course work, and it provides us with an early measurement of their skills. The oral report can help us to measure the following learning outcomes: · CE: Communicate Effectively (MS & PhD) · UT: Use appropriate technologies to communicate, collaborate, conduct research, and solve problems (MS & PhD) The written report can help us to measure the following learning outcomes: · AK: Apply subject matter knowledge in a range of contexts to solve problems and make decisions (MS) · UVS: Use a variety of sources and evaluate multiple points of view to analyze and integrate information and to conduct critical, reasoned arguments (MS) · DCR: Develop clear research plans and conduct valid (data-supported), theoretically consistent, and institutionally appropriate research (MS)

Source of Evidence: Existing data

**Target:**
That 100% of the students will earn a "B" or higher.

**M 7:Thesis committee evaluation**
Students will make a formal thesis presentation to their committee members and be evaluated on a number of Graduate SLO variables.

Source of Evidence: Presentation, either individual or group

**Target:**
100% of the students will have marks of "Meets Expectations" or higher.

**SLO 6:Communicate Effectively**
Graduates will be able to readily and effectively communicate complex technical information to a wide variety of audiences in both written and oral form.

**Relevant Associations:**

**Graduate Outcome Associations:**
1.4 Communicate effectively.

**Related Measures:**

**M 6:NUEN 604 Report**
NUEN 604 Oral and Written Report - This is an excellent course to help us measure the effectiveness of our student's to meet these learning outcomes. One, this course is in the majority of the student's degree plans, so it will do well to capture a large response from our base. Second, this course is typically taken in the second semester of their graduate coursework. This allows our students to acclimate to rigor of graduate course work, and it provides us with an early measurement of their skills. The oral report can help us to measure the following learning outcomes: · CE: Communicate Effectively (MS & PhD) · UT: Use appropriate technologies to communicate, collaborate, conduct research, and solve problems (MS & PhD) The written report can help us to measure the following learning outcomes: · AK: Apply subject matter knowledge in a range of contexts to solve problems and make decisions (MS) · UVS: Use a variety of sources and evaluate multiple points of view to analyze and integrate information and to conduct critical, reasoned arguments (MS) · DCR: Develop clear research plans and conduct valid (data-supported), theoretically consistent, and institutionally appropriate research (MS)

Source of Evidence: Existing data

Target:
That 100% of the students will earn a "B" or higher.

M 7:Thesis committee evaluation
Students will make a formal thesis presentation to their committee members and be evaluated on a number of Graduate SLO variables.

Source of Evidence: Presentation, either individual or group

Target:
100% of the students will have marks of "Meets Expectations" or higher.

SLO 7:Use Appropriate Technologies
Use appropriate technologies to communicate, collaborate, conduct research, and solve problems.

Relevant Associations:

Graduate Outcome Associations:
1.5 Use appropriate technologies to communicate, collaborate, conduct research, and solve problems.

Related Measures:

M 6:NUEN 604 Report
NUEN 604 Oral and Written Report - This is an excellent course to help us measure the effectiveness of our student's to meet these learning outcomes. One, this course is in the majority of the student's degree plans, so it will do well to capture a large response from our base. Second, this course is typically taken in the second semester of their graduate coursework. This allows our students to acclimate to rigor of graduate course work, and it provides us with an early measurement of their skills. The oral report can help us to measure the following learning outcomes: · CE: Communicate Effectively (MS & PhD) · UT: Use appropriate technologies to communicate, collaborate, conduct research, and solve problems (MS & PhD) The written report can help us to measure the following learning outcomes: · AK: Apply subject matter knowledge in a range of
contexts to solve problems and make decisions (MS) · UVS: Use a variety of sources and evaluate multiple points of view to analyze and integrate information and to conduct critical, reasoned arguments (MS) · DCR: Develop clear research plans and conduct valid (data-supported), theoretically consistent, and institutionally appropriate research (MS)

Source of Evidence: Existing data

**Target:**
That 100% of the students will earn a "B" or higher.

**M 7: Thesis committee evaluation**
Students will make a formal thesis presentation to their committee members and be evaluated on a number of Graduate SLO variables.

Source of Evidence: Presentation, either individual or group

**Target:**
100% of the students will have marks of "Meets Expectations" or higher.

**SLO 9: Ethical Course of Action**
Choose ethical courses of action in research and practice.

**Relevant Associations:**

**General Education/Core Curriculum Associations:**
4 Practice personal and social responsibility

**Graduate Outcome Associations:**
1.7 Choose ethical courses of action in research and practice.

**Related Measures:**

**M 8: Ethical Enrichment Activity**
100% of our students will attend an ethical related seminar or some another enrichment activity that speaks to ethical choices and action.

Source of Evidence: Existing data

**Target:**
100% of our students will attend an enrichment activity.

**G 3: Research Excellence**
Graduate students will contribute and maintain the internationally recognized excellence in teaching and research.

**SLO 5: Use a Variety of Sources**
Use a variety of sources and evaluate multiple points of view to analyze and integrate information and to conduct critical, reasoned arguments.

**Relevant Associations:**

**Graduate Outcome Associations:**
1.3 Use a variety of sources and evaluate multiple points of view to analyze and integrate information and to conduct critical, reasoned arguments.

**Related Measures:**

**M 6:NUEN 604 Report**

NUEN 604 Oral and Written Report - This is an excellent course to help us measure the effectiveness of our student's to meet these learning outcomes. One, this course is in the majority of the student's degree plans, so it will do well to capture a large response from our base. Second, this course is typically taken in the second semester of their graduate coursework. This allows our students to acclimate to rigor of graduate course work, and it provides us with an early measurement of their skills. The oral report can help us to measure the following learning outcomes: · CE: Communicate Effectively (MS & PhD) · UT: Use appropriate technologies to communicate, collaborate, conduct research, and solve problems (MS & PhD) The written report can help us to measure the following learning outcomes: · AK: Apply subject matter knowledge in a range of contexts to solve problems and make decisions (MS) · UVS: Use a variety of sources and evaluate multiple points of view to analyze and integrate information and to conduct critical, reasoned arguments (MS) · DCR: Develop clear research plans and conduct valid (data-supported), theoretically consistent, and institutionally appropriate research (MS)

Source of Evidence: Existing data

**Target:**

That 100% of the students will earn a "B" or higher.

**M 7:Thesis committee evaluation**

Students will make a formal thesis presentation to their committee members and be evaluated on a number of Graduate SLO variables.

Source of Evidence: Presentation, either individual or group

**Target:**

100%

**SLO 8:Develop Clear Research Plans**

Develop clear research plans and conduct valid (data-supported), theoretically consistent, and institutionally appropriate research.

**Relevant Associations:**

**General Education/Core Curriculum Associations:**

1. Master the depth of knowledge required for a degree
2. Demonstrate critical thinking
6. Prepare to engage in lifelong learning

**Graduate Outcome Associations:**

1.6 Develop clear research plans and conduct valid, data-supported, theoretically consistent, and institutionally appropriate research.

**Related Measures:**
M 6: NUEN 604 Report
NUEN 604 Oral and Written Report - This is an excellent course to help us measure the effectiveness of our student's to meet these learning outcomes. One, this course is in the majority of the student's degree plans, so it will do well to capture a large response from our base. Second, this course is typically taken in the second semester of their graduate coursework. This allows our students to acclimate to rigor of graduate course work, and it provides us with an early measurement of their skills. The oral report can help us to measure the following learning outcomes: · CE: Communicate Effectively (MS & PhD) · UT: Use appropriate technologies to communicate, collaborate, conduct research, and solve problems (MS & PhD) The written report can help us to measure the following learning outcomes: · AK: Apply subject matter knowledge in a range of contexts to solve problems and make decisions (MS) · UVS: Use a variety of sources and evaluate multiple points of view to analyze and integrate information and to conduct critical, reasoned arguments (MS) · DCR: Develop clear research plans and conduct valid (data-supported), theoretically consistent, and institutionally appropriate research (MS)

Source of Evidence: Existing data

Target:
That 100% of the students will earn a "B" or higher.

M 7: Thesis committee evaluation
Students will make a formal thesis presentation to their committee members and be evaluated on a number of Graduate SLO variables.

Source of Evidence: Presentation, either individual or group

Target:
100% of the students will have marks of "Meets Expectations" or higher.

Details of Action Plans for This Cycle (by Established cycle, then alpha)

Graduate Student Learning Outcomes
To implement new assessment methods that coordinate with the most recent Graduate Student learning outcomes.

Established in Cycle: 2012-2013
Implementation Status: Planned
Priority: High
Implementation Description: This involves creating a new assessment method for our final defenses.
Responsible Person/Group: Robb Jenson/Karen Vierow
Additional Resources Requested: None

Eliminating
This program will no longer be available after the Fall 2015 semester, thus we are not creating a new action plan.
Established in Cycle: 2013-2014
Implementation Status: Planned
Priority: High
Detailed Assessment Report  
As of: 1/09/2015 03:02 PM CENTRAL  
2014-2015 Nuclear Engineering, MENG  
(Includes those Action Plans with Budget Amounts marked One-Time, Recurring, No Request.)

Mission / Purpose

To enable students to successfully perform as professional nuclear engineers.

Goals and Student Learning Outcomes/Objectives, with Any Associations and Related Measures, Targets, Findings, and Action Plans

G 1:Recruitment

Recruit highly qualified graduate students and work to achieve greater diversity in the department.

SLO 1:Enrollees - High Quality

Enrollees will be of high quality.

Relevant Associations:

Strategic Plan Associations:

Executive Vice President for Academics and Provost

1.1 Accountability: Establish structures, processes, and policies that hold the unit accountable and eligible for rewards for demonstrating their current standing, plans, and progress in creating an environment where the diversity of individual identities and ideas are treated equitably in a climate that fosters success and achievement by all.

1.2 Climate: Promote a positive and supportive climate by identifying aspects in the climate of individual units and the University which foster and/or impede a working and learning environment that fully recognizes, values, and integrates diversity in the pursuit of academic excellence.

1.3 Equity: Integrate into the mission and goals of the unit that students, staff, and faculty (tenure and non-tenure track), regardless of identity, are all treated equitably.

Texas A&M University

2 Strengthen our graduate programs.

6 Diversify and globalize the A&M community.

8 Enrich our campus.

12 Meet our commitment to Texas.

Related Measures:

M 1:GRE Scores

GRE Scores - Common indicator of the quality of the graduate student's preparation. GRE scores will be compared to the program and the College.

Source of Evidence: Standardized test of subject matter knowledge

Target:

Quantitative Average: 161 (770 on previous scale) Verbal Average: 155 (530 on previous scale)
M 2: Prospectives GPA
GPA Average - Incoming students will possess a competitive GPA.

Source of Evidence: Performance (recital, exhibit, science project)

Target:
Our departmental goal is that incoming students average a 3.4

SLO 2: Enrollees - Achieve Diversity
Enrollees will help us achieve our diversity goals.

Relevant Associations:

Strategic Plan Associations:
Executive Vice President for Academics and Provost
1.1 Accountability: Establish structures, processes, and policies that hold the unit accountable and eligible for rewards for demonstrating their current standing, plans, and progress in creating an environment where the diversity of individual identities and ideas are treated equitably in a climate that fosters success and achievement by all.
1.2 Climate: Promote a positive and supportive climate by identifying aspects in the climate of individual units and the University which foster and/or impede a working and learning environment that fully recognizes, values, and integrates diversity in the pursuit of academic excellence.
1.3 Equity: Integrate into the mission and goals of the unit that students, staff, and faculty (tenure and non-tenure track), regardless of identity, are all treated equitably.

Texas A&M University
2 Strengthen our graduate programs.
6 Diversify and globalize the A&M community.
8 Enrich our campus.
12 Meet our commitment to Texas.

Related Measures:

M 3: Program Diversity - Race/Ethnicities
Student Program Diversity - The program has and will continue to strive for a diverse program of students and meet the University's initiative to increase our under-represented groups.

Source of Evidence: Existing data

Target:
Increase domestic race/ethnic groups of under-represented students to 16%.

M 4: Program Diversity – Females
Increase our female representation to 19.1%.

Source of Evidence: Existing data

Target:
Increase our female representation to 19.1%.
G 2: Academic & Professional Excellence
Active and productive graduate students who will contribute to the overall excellence of the department.

SLO 3: Master degree program requirements
Master degree program requirements.

Relevant Associations:

General Education/Core Curriculum Associations:
1. Master the depth of knowledge required for a degree
2. Demonstrate critical thinking
6. Prepare to engage in lifelong learning
7. Work collaboratively

Graduate Outcome Associations:
1.1 Master degree program requirements, including theories, concepts, principles, and practice, and develop a coherent understanding of the subject matter through synthesis across courses and experiences.

Related Measures:

M 5: Time of Completion to Graduation
Our students will graduate from our program in a reasonable amount of time.

Source of Evidence: Existing data

Target:
85% of the students are completing this degree within two years.

SLO 4: Apply Knowledge
Apply subject matter knowledge in a range of contexts to solve problems and make decisions.

Relevant Associations:

General Education/Core Curriculum Associations:
1. Master the depth of knowledge required for a degree
2. Demonstrate critical thinking
3. Communicate effectively

Graduate Outcome Associations:
1.2 Apply subject matter knowledge in a range of contexts to solve problems and make decisions.

Related Measures:

M 6: NUEN 604 Report
NUEN 604 Oral and Written Report - This is an excellent course to help us measure the effectiveness of our student's to meet these learning outcomes. One, this course is in the majority of the student's degree plans, so it will do well to capture a large response from our base. Second, this course is typically taken in the second semester of their graduate coursework. This allows our students to acclimate to rigor of graduate course work, and it provides us with an early measurement of their skills. The oral report can help us to measure the following
learning outcomes: · CE: Communicate Effectively (MS & PhD) · UT: Use appropriate technologies to communicate, collaborate, conduct research, and solve problems (MS & PhD) The written report can help us to measure the following learning outcomes: · AK: Apply subject matter knowledge in a range of contexts to solve problems and make decisions (MS) · UVS: Use a variety of sources and evaluate multiple points of view to analyze and integrate information and to conduct critical, reasoned arguments (MS) · DCR: Develop clear research plans and conduct valid (data-supported), theoretically consistent, and institutionally appropriate research (MS)

Source of Evidence: Project, either individual or group

Target:
That 100% of the students will earn a "B" or higher.

SLO 6: Communicate Effectively
Graduates will be able to readily and effectively communicate complex technical information to a wide variety of audiences in both written and oral form.

Related Measures:

M 6: NUEN 604 Report
NUEN 604 Oral and Written Report - This is an excellent course to help us measure the effectiveness of our student's to meet these learning outcomes. One, this course is in the majority of the student's degree plans, so it will do well to capture a large response from our base. Second, this course is typically taken in the second semester of their graduate coursework. This allows our students to acclimate to rigor of graduate course work, and it provides us with an early measurement of their skills. The oral report can help us to measure the following learning outcomes: · CE: Communicate Effectively (MS & PhD) · UT: Use appropriate technologies to communicate, collaborate, conduct research, and solve problems (MS & PhD) The written report can help us to measure the following learning outcomes: · AK: Apply subject matter knowledge in a range of contexts to solve problems and make decisions (MS) · UVS: Use a variety of sources and evaluate multiple points of view to analyze and integrate information and to conduct critical, reasoned arguments (MS) · DCR: Develop clear research plans and conduct valid (data-supported), theoretically consistent, and institutionally appropriate research (MS)

Source of Evidence: Project, either individual or group

Target:
That 100% of the students will earn a "B" or higher.

SLO 7: Use Appropriate Technologies
Use appropriate technologies to communicate, collaborate, conduct research, and solve problems.

Relevant Associations:

General Education/Core Curriculum Associations:
1 Master the depth of knowledge required for a degree
2 Demonstrate critical thinking
3 Communicate effectively
6 Prepare to engage in lifelong learning
7 Work collaboratively

**Graduate Outcome Associations:**
1.5 Use appropriate technologies to communicate, collaborate, conduct research, and solve problems.

**Strategic Plan Associations:**
Texas A&M University
2 Strengthen our graduate programs.

**Related Measures:**

**M 6:NUEN 604 Report**
NUEN 604 Oral and Written Report - This is an excellent course to help us measure the effectiveness of our student's to meet these learning outcomes. One, this course is in the majority of the student's degree plans, so it will do well to capture a large response from our base. Second, this course is typically taken in the second semester of their graduate coursework. This allows our students to acclimate to rigor of graduate course work, and it provides us with an early measurement of their skills. The oral report can help us to measure the following learning outcomes: · CE: Communicate Effectively (MS & PhD) · UT: Use appropriate technologies to communicate, collaborate, conduct research, and solve problems (MS & PhD) The written report can help us to measure the following learning outcomes: · AK: Apply subject matter knowledge in a range of contexts to solve problems and make decisions (MS) · UVS: Use a variety of sources and evaluate multiple points of view to analyze and integrate information and to conduct critical, reasoned arguments (MS) · DCR: Develop clear research plans and conduct valid (data-supported), theoretically consistent, and institutionally appropriate research (MS)

Source of Evidence: Project, either individual or group

**Target:**
That 100% of the students will earn a "B" or higher.

**SLO 9: Ethical Course of Action**
Choose ethical courses of action in research and practice.

**Relevant Associations:**

**General Education/Core Curriculum Associations:**
4 Practice personal and social responsibility
5 Demonstrate social, cultural, and global competence

**Graduate Outcome Associations:**
1.7 Choose ethical courses of action in research and practice.

**Related Measures:**

**M 8: Ethical Enrichment Activity**
100% of our students will attend an ethical related seminar or some another enrichment activity that speaks to ethical choices and action.

Source of Evidence: Academic indirect indicator of learning - other
**Target:**
100% of our students will attend an enrichment activity.

**G 3: Research Excellence**
Graduate students will contribute and maintain the internationally recognized excellence in teaching and research.

**SLO 5: Use a Variety of Sources**
Use a variety of sources and evaluate multiple points of view to analyze and integrate information and to conduct critical, reasoned arguments.

**Related Measures:**

**M 6: NUEN 604 Report**
NUEN 604 Oral and Written Report - This is an excellent course to help us measure the effectiveness of our student's to meet these learning outcomes. One, this course is in the majority of the student's degree plans, so it will do well to capture a large response from our base. Second, this course is typically taken in the second semester of their graduate coursework. This allows our students to acclimate to rigor of graduate course work, and it provides us with an early measurement of their skills. The oral report can help us to measure the following learning outcomes: · CE: Communicate Effectively (MS & PhD) · UT: Use appropriate technologies to communicate, collaborate, conduct research, and solve problems (MS & PhD) The written report can help us to measure the following learning outcomes: · AK: Apply subject matter knowledge in a range of contexts to solve problems and make decisions (MS) · UVS: Use a variety of sources and evaluate multiple points of view to analyze and integrate information and to conduct critical, reasoned arguments (MS) · DCR: Develop clear research plans and conduct valid (data-supported), theoretically consistent, and institutionally appropriate research (MS)

Source of Evidence: Project, either individual or group

**Target:**
That 100% of the students will earn a "B" or higher.

**SLO 8: Develop Clear Research Plans**
Develop clear research plans and conduct valid (data-supported), theoretically consistent, and institutionally appropriate research.

**Relevant Associations:**

**General Education/Core Curriculum Associations:**
1 Master the depth of knowledge required for a degree
2 Demonstrate critical thinking
3 Communicate effectively
6 Prepare to engage in lifelong learning
7 Work collaboratively

**Graduate Outcome Associations:**
1.6 Develop clear research plans and conduct valid, data-supported, theoretically consistent, and institutionally appropriate research.

**Strategic Plan Associations:**
Texas A&M University
2 Strengthen our graduate programs.

**Related Measures:**

**M 6:NUEN 604 Report**

NUEN 604 Oral and Written Report - This is an excellent course to help us measure the effectiveness of our student's to meet these learning outcomes. One, this course is in the majority of the student's degree plans, so it will do well to capture a large response from our base. Second, this course is typically taken in the second semester of their graduate coursework. This allows our students to acclimate to rigor of graduate course work, and it provides us with an early measurement of their skills. The oral report can help us to measure the following learning outcomes: · CE: Communicate Effectively (MS & PhD) · UT: Use appropriate technologies to communicate, collaborate, conduct research, and solve problems (MS & PhD) The written report can help us to measure the following learning outcomes: · AK: Apply subject matter knowledge in a range of contexts to solve problems and make decisions (MS) · UVS: Use a variety of sources and evaluate multiple points of view to analyze and integrate information and to conduct critical, reasoned arguments (MS) · DCR: Develop clear research plans and conduct valid (data-supported), theoretically consistent, and institutionally appropriate research (MS)

Source of Evidence: Project, either individual or group

**Target:**

That 100% of the students will earn a "B" or higher.

**Details of Action Plans for This Cycle (by Established cycle, then alpha)**

**Departmental Awareness**

- Provide awareness to our faculty of our desired departmental goals. - Identify a time that will allow us to check up on student's progress. - Present findings to the faculty. - Announce at departmental student seminar's about this goal and supoprt resources.

<table>
<thead>
<tr>
<th>Established in Cycle:</th>
<th>2011-2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Implementation Status:</td>
<td>Planned</td>
</tr>
<tr>
<td>Priority:</td>
<td>High</td>
</tr>
<tr>
<td>Implementation Description:</td>
<td>Discuss at faculty and departmental meetings.</td>
</tr>
<tr>
<td>Responsible Person/Group:</td>
<td>Dr. Karen Vierow/Mr. Robb Jenson</td>
</tr>
<tr>
<td>Additional Resources Requested:</td>
<td>none</td>
</tr>
</tbody>
</table>

**Graduate Student Learning Outcomes**

To implement new assessment methods that coordinate with the most recent Graduate Student learning outcomes.

<table>
<thead>
<tr>
<th>Established in Cycle:</th>
<th>2012-2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Implementation Status:</td>
<td>Planned</td>
</tr>
<tr>
<td>Priority:</td>
<td>High</td>
</tr>
<tr>
<td>Implementation Description:</td>
<td>This involves creating a new assessment method for our final defenses.</td>
</tr>
</tbody>
</table>
More Students
This current program is lacking students and we wish to increase our numbers, which will help us to attain our overall departmental numbers. We will increase our recruitment efforts in this area to attract more students.

Established in Cycle: 2013-2014
Implementation Status: Planned
Priority: Medium
Implementation Description: Visit surrounding system schools in the state of Texas.
Responsible Person/Group: Robb Jenson and Dr. Karen Vierow
Additional Resources Requested: Financial for travel.
Mission / Purpose

To enable students to successfully perform as professional nuclear engineers, and to prepare them for further graduate study.

Goals and Student Learning Outcomes/Objectives, with Any Associations and Related Measures, Targets, Findings, and Action Plans

G 1: Recruitment
Recruit highly qualified graduate students and work to achieve greater diversity in the department.

SLO 1: Enrollees - High Quality
Enrollees will be of high quality.

Relevant Associations:

Strategic Plan Associations:
Executive Vice President for Academics and Provost
1.1 Accountability: Establish structures, processes, and policies that hold the unit accountable and eligible for rewards for demonstrating their current standing, plans, and progress in creating an environment where the diversity of individual identities and ideas are treated equitably in a climate that fosters success and achievement by all.
1.2 Climate: Promote a positive and supportive climate by identifying aspects in the climate of individual units and the University which foster and/or impede a working and learning environment that fully recognizes, values, and integrates diversity in the pursuit of academic excellence.
1.3 Equity: Integrate into the mission and goals of the unit that students, staff, and faculty (tenure and non-tenure track), regardless of identity, are all treated equitably.

Texas A&M University
2 Strengthen our graduate programs.
6 Diversify and globalize the A&M community.
8 Enrich our campus.
12 Meet our commitment to Texas.

Related Measures:

M 1: GRE Scores
GRE Scores - Common indicator of the quality of the graduate student's preparation. GRE scores will be compared to the program and the College.

Source of Evidence: Administrative measure - other
Target:
Quantitative Average: 161 (770 on previous scale) Verbal Average: 155 (530 on previous scale)

M 2: Prospectives GPA
GPA Average - Incoming students will possess a competitive GPA.

Source of Evidence: Administrative measure - other

Target:
Our departmental goal is that incoming students average a 3.4

SLO 2: Enrollees - Achieve Diversity
Enrollees will help us achieve our diversity goals.

Relevant Associations:

Strategic Plan Associations:
Executive Vice President for Academics and Provost
1.1 Accountability: Establish structures, processes, and policies that hold the unit accountable and eligible for rewards for demonstrating their current standing, plans, and progress in creating an environment where the diversity of individual identities and ideas are treated equitably in a climate that fosters success and achievement by all.
1.2 Climate: Promote a positive and supportive climate by identifying aspects in the climate of individual units and the University which foster and/or impede a working and learning environment that fully recognizes, values, and integrates diversity in the pursuit of academic excellence.
1.3 Equity: Integrate into the mission and goals of the unit that students, staff, and faculty (tenure and non-tenure track), regardless of identity, are all treated equitably.

Texas A&M University
2 Strengthen our graduate programs.
6 Diversify and globalize the A&M community.
8 Enrich our campus.
12 Meet our commitment to Texas.

Related Measures:

M 3: Program Diversity - Race/Ethnicities
Student Program Diversity - The program has and will continue to strive for a diverse program of students and meet the University's initiative to increase our under-represented groups.

Source of Evidence: Senior thesis or culminating major project

Target:
Increase domestic race/ethnic groups of under-represented students to 16%.

M 4: Program Diversity – Females
Student Program Diversity - The program has and will continue to strive for a diverse program of students and meet the University's initiative to increase our make-up of female students.
Source of Evidence: Senior thesis or culminating major project

**Target:**
Increase our female representation to 19.1%.

**SLO 3: Master degree program requirements**
Master degree program requirements.

**Relevant Associations:**

**General Education/Core Curriculum Associations:**
1. Master the depth of knowledge required for a degree
2. Demonstrate critical thinking
3. Communicate effectively
6. Prepare to engage in lifelong learning

**Graduate Outcome Associations:**
1.1 Master degree program requirements, including theories, concepts, principles, and practice, and develop a coherent understanding of the subject matter through synthesis across courses and experiences.

**Related Measures:**

**M 5: Time to Completion for Graduation**
Our students will graduate from our program in a reasonable amount of time.

Source of Evidence: Existing data

**Target:**
Seventy-five percent of our students will graduate in 30 months on average.

**M 6: NUEN 604 Report**
NUEN 604 Oral and Written Report - This is an excellent course to help us measure the effectiveness of our student's to meet these learning outcomes. One, this course is in the majority of the student's degree plans, so it will do well to capture a large response from our base. Second, this course is typically taken in the second semester of their graduate coursework. This allows our students to acclimate to rigor of graduate course work, and it provides us with an early measurement of their skills. The oral report can help us to measure the following learning outcomes: · CE: Communicate Effectively (MS & PhD) · UT: Use appropriate technologies to communicate, collaborate, conduct research, and solve problems (MS & PhD) The written report can help us to measure the following learning outcomes: · AK: Apply subject matter knowledge in a range of contexts to solve problems and make decisions (MS) · UVS: Use a variety of sources and evaluate multiple points of view to analyze and integrate information and to conduct critical, reasoned arguments (MS) · DCR: Develop clear research plans and conduct valid (data-supported), theoretically consistent, and institutionally appropriate research (MS)

Source of Evidence: Presentation, either individual or group

**Target:**
That 100% of the students will earn a "B" or higher.
M 7: Thesis committee evaluation

Students will make a formal thesis presentation to their committee members and be evaluated on a number of Graduate SLO variables.

Source of Evidence: Academic direct measure of learning - other

Target:
100% of the students will have marks of "Meets Expectations" or higher.

M 8: Develop Clear Research Plans

This measure was inadvertently repeated and should be deleted.

Source of Evidence: Senior thesis or culminating major project

G 2: Academic & Professional Excellence

Active and productive graduate students who will contribute to the overall excellence of the department.

SLO 4: Apply Knowledge

Apply subject matter knowledge in a range of contexts to solve problems and make decisions.

Relevant Associations:

General Education/Core Curriculum Associations:
1. Master the depth of knowledge required for a degree
2. Demonstrate critical thinking
3. Communicate effectively
6. Prepare to engage in lifelong learning
7. Work collaboratively

Graduate Outcome Associations:
1.2 Apply subject matter knowledge in a range of contexts to solve problems and make decisions.

Related Measures:

M 6: NUEN 604 Report

NUEN 604 Oral and Written Report - This is an excellent course to help us measure the effectiveness of our student's to meet these learning outcomes. One, this course is in the majority of the student's degree plans, so it will do well to capture a large response from our base. Second, this course is typically taken in the second semester of their graduate coursework. This allows our students to acclimate to rigor of graduate course work, and it provides us with an early measurement of their skills. The oral report can help us to measure the following learning outcomes: · CE: Communicate Effectively (MS & PhD) · UT: Use appropriate technologies to communicate, collaborate, conduct research, and solve problems (MS & PhD) The written report can help us to measure the following learning outcomes: · AK: Apply subject matter knowledge in a range of contexts to solve problems and make decisions (MS) · UVS: Use a variety of sources and evaluate multiple points of view to analyze and integrate information and to conduct critical, reasoned arguments (MS) · DCR: Develop clear research plans and conduct valid (data-supported), theoretically consistent, and institutionally appropriate research (MS)
Source of Evidence: Presentation, either individual or group

**Target:**
That 100% of the students will earn a "B" or higher.

**M 7: Thesis committee evaluation**
Students will make a formal thesis presentation to their committee members and be evaluated on a number of Graduate SLO variables.

Source of Evidence: Academic direct measure of learning - other

**Target:**
100% of the students will have marks of "Meets Expectations" or higher.

**M 8: Develop Clear Research Plans**
This measure was inadvertently repeated and should be deleted.

Source of Evidence: Senior thesis or culminating major project

**SLO 6: Communicate Effectively**
Graduates will be able to readily and effectively communicate complex technical information to a wide variety of audiences in both written and oral form.

**Relevant Associations:**

**General Education/Core Curriculum Associations:**
- 3 Communicate effectively
- 4 Practice personal and social responsibility
- 5 Demonstrate social, cultural, and global competence

**Graduate Outcome Associations:**
- 1.4 Communicate effectively

**Related Measures:**

**M 6: NUEN 604 Report**
NUEN 604 Oral and Written Report - This is an excellent course to help us measure the effectiveness of our student's to meet these learning outcomes. One, this course is in the majority of the student's degree plans, so it will do well to capture a large response from our base. Second, this course is typically taken in the second semester of their graduate coursework. This allows our students to acclimate to rigor of graduate course work, and it provides us with an early measurement of their skills. The oral report can help us to measure the following learning outcomes: · CE: Communicate Effectively (MS & PhD) · UT: Use appropriate technologies to communicate, collaborate, conduct research, and solve problems (MS & PhD) The written report can help us to measure the following learning outcomes: · AK: Apply subject matter knowledge in a range of contexts to solve problems and make decisions (MS) · UVS: Use a variety of sources and evaluate multiple points of view to analyze and integrate information and to conduct critical, reasoned arguments (MS) · DCR: Develop clear research plans and conduct valid (data-supported), theoretically consistent, and institutionally appropriate research (MS)
Source of Evidence: Presentation, either individual or group

**Target:**
That 100% of the students will earn a "B" or higher.

**M 7: Thesis committee evaluation**
Students will make a formal thesis presentation to their committee members and be evaluated on a number of Graduate SLO variables.

Source of Evidence: Academic direct measure of learning - other

**Target:**
100% of the students will have marks of "Meets Expectations" or higher.

**M 8: Develop Clear Research Plans**
This measure was inadvertently repeated and should be deleted.

Source of Evidence: Senior thesis or culminating major project

**SLO 7: Use Appropriate Technologies**

Use appropriate technologies to communicate, collaborate, conduct research, and solve problems.

**Relevant Associations:**

**General Education/Core Curriculum Associations:**
1 Master the depth of knowledge required for a degree
2 Demonstrate critical thinking
3 Communicate effectively
6 Prepare to engage in lifelong learning

**Graduate Outcome Associations:**
1.5 Use appropriate technologies to communicate, collaborate, conduct research, and solve problems.

**Related Measures:**

**M 6: NUEN 604 Report**

NUEN 604 Oral and Written Report - This is an excellent course to help us measure the effectiveness of our student's to meet these learning outcomes. One, this course is in the majority of the student's degree plans, so it will do well to capture a large response from our base. Second, this course is typically taken in the second semester of their graduate coursework. This allows our students to acclimate to rigor of graduate course work, and it provides us with an early measurement of their skills. The oral report can help us to measure the following learning outcomes: · CE: Communicate Effectively (MS & PhD) · UT: Use appropriate technologies to communicate, collaborate, conduct research, and solve problems (MS & PhD) The written report can help us to measure the following learning outcomes: · AK: Apply subject matter knowledge in a range of contexts to solve problems and make decisions (MS) · UVS: Use a variety of sources and evaluate multiple points of view to analyze and integrate information and to conduct critical, reasoned arguments (MS) · DCR: Develop clear research plans and conduct valid (data-supported), theoretically consistent, and institutionally appropriate research (MS)
Source of Evidence: Presentation, either individual or group

**Target:**
That 100% of the students will earn a "B" or higher.

**M 7: Thesis committee evaluation**
Students will make a formal thesis presentation to their committee members and be evaluated on a number of Graduate SLO variables.

Source of Evidence: Academic direct measure of learning - other

**Target:**
100% of the students will have marks of "Meets Expectations" or higher.

**M 8: Develop Clear Research Plans**
This measure was inadvertently repeated and should be deleted.

Source of Evidence: Senior thesis or culminating major project

**SLO 9: Ethical Course of Action**
Choose ethical courses of action in research and practice.

**Relevant Associations:**

**General Education/Core Curriculum Associations:**
4 Practice personal and social responsibility
5 Demonstrate social, cultural, and global competence

**Graduate Outcome Associations:**
1.7 Choose ethical courses of action in research and practice.

**Strategic Plan Associations:**
Texas A&M University
6 Diversify and globalize the A&M community.

**Related Measures:**

**M 9: Ethical Enrichment Activity**
100% of our students will attend an ethical related seminar or some another enrichment activity that speaks to ethical choices and action.

Source of Evidence: Presentation, either individual or group

**Target:**
100% of our students will attend an enrichment activity.

**G 3: Research Excellence**
Graduate students will contribute and maintain the internationally recognized excellence in teaching and research.

**SLO 5: Use a Variety of Sources**
Use a variety of sources and evaluate multiple points of view to analyze and integrate information and to conduct critical, reasoned arguments.
Relevant Associations:

General Education/Core Curriculum Associations:
1. Master the depth of knowledge required for a degree
2. Demonstrate critical thinking
3. Communicate effectively
6. Prepare to engage in lifelong learning
7. Work collaboratively

Graduate Outcome Associations:
1.3. Use a variety of sources and evaluate multiple points of view to analyze and integrate information and to conduct critical, reasoned arguments.

Related Measures:

M 6: NUEN 604 Report
NUEN 604 Oral and Written Report - This is an excellent course to help us measure the effectiveness of our student's to meet these learning outcomes. One, this course is in the majority of the student's degree plans, so it will do well to capture a large response from our base. Second, this course is typically taken in the second semester of their graduate coursework. This allows our students to acclimate to rigor of graduate course work, and it provides us with an early measurement of their skills. The oral report can help us to measure the following learning outcomes: · CE: Communicate Effectively (MS & PhD) · UT: Use appropriate technologies to communicate, collaborate, conduct research, and solve problems (MS & PhD) The written report can help us to measure the following learning outcomes: · AK: Apply subject matter knowledge in a range of contexts to solve problems and make decisions (MS) · UVS: Use a variety of sources and evaluate multiple points of view to analyze and integrate information and to conduct critical, reasoned arguments (MS) · DCR: Develop clear research plans and conduct valid (data-supported), theoretically consistent, and institutionally appropriate research (MS)

Source of Evidence: Presentation, either individual or group

Target:
That 100% of the students will earn a "B" or higher.

M 7: Thesis committee evaluation
Students will make a formal thesis presentation to their committee members and be evaluated on a number of Graduate SLO variables.

Source of Evidence: Academic direct measure of learning - other

Target:
100% of the students will have marks of "Meets Expectations" or higher.

M 8: Develop Clear Research Plans
This measure was inadvertently repeated and should be deleted.

Source of Evidence: Senior thesis or culminating major project

Target:
100%
SLO 8: Develop Clear Research Plans
Develop clear research plans and conduct valid (data-supported), theoretically consistent, and institutionally appropriate research.

Relevant Associations:

General Education/Core Curriculum Associations:
1. Master the depth of knowledge required for a degree
2. Demonstrate critical thinking
3. Communicate effectively
4. Prepare to engage in lifelong learning
5. Work collaboratively

Graduate Outcome Associations:
1. Develop clear research plans and conduct valid, data-supported, theoretically consistent, and institutionally appropriate research.

Related Measures:

M 6: NUEN 604 Report
NUEN 604 Oral and Written Report - This is an excellent course to help us measure the effectiveness of our student's to meet these learning outcomes. One, this course is in the majority of the student's degree plans, so it will do well to capture a large response from our base. Second, this course is typically taken in the second semester of their graduate coursework. This allows our students to acclimate to rigor of graduate coursework, and it provides us with an early measurement of their skills. The oral report can help us to measure the following learning outcomes: · CE: Communicate Effectively (MS & PhD) · UT: Use appropriate technologies to communicate, collaborate, conduct research, and solve problems (MS & PhD) The written report can help us to measure the following learning outcomes: · AK: Apply subject matter knowledge in a range of contexts to solve problems and make decisions (MS) · UVS: Use a variety of sources and evaluate multiple points of view to analyze and integrate information and to conduct critical, reasoned arguments (MS) · DCR: Develop clear research plans and conduct valid (data-supported), theoretically consistent, and institutionally appropriate research (MS)

Source of Evidence: Presentation, either individual or group

Target:
That 100% of the students will earn a "B" or higher.

M 7: Thesis committee evaluation
Students will make a formal thesis presentation to their committee members and be evaluated on a number of Graduate SLO variables.

Source of Evidence: Academic direct measure of learning - other

Target:
100% of the students will have marks of "Meets Expectations" or higher.

M 8: Develop Clear Research Plans
This measure was inadvertently repeated and should be deleted.

Source of Evidence: Senior thesis or culminating major project

**Details of Action Plans for This Cycle (by Established cycle, then alpha)**

**Diversity Recruitment**
Currently, our overall departmental numbers are behind those of the college. We strive to be equal or exceed those of the college of engineering. Strive to reach a total population of 18% race/ethnic diversity and 20% females.

**Established in Cycle:** 2013-2014  
**Implementation Status:** Planned  
**Priority:** Medium  
**Implementation Description:** Recruit in-state system schools that have undergrad majors (physics and mechanical engineering) that feed into NUEN.  
**Responsible Person/Group:** Robb Jenson and Dr. Karen Vierow  
**Additional Resources Requested:** Funds for travel

**Diversity Recruitment**
Currently, our overall departmental numbers are behind those of the college. We strive to be equal or exceed those of the college of engineering. Strive to reach a total population of 18% race/ethnic diversity and 20% females.

**Established in Cycle:** 2013-2014  
**Implementation Status:** Planned  
**Priority:** Medium  
**Implementation Description:** Recruit in-state system schools that have undergrad majors (physics and mechanical engineering) that feed into NUEN.  
**Responsible Person/Group:** Robb Jenson and Dr. Karen Vierow  
**Additional Resources Requested:** Funds for travel

**Diversity Recruitment**
Currently, our overall departmental numbers are behind those of the college. We strive to be equal or exceed those of the college of engineering. Strive to reach a total population of 18% race/ethnic diversity and 20% females.

**Established in Cycle:** 2013-2014  
**Implementation Status:** Planned  
**Priority:** Medium  
**Implementation Description:** Recruit in-state system schools that have undergrad majors (physics and mechanical engineering) that feed into NUEN.  
**Responsible Person/Group:** Robb Jenson and Dr. Karen Vierow  
**Additional Resources Requested:** Funds for travel
Increase Diversity Recruitment

Currently, our overall departmental numbers are behind those of the college. We strive to be equal or exceed those of the college of engineering. Strive to reach a total population of 18% race/ethnic diversity and 20% females.

Established in Cycle: 2013-2014
Implementation Status: Planned
Priority: Medium
Implementation Description: Recruit in-state system schools that have undergrad majors (physics and mechanical engineering) that feed into NUEN.
Responsible Person/Group: Robb Jenson and Dr. Karen Vierow
Additional Resources Requested: Funds for travel
Mission / Purpose

To enable students to successfully perform as professional nuclear engineers with research expertise.

Goals and Student Learning Outcomes/Objectives, with Any Associations and Related Measures, Targets, Findings, and Action Plans

G 1: Recruitment
Recruit highly qualified graduate students and work to achieve greater diversity in the department.

SLO 1: Enrollees - High Quality
Enrollees will be of high quality.

Relevant Associations:

Strategic Plan Associations:
Executive Vice President for Academics and Provost
1.1 Accountability: Establish structures, processes, and policies that hold the unit accountable and eligible for rewards for demonstrating their current standing, plans, and progress in creating an environment where the diversity of individual identities and ideas are treated equitably in a climate that fosters success and achievement by all.
1.2 Climate: Promote a positive and supportive climate by identifying aspects in the climate of individual units and the University which foster and/or impede a working and learning environment that fully recognizes, values, and integrates diversity in the pursuit of academic excellence.
1.3 Equity: Integrate into the mission and goals of the unit that students, staff, and faculty (tenure and non-tenure track), regardless of identity, are all treated equitably.

Texas A&M University
2 Strengthen our graduate programs.
6 Diversify and globalize the A&M community.
8 Enrich our campus.
12 Meet our commitment to Texas.

Related Measures:

M 1: GRE Scores
GRE Scores - Common indicator of the quality of the graduate student's preparation. GRE scores will be compared to the program and the College. PhD NUEN - Fall 2012 Applied Admitted Q - 162162 V - 153156

Source of Evidence: Administrative measure - other
Target:
Quantitative Average: 161 (770 on previous scale) Verbal Average: 155 (530 on previous scale)

M 2: Prospectives GPA
GPA Average - Incoming students will possess a competitive GPA. PhD NUEN - Fall 2012 Applied Admitted 3.5883.600

Source of Evidence: Administrative measure - other

Target:
Our departmental goal is that incoming students average a 3.4

M 3: Program Diversity - Race/Ethnicities
Student Program Diversity - The program has and will continue to strive for a diverse program of students and meet the University's initiative to increase our under-represented groups. Fall 2012 - 13.7% under-represented students

Source of Evidence: Administrative measure - other

Target:
Increase domestic race/ethnic groups of under-represented students to 16%.

M 4: Program Diversity – Females
Student Program Diversity - The program has and will continue to strive for a diverse program of students and meet the University’s initiative to increase our make-up of female students. Fall 2012 - 13.6% of females in dept.

Source of Evidence: Presentation, either individual or group

Target:
Increase our female representation to 19.1%.

SLO 2: Enrollees - Achieve Diversity
Enrollees will help us achieve our diversity goals.

Relevant Associations:

Strategic Plan Associations:
Executive Vice President for Academics and Provost
1.1 Accountability: Establish structures, processes, and policies that hold the unit accountable and eligible for rewards for demonstrating their current standing, plans, and progress in creating an environment where the diversity of individual identities and ideas are treated equitably in a climate that fosters success and achievement by all.
1.2 Climate: Promote a positive and supportive climate by identifying aspects in the climate of individual units and the University which foster and/or impede a working and learning environment that fully recognizes, values, and integrates diversity in the pursuit of academic excellence.
1.3 Equity: Integrate into the mission and goals of the unit that students, staff, and faculty (tenure and non-tenure track), regardless of identity, are all treated equitably.
Texas A&M University
2 Strengthen our graduate programs.
6 Diversify and globalize the A&M community.
8 Enrich our campus.
12 Meet our commitment to Texas.

**G 2: Academic & Professional Excellence**
Active and productive graduate students who will contribute to the overall excellence of the department.

**SLO 3: Master degree program requirements**
Master degree program requirements.

**Relevant Associations:**

**General Education/Core Curriculum Associations:**
1 Master the depth of knowledge required for a degree
2 Demonstrate critical thinking
3 Communicate effectively
6 Prepare to engage in lifelong learning
7 Work collaboratively

**Graduate Outcome Associations:**
2.1 Master degree program requirements, including theories, concepts, principles, and practice; develop a coherent understanding of the subject matter through synthesis across courses and experiences; and apply subject matter knowledge to solve problems and make decisions.

**Related Measures:**

**M 6: Time of Completion to Graduation**
Our students will graduate from our program in a reasonable amount of time.

Source of Evidence: Existing data

**Target:**
Graduates of this program will have an average time of completion of 66 months.

**M 7: Qualifying Examination**
The passing rate of this can be tracked to demonstrate the competency of our PhD candidates. The learning outcome (MR) can be measured with this tool.

Source of Evidence: Standardized test of subject matter knowledge

**Target:**
That 60% of our students pass the QE on their first attempt, 90% on the second attempt.

**M 8: Dissertation Committee Evaluation**
Students will make a formal thesis presentation to their committee members and be evaluated on a number of Graduate SLO variables.

Source of Evidence: Academic direct measure of learning - other
Target:
100% of the students will have marks of "Meets Expectations" or higher.

SLO 4: Communicate Effectively
Graduates will be able to readily and effectively communicate complex technical information to a wide variety of audiences in both written and oral form.

Relevant Associations:

General Education/Core Curriculum Associations:
3 Communicate effectively
4 Practice personal and social responsibility
5 Demonstrate social, cultural, and global competence

Graduate Outcome Associations:
2.3 Communicate effectively.

Related Measures:

M 5: NUEN 604 Report
NUEN 604 Oral and Written Report - This is an excellent course to help us measure the effectiveness of our student's to meet these learning outcomes. One, this course is in the majority of the student's degree plans, so it will do well to capture a large response from our base. Second, this course is typically taken in the second semester of their graduate coursework. This allows our students to acclimate to rigor of graduate course work, and it provides us with an early measurement of their skills. The oral report can help us to measure the following learning outcomes: · CE: Communicate Effectively (MS & PhD) · UT: Use appropriate technologies to communicate, collaborate, conduct research, and solve problems (MS & PhD) The written report can help us to measure the following learning outcomes: · AK: Apply subject matter knowledge in a range of contexts to solve problems and make decisions (MS) · UVS: Use a variety of sources and evaluate multiple points of view to analyze and integrate information and to conduct critical, reasoned arguments (MS) · DCR: Develop clear research plans and conduct valid (data-supported), theoretically consistent, and institutionally appropriate research (MS)

Source of Evidence: Administrative measure - other

Target:
That 100% of the students will earn a "B" or higher.

M 8: Dissertation Committee Evaluation
Students will make a formal thesis presentation to their committee members and be evaluated on a number of Graduate SLO variables.

Source of Evidence: Academic direct measure of learning - other

Target:
100% of the students will have marks of "Meets Expectations" or higher.

SLO 5: Use Appropriate Technologies
Use appropriate technologies to communicate, collaborate, conduct research, and solve problems.
Relevant Associations:

General Education/Core Curriculum Associations:
1. Master the depth of knowledge required for a degree
2. Demonstrate critical thinking
3. Communicate effectively
6. Prepare to engage in lifelong learning
7. Work collaboratively

Graduate Outcome Associations:
2.5. Use appropriate technologies to communicate, collaborate, conduct research, and solve problems.

Related Measures:

**M 5: NUEN 604 Report**
NUEN 604 Oral and Written Report - This is an excellent course to help us measure the effectiveness of our student's to meet these learning outcomes. One, this course is in the majority of the student's degree plans, so it will do well to capture a large response from our base. Second, this course is typically taken in the second semester of their graduate coursework. This allows our students to acclimate to the rigor of graduate course work, and it provides us with an early measurement of their skills. The oral report can help us to measure the following learning outcomes: · CE: Communicate Effectively (MS & PhD) · UT: Use appropriate technologies to communicate, collaborate, conduct research, and solve problems (MS & PhD) The written report can help us to measure the following learning outcomes: · AK: Apply subject matter knowledge in a range of contexts to solve problems and make decisions (MS) · UVS: Use a variety of sources and evaluate multiple points of view to analyze and integrate information and to conduct critical, reasoned arguments (MS) · DCR: Develop clear research plans and conduct valid (data-supported), theoretically consistent, and institutionally appropriate research (MS)

Source of Evidence: Administrative measure - other

**Target:**
That 100% of the students will earn a "B" or higher.

**M 8: Dissertation Committee Evaluation**
Students will make a formal thesis presentation to their committee members and be evaluated on a number of Graduate SLO variables.

Source of Evidence: Academic direct measure of learning - other

**Target:**
100% of the students will have marks of "Meets Expectations" or higher.

**SLO 6: Ethical Course of Action**
Choose ethical courses of action in research and practice.

**Relevant Associations:**

General Education/Core Curriculum Associations:
4 Practice personal and social responsibility
5 Demonstrate social, cultural, and global competence

**Graduate Outcome Associations:**
2.7 Choose ethical courses of action in research and practice.

**Related Measures:**

**M 9: Ethical Enrichment Activity**
100% of our students will attend an ethical related seminar or some another enrichment activity that speaks to ethical choices and action.

Source of Evidence: Standardized test of subject matter knowledge

**Target:**
100% of our students will attend an enrichment activity.

**SLO 9: Teaching Subject Matter**
Teach and explain the subject matter in their discipline

**Relevant Associations:**

**General Education/Core Curriculum Associations:**
1 Master the depth of knowledge required for a degree
2 Demonstrate critical thinking
3 Communicate effectively
5 Demonstrate social, cultural, and global competence
7 Work collaboratively

**Graduate Outcome Associations:**
2.6 Teach and explain the subject matter in their discipline.

**Related Measures:**

**M 10: Presentations and Publishing of Journal Articles**
Doctoral students are expected to effectively teach and explain their subject matter (TE). They will meet this objective through conference presentations or by preparations of manuscripts for submission to a peer-reviewed journal.

Source of Evidence: Senior thesis or culminating major project

**Target:**
100% of our doctoral students will meet this requirement by graduation.

**G 3: Research Excellence**
Graduate students will contribute and maintain the internationally recognized excellence in teaching and research.

**SLO 7: Apply a variety of strategies**
Apply a variety of strategies and tools, use a variety of sources, and evaluate multiple points of view to analyze and integrate information and to conduct critical, reasoned arguments.

**Relevant Associations:**
General Education/Core Curriculum Associations:
1 Master the depth of knowledge required for a degree
2 Demonstrate critical thinking
3 Communicate effectively
6 Prepare to engage in lifelong learning
7 Work collaboratively

Graduate Outcome Associations:
2.2 Apply a variety of strategies and tools, use a variety of sources, and evaluate multiple points of view to analyze and integrate information and to conduct critical, reasoned arguments.

Related Measures:

M 8: Dissertation Committee Evaluation
Students will make a formal thesis presentation to their committee members and be evaluated on a number of Graduate SLO variables.

Source of Evidence: Academic direct measure of learning - other

Target:
100% of the students will have marks of "Meets Expectations" or higher.

SLO 8: Develop clear research plans
Develop clear research plans, conduct valid, data-supported, theoretically consistent, and institutionally appropriate research and effectively disseminate the results of the research in appropriate venues to a range of audiences

Relevant Associations:

General Education/Core Curriculum Associations:
1 Master the depth of knowledge required for a degree
2 Demonstrate critical thinking
3 Communicate effectively
6 Prepare to engage in lifelong learning
7 Work collaboratively

Graduate Outcome Associations:
2.4 Develop clear research plans, conduct valid, data-supported, theoretically consistent, and institutionally appropriate research and effectively disseminate the results of the research in appropriate venues to a range of audiences.

Related Measures:

M 8: Dissertation Committee Evaluation
Students will make a formal thesis presentation to their committee members and be evaluated on a number of Graduate SLO variables.

Source of Evidence: Academic direct measure of learning - other

Target:
100% of the students will have marks of "Meets Expectations" or higher.
Details of Action Plans for This Cycle (by Established cycle, then alpha)

Graduate Student Learning Outcomes
To implement new assessment methods that coordinate with the most recent Graduate Student learning outcomes.

Established in Cycle: 2012-2013
Implementation Status: Planned
Priority: High
Implementation Description: This involves creating a new assessment method for our final defenses.
Responsible Person/Group: Robb Jenson/Karen Vierow
Additional Resources Requested: None

Diversity Recruitment
Currently, our overall departmental numbers are behind those of the college. We strive to be equal or exceed those of the college of engineering. Strive to reach a total population of 18% race/ethnic diversity and 20% females.

Established in Cycle: 2013-2014
Implementation Status: Planned
Priority: Medium
Implementation Description: Recruit in-state system schools that have undergrad majors (physics and mechanical engineering) that feed into NUEN. Work to nominate 2 students a year for the Pathways PhD Fellowship.
Responsible Person/Group: Robb Jenson and Karen Vierow
Additional Resources Requested: Travel funds
Please define the groups applicable to your unit for which you collect information and make peer comparisons.

- X Students
  - X Undergraduate
  - X Masters
  - X Doctoral
  - __ Professional
- X Faculty, Lecturers, and Instructors
- X Administrators (applicable to all units)
- X Budgeted Staff (applicable to all units)
- __ Other (Define) __________________________

For the applicable groups above, please answer questions 1-6 below. Please provide concrete, specific examples (using visual illustrations as appropriate) referencing percentage and numeric changes in as succinct a manner as possible.

Limit responses to the Annual Assessment Report to five (5) pages. Please note that if visual illustrations are used, these are included in the five pages.

1) Engaging the Data

The following summarizes the trends identified by the data for the Dwight Look College of Engineering. The data reflects the results from the following data sources: DARS (for the student data) and TEES Human Resources (for the faculty and staff data, which includes faculty and staff funded by TEES and TAMU). These sources were used to provide the data for all four years in a consistent manner. The faculty members who are college administrators were counted in the faculty-staff tab as well as the tabs corresponding to their respective faculty ranks; this was done to give an accurate view of faculty progression through the ranks. In addition to the college administrators, the faculty data for the rank of professor includes the following university administrators: President Bowen Loftin, Provost Karan Watson, Associate Provost Karen Butler-Purry, Vice President and Associate Provost Pierce Cantrell, and CEO of Texas A&M Qatar Mark Weichold. The total faculty represents a summation of the faculty at the different ranks (lecturer, assistant professor, associate professor, full professor); the total faculty does not include the college administrators to avoid double counting. Departments were engaged with reviewing the data for the individual departments and providing valuable feedback.

Students

The Look College is making positive progress with respect to increasing the diversity of the total student population (undergraduate and graduate students). In Fall 2010, the percentage of women enrolled was 19% and the current percentage is 20%, while at the same time the student population increased from 11,059 students to 12,328 students (corresponding to an 11.5% increase in total students). For degrees awarded, the percentage of women was 20% for 2009-2010 and remained 20% in 2012-2013. As for Hispanic students enrolled in engineering, the percentage increased from 13% in Fall 2010 to 15% in Fall 2013. For degrees awarded, the percentage of Hispanic students increased from 9% in 2009-2010 to 11% in 2012-2013. With respect to Black students, the percentage enrolled decreased from 3% in Fall 2010 to 2% in Fall 2013. It is noted, however, that there has been a recent increase in number of Black students enrolled, from 269 in Fall 2012 to 282 in Fall 2013. For total degrees awarded, the percentage for Black students increased from 2% in 2009-2010 to 3% in 2012-2013. For American Indian students, enrollment increased from 28 to 37 students; the percentage rounds to 0%, however. For degrees awarded for American Indian students, the number decreased from eight in 2009-2010 to three in 2012-2013, again rounding to 0%.
We find that the trends for undergraduate students follow the same trends as the total student population, which is expected given that the undergraduate students account for 75% of the total student population in the Look College. The women enrolled in the undergraduate programs increased from 19% in Fall 2010 to 20% in Fall 2013. The national average, as indicated by the American Association of Engineering Education (ASEE), indicates women’s enrollment in engineering bachelor’s degree programs increased slightly from 18.1% in 2010 to 18.9% in 2012 (the data for 2013 is not available at this time). As for degrees awarded to women, there was a slight drop from 20% in 2009-2010 to 19% in 2012-2013, but the numbers increased from 266 to 317. Currently, the national average indicates 18.9% for women earning engineering bachelor’s degrees. For Black students, the percentage enrolled decreased from 3% in Fall 2010 to 2% in Fall 2013; the numbers also decreased from 245 to 225. With respect to bachelor’s degrees awarded to Black students, the percentage increased from 2% in 2009-2010 to 3% in 2012-2013. The national average indicates 4.2% for engineering bachelor’s degrees awarded to Black students in 2012. For Hispanic students, the percentage enrolled increased from 16% in Fall 2010 to 18% in Fall 2013. With respect to bachelor’s degrees awarded to Hispanic students, the percentage increased from 12% in 2009-2010 to 15% in 2012-2013. The national average indicates 9% for engineering bachelor’s degrees awarded to Hispanic students in 2012.

For master’s students, the percentage of women increased from 21% in Fall 2010 to 24% in Fall 2013. For Black students, the percentage remained 2% over the years; for Hispanic students the percentage was 6% in Fall 2010 and is currently 6%. For master’s degrees awarded to women, the percentage was 22% for 2009-2010, but dropped slightly to 21% for 2012-2013. For masters degrees awarded to Hispanic students, the percentage was 3% in 2009-2010, and increased to 5% for 2012-2013; it is noted that the percentage was 6% in 2011-2012. For master’s degrees awarded to Black students, the percentage increased from 1% in 2009-2010 to 2% in 2012-2013. For 2012, the national average for engineering master’s degrees awarded to women is 23.1%, to Black students is 4.7%, and to Hispanic students is 7.3%.

For doctoral students enrolled, the percentage of women increased from 18% in Fall 2010 to 19% in Fall 2013; this is important as the number of doctoral students also increased from 1122 in Fall 2010 to 1484 in Fall 2013. For Hispanic students enrolled in the doctoral program, the percentage increased from 3% in Fall 2010 to 4% in Fall 2013. With respect to Black students, the percentage decreased from 2% in Fall 2010 to 1% in Fall 2013. For doctoral degrees awarded, the percentage for women decreased from 19% in 2009-2010 to 18% in 2012-2013. For Hispanic students, the percentage of doctoral degrees awarded decreased from 4% in 2009-2010 to 3% in 2012-2013. For Black students, however, the percentage increased from 1% in 2009-2010 to 2% in 2012-2013. For 2012, the national average for doctoral degrees awarded to women is 22.2%, to Black students is 4.1%, and to Hispanic students is 4.1%.

In summary, with respect to student demographics in the Look College, the college efforts have resulted in mostly positive trends with respect to student diversity. While the Look College will continue to increase diversity of students enrolled and matriculation to the degree, major efforts are placed on Black students at the undergraduate and graduate levels, in addition to a focus on women at the undergraduate level and degrees awarded at the master’s level. We also have a major focus on increasing diversity for the doctoral program. The details of the actions taken by the Look College are given below in the sections on Recruitment, Retention, and Future Efforts.

Faculty
The Look College has some positive trends with respect to faculty diversity. The percentage of Hispanic faculty has increased from 6.2% in FY 2011 to 7.9% in FY 2014; and for women the percentage has remained at 15%. For the case of Black faculty, however, the percentage decreased from 2.1% in FY 2011 to 1.7% in FY 2014. Looking across the faculty ranks of assistant professor to professor, we can see a good progression of faculty from assistant to associate professors. With respect to national averages, the ASEE data for 2012 indicates women comprise 14% of the tenured and tenure-track faculty, Black faculty comprise 2.7%, and Hispanic faculty comprise 3.9%. It is recognized that more effort is needed with the Black faculty and women. Faculty search committees continue to complete the training sessions given by the Dean of Faculties. Further, the dean’s office continues to work with the departments to insure that faculty advertisements are placed in key venues that target diverse
populations in addition to providing oversight to insure that diverse populations are considered with respect to faculty interviews.

Administrators
The Look College is doing very well with respect to diversity in faculty and staff in administrative rolls. As for faculty in administrative rolls, the percentage of women has increased significantly from 15% in FY 2011 to 24% in FY 2014. Further, there is ethnic diversity of faculty administrators, with one Black faculty (4%), one Hispanic faculty (4%), and five Asian faculty members (20%). In regard to staff in the executive-admin-manager titles, the percentage of women has increased in number from five in FY 2011 to 10 in FY 2014. Further, for the staff in the executive-admin-manager titles, the Look College is moving toward a gender balance with 100% women in FY2011 to 63% women in FY 2014. Ethnic diversity for staff in the executive-admin-manager titles is significantly better with 100% White in FY 2011 to 6.3% Black and 6.3% Hispanic in FY 2014. It is important to note that the Vice Chancellor and Dean of Engineering is a woman.

Staff
With respect to staff overall, the Look College continues to have gender balance with 50% women and 50% men in FY 2014. As for ethnic diversity, there have been some small decreases in percentages from FY 2011 to FY 2014. For example, for Black staff, the percentage was 3.2% in FY 2011 and is now 3.0%. For Hispanic staff, the percentage was 10.3% in FY 2011 and is now 9.5%. In October of this year, the Look College distributed a staff climate survey to better understand the issues. The results of the survey are still being analyzed and will be used to aid in changing the trend to positive increases in ethnic diversity among the staff.

2) Recruitment and Retention

Below, we provide the details about different recruitment and retention efforts. Several of these efforts were made possible with the diversity funds received from Provost office.

Recruitment
Students: Significant efforts have been undertaken to recruit diverse undergraduate and graduate student populations. For the undergraduate students, these efforts include the Summer Camps (five-day residential camps targeting rising juniors and seniors; the Look College has two camps – one for women and one for E12 schools, electrical engineering has a camp, aerospace engineering also has a camp); Collaborations with the Office of Admissions (participate with events that target ethnic minorities and women interested in engineering); E12 Program (established partnerships with 12 top performing Texas high schools with diverse students); Engineering Academies (starting with Blinn College, develop programs whereby students have an opportunity to take engineering courses while enrolled at Blinn; currently called Blinn Team E); and participating with the student selections for the Atlanta Posse and Houston Posse Programs (currently, the Look College has seven Posse scholars).

For graduate students, the recruiting efforts include Participation in National Conferences for Key Organizations (the Look College participates in the following national conferences: National Society of Black Engineers, Society of Women Engineers, American Indian Science and Engineering Society, Society of Hispanic Professional Engineers, Latinos in Science and Engineering, and Society of Asian Americans in Science and Engineering); the Undergraduate Summer Research Grants Program (10-week summer research program that targets undergraduate students, with a focus on students from underrepresented groups; leverage from REU supplements obtained by NSF PIs or co-Pis); and many of the engineering faculty are involved with the recently funded NSF AGEP (Alliances for Graduate Education and the Professoriate) grant, which is a Texas A&M System effort focused on increasing the number of underrepresented minorities obtaining graduate degrees in STEM.
Faculty: With respect to faculty recruitment, the Vice Chancellor and Dean continues to insist that all faculty search committees have a very diverse pool of candidates invited for interviews. The college works with all of the departments to advertise open faculty positions in key venues that target underrepresented groups. Further, department search committee chairs are required to complete the Dean of Faculties training session for effective searchers. Departments are required to provide the list of faculty candidates invited for interviews to insure a diverse pool of candidates is considered for interviews. All faculty candidates are required to meet with one of the deans.

Staff: For staff recruitment, TEES HR provides oversight that a diverse pool of candidates is considered for each position.

Retention

Students: Significant efforts have been undertaken to retain the diversity of the undergraduate and graduate student populations. For the undergraduate students, the retention efforts include the Engineering Living Learning Community (ELLC) (a residence hall program for first year engineering students with programs designed to create a community of scholars, aid in the transition to college, and foster a commitment to academic excellence; over 600 students participated in 2012 with 82.8% retention overall and 84.5% retention for women); Peer Teachers and Tutors (offered in ELLC as well as for all students with a focus on the freshman and sophomore level courses); Supplemental Instruction (support SI sessions for freshman and sophomore courses through the Peer Academic Services); and the Success Seminar (one hour weekly seminar that focuses on success strategies, with a focus on Regent Scholars).

With respect to undergraduate and graduate students, many of the departments are working with their respective student organizations to put into place mentoring programs. Some departments have student organizations that target women, such as computer science and engineering (Aggie Women in Computer Science) and a new organization for women in aerospace engineering (Aggie Aerospace Women in Engineering). The college provided support to the Department of Computer Science and Engineering to send students to the Richard Tapia Celebration of Diversity in Computing Conference (February 5-8, 2013) and the Grace Hopper Celebration of Women in Computing Conference (October 2-5, 2013).

Faculty and Staff: A number of faculty members from the Look College have participated in different TAMU ADVANCE programs, ranging from the LEAD program (for department heads), the Faculty-Staff program (workshop and two quarterly meetings), to the Roadmap workshop. In total, the Look College had over 60 faculty and staff participants, from all departments, take part in the ADVANCE programs or are apart of the ADVANCE leadership. In addition, staff members are encouraged and provided support to participate in various professional development activities, ranging from participation in appropriate conferences to enrollment in classes and/or leadership workshops and seminars. With respect to faculty, the college of engineering is very supportive of the Women Engineering Faculty Interest Group and the Minority Engineering Faculty Group. Additionally, the college has in place an Ombudsperson to facilitate individual faculty issues being brought to the dean’s office.

3) Advisory and/or Developmental Council Groups

Each department in the Look College has an advisory board, with the goal of being proactive with advice about undergraduate and graduate curricular and department development activities. Departments with small boards were encouraged to increase the size of the boards to have a critical mass for each board meeting. In addition, the college has an external advisory board comprised of top executives from industry and one representative from each department’s advisory board. For all advisory boards, significant focus is placed on diversity of the memberships. Overall, the current demographics of the departmental advisory boards consist of 9% women, 5% Hispanic, 2% Black and 2% Asian. The Vice Chancellor and Dean has committed to tracking the demographics of the advisory boards.
4) Unit Climate

The Look College distributed the university faculty climate survey (developed by Dr. Victor Willson, Department Head for EDPY) to all departments in 2012. The results of the survey were returned to each department for discussion and appropriate follow-up. One department, Mechanical Engineering, used the survey results to identify the need for a department-wide diversity committee. As mentioned previously, staff climate survey was distributed in the college this past October. The results of the survey are being analyzed.

5) Equity

Each year the Look College receives data about faculty salaries from the Dean of Faculties through the ADVANCE program. This data is used to address equity issues among salaries. Further, departments are given the opportunity to submit equity requests at the time of merit raises. With respect to start-up packages and salary offers, all requests must be approved by the dean’s office to insure equity among the offers. Additionally, each year TEES HR visits each department to discuss equity issues among staff salaries. TEES HR works with the departments to submit requests to address staff equity issues.

6) Future Efforts

The Look College has the following new efforts in place for this current year. Again, several of these efforts are made possible with the diversity funds received from the Provost office.

- **Director of Access and Inclusion** [impacts undergraduate and graduate students]: The Look College has an active search for the position of Director of Access and Inclusion, whose responsibilities include the initiation, development, management, evaluation, and promotion of research informed and strategic comprehensive activities and programs for recruitment and success of students from historically under-represented groups and under-served communities in the Look College.

- **E12+ Program** [impacts undergraduate students]: The E12 program has provided a great partnership with high schools and industry sponsors. To further increase the impact of the program and reach more students across the state of Texas, the Look College plans to expand the program to include additional high schools. Each of the current E12 high schools will serve as a hub for several other high schools in their area.

- **Look College of Engineering Diversity Committee** [impacts faculty, staff, students, and advisory boards]: The Look College is in the process of establishing a diversity committee composed of faculty, staff, and students (undergraduate and graduate students) with a focus on diversity for students, faculty, staff, and advisory boards. The committee’s responsibilities include identifying best practices within the departments for sharing among departments, providing college-level responses and initiatives resulting from climate surveys, and developing annual reports that summarize progress and elicit college-wide discussions.

- **Partnership with the Texas A&M Success Center** [impacts undergraduate students]: The Look College has provided support to hire one full time coach with the Texas A&M Success Center to work directly with our students with a term GPA of < 2.0 (as opposed to a cumulative GPA of < 2.0) to develop a success plan for improvement. The goal is to be proactive instead of reactive. The Look College is also working with the Success Center and the Math Department to identify at risk students early in the math course to provide guidance for course success.

- **Newly Awarded National Action Council for Minorities in Engineering Grant** [impacts undergraduate students]: The Look College was awarded a grant for $225,000 through the Texas A&M Foundation to provide scholarships over a five-year period.

- **Leadership Workshop for Underrepresented Faculty** [impacts faculty]: The Look College is organizing a two-day leadership workshop that will include Adrianna Kezar (a national expert in change and leadership education at USC), Shirley Malcom (Director of Education for the American Association for the Advancement of Science), and Richard Tapia (Professor at Rice University). As this is the first of such workshops, the focus will be on women faculty and faculty from underrepresented groups. The workshop is scheduled for May 13-14, 2014.

- **Summer Camp for Middle School Students** [impacts undergraduate student recruitment]: Industrial and Systems Engineering, in collaboration with the Bryan Independent School District, is organizing a new summer camp that targets middle school students.

- **Study Abroad** [impacts undergraduate students]: For Summer 2014, the college has 19 programs that include sessions in Brazil, China, India, Rwanda, Italy, and Spain.
No data
Appendix E. Growth Plan
Department of Nuclear Engineering
25x25 Growth Plan

Department Head:
Dr. Yassin A. Hassan

Growth Committee Members:
Dr. William Charlton
Dr. William Marlow
Dr. Lee Peddicord
Dr. Karen Vierow

Report written with participation by:
The entire Department of Nuclear Engineering Faculty
Mrs. Kristina Ballard, Communications Specialist
Mr. Robb Jenson, Graduate Program Coordinator

Submitted to the College of Engineering
Texas A&M University
August 1, 2013
Table of Contents

1. Introduction ......................................................................................................................................................... 3
   1.1 Department Overview as of August 2013 ............................................................................................................. 3
   1.2 Formation of the Department’s Growth Plan .................................................................................................... 4
2. Student Population Growth ...................................................................................................................................... 5
3. Undergraduate Program Growth .......................................................................................................................... 8
   3.1 Undergraduate Population Growth Plan ............................................................................................................. 8
   3.2 Undergraduate Retention Plan .......................................................................................................................... 10
   3.3 New Instructional Methodologies for Undergraduates ..................................................................................... 13
   3.4 Sharing of Large Undergraduate Laboratories ................................................................................................. 18
4. Graduate Program Growth ...................................................................................................................................... 19
   4.1 Master of Engineering Growth and Recruitment Plan ....................................................................................... 19
   4.2 M.S. and PhD Growth Plan ............................................................................................................................... 24
   4.3 Distance Education Program ............................................................................................................................ 25
   4.4 Certificate Programs ............................................................................................................................................ 28
5. Research Growth Plan ............................................................................................................................................ 29
6. Faculty Hiring Plan .................................................................................................................................................. 30
   6.1 Tenured/Tenure Track Faculty Hiring Plan ......................................................................................................... 30
   6.2 Estimate of Teaching Faculty Needs for Growth Plan ........................................................................................ 30
7. Additional Space and Equipment Needed ................................................................................................................ 32
8. Periodic Review and Revision of Growth Plan ..................................................................................................... 34
9. Anticipated Challenges or Delays ........................................................................................................................ 35
   9.1 Marketing of the New Graduate Programs ......................................................................................................... 35
   9.2 Supply of Non-tenure Track Faculty .................................................................................................................. 35
   9.3 Establishment of Distance Learning Programs ................................................................................................ 35
   9.4 Fragmentation of the Department ..................................................................................................................... 35
1 Introduction

1.1 Department Overview as of August 2013

The Department of Nuclear Engineering had the following enrollment for Fall 2012:

<table>
<thead>
<tr>
<th>Undergraduate Student Enrollment</th>
<th>Graduate Student Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>255 B.S. Nuclear Engineering</td>
<td>75 M.S. Nuclear Engineering</td>
</tr>
<tr>
<td>71 B.S. Radiological Health Engineering</td>
<td>11 M.S. Health Physics</td>
</tr>
<tr>
<td>323 Total</td>
<td>54 Ph.D. Nuclear Engineering</td>
</tr>
<tr>
<td>140 Total</td>
<td></td>
</tr>
</tbody>
</table>

The department’s total research expenditure for the fiscal year 2012 was as follows: $10.2 million in research expenditures, $12.9 million in research awards. According to U.S. News & World Report, the department’s graduate program is ranked third among public institutions, and fourth overall. The undergraduate program, when last ranked, was second overall.

Research areas include fuel cycles & materials, health physics, medical physics, radiation transport, security, safeguards & nonproliferation, and thermal hydraulics.

The department’s facilities and centers are numerous, most important to mention are the two reactors, our AGN-201M Nuclear Reactor laboratory, and our 1MW Triga Reactor at the Nuclear Science Center. Having two reactors makes our department the only nuclear engineering program in the country with two operating reactors.
1.2 Formation of the Department’s Growth Plan

The Department of Nuclear Engineering’s philosophy for the 25x25 Growth Plan revolves primarily around growth in the graduate program, for the Master of Engineering, Master of Science and Ph.D. degrees, and the development of distance education and certificate programs. A largely untapped market of graduate students exists in the professional nuclear sector. The department envisions large benefits to these potential students, the nuclear profession, and the College of Engineering from extending our educational efforts to these groups. Since these students already have employment, they would not be seeking jobs. Therefore, the student population can grow without adversely impacting the job market for nuclear engineers.

The Department anticipates being able to achieve modest growth in the undergraduate program by recruiting international students from countries that are developing new nuclear power programs. These students are expected to return to their home country, with the benefit being strengthened ties between the department and institutions in their home countries, and student population growth without increased employment competition for domestic students.

The Department’s Growth Plan was developed with participation of the full faculty. The Department of Nuclear Engineering Growth Committee was formed to lead the effort, with membership consisting of a former department head and college-level administrator, the department’s lead undergraduate advisor, the head of an institute and the department’s graduate coordinator. The committee met approximately bi-weekly from March through May and at least monthly thereafter.

This committee reported to the faculty at full faculty meetings a total of five times. Three of the faculty meetings were extended lunch meetings that lasted 1-1/2 to 2 hours. Faculty were also consulted outside these meetings and asked to provide feedback on all drafts of the report. The assistance of departmental staff was enlisted to coordinate meetings, provide data to generate growth estimates, review report sections, format the report and otherwise provide input to growth plans.
Student Population Growth

The Department of Nuclear Engineering anticipates growth of the student population as shown in the following tables and graphs.

![Figure 2.1](image1)

The curve of the total student population has been deleted from Figure 2.2 to distinguish more clearly between the various growth components.

![Figure 2.2](image2)
The size of the undergraduate population is expected to be constant or possibly decline slightly in the first few years for domestic students. An increase in the number of international students will offset any decrease in domestic student numbers and will later serve to increase the total undergraduate population.

The number of Master of Science students will be proportional to the number of tenured/tenure track faculty. Both are expected to increase during this growth plan.

A Master of Engineering program is being proposed herein which will provide the majority of the student population growth. The department will be striving for equal growth of the three Master of Engineering program components: the Traditional Master of Engineering degree; the Master of Engineering Roadmap to Excellence degree; and the Distance Learning Master of Engineering degree. We anticipate being a seven-year ramp up to a steady-state level of 60 new students each year in each of the three components, for a total of 360 students at any one time.

The prediction of the PhD student population growth is the sum of an extrapolation of past growth plus an increase due to additional tenured/tenure track faculty.

Figure 2.3 reveals the contributions of each Master of Engineering cohort.

The number of Weighted Student Credit Hours (WSCH) will more than double by 2025 the projected number for 2013 due, in large part, to growth of the Master of Engineering program. In the fall of 2013, a total of about 41,935 WSCH is projected. By fall 2018, this number should increase to 86,414 WSCH. By fall 2025, the department aims to have 105,743 WSCH.

The data provided by the Dean’s office to the growth chairs was used for these estimations.
Figure 2.4  Growth in the Number of Weighted Student Credit Hours
3 Undergraduate Program Growth

3.1 Undergraduate Population Growth Plan

Background
In recent years, the undergraduate enrollment in the Department of Nuclear Engineering has grown at a rate that, extrapolated to 2024, will increase its enrollment by 50% relative to current enrollment. This growth is due to a combination of freshman enrollment, transfers into the department by students initially enrolling in other TAMU departments, transfers into NE by students beginning college elsewhere, and finally by enrollment by foreign students. Approximately half of our baccalaureate graduates continue their education in either graduate or professional schools and an additional fraction changes fields. To some extent, these fractions of students are affected by their employment opportunities in nuclear engineering upon completion of their undergraduate degrees, but in all cases students enter the department under the assumption that employment opportunities related to nuclear or radiological health protection engineering will be available when they graduate. Therefore, projections of employment opportunities are critical for the stability and growth of the programs of the Nuclear Engineering Department.

Assessment of the likelihood of the continuation of growth in enrollment is here based upon anticipated demand growth for our graduates. The Bureau of Labor Statistics projects a US growth in demand of 10% for 2010 to 2020, or extrapolating to 12% from 2012 to 2024 plus a 22% growth due to personnel replacements for 2010-2020 or about 24% for 2012-2024. Together, this 12% + 24% suggests an increase in demand from these two sources alone corresponding to at least 2/3’s of the anticipated 50% fractional increase in the TAMU program at its current growth rate. In contrast, the Nuclear Energy Institute, which speaks for the nuclear power industry, expects stable hiring of 150 nuclear engineers per year for the next 5 years as has been true for the last 5 years. This can be understood by the fact that growth of the US nuclear power industry is currently in hiatus for multiple reasons that will gradually disappear in 5 to 15 years. Finally, on the current demand side, is the rise of nuclear power in the developing world where most near-term growth is due to expansion of the industry. This expansion requires many new nuclear engineering hires for their emergent nuclear power industry and is largely responsible for the enrollment of foreign students in our undergraduate program with rising demand. One additional and important, but difficult to quantify, factor is the demand for nuclear engineering graduates in non-nuclear power sectors where increasingly diverse applications and needs for personnel educated in nuclear radiation-related opportunities and issues are continually arising.

Growth Plan
The growth scenario discussed above suggests that the growth in domestic demand by students will not increase, and quite possibly will marginally decrease in the near term due to the hiatus in new nuclear power development. This hiatus notwithstanding, students still seek employment at current facilities or use their undergraduate education for a variety of other endeavors, so the demand will continue with prospects for resumption of considerable domestic growth in the 5-15 year time frame. In contrast, the demand for rigorously prepared nuclear and radiological health protection engineering graduates by the emergent nuclear power states is real, is growing, and will continue until the national personnel infrastructures of those countries are met years into the future. These complementary demand projections provide the basis for the Growth Plan of the Nuclear Engineering Department:

1) Annual enrollment growth of 3% to 4% of 2010 base-year enrollment will continue through 2024
2) Enrollment by US students will either remain constant or marginally decrease until approximately 2020.
3) Enrollment in the Nuclear Engineering Department by foreign students will be permitted to increase to meet the Department’s enrollment growth goals.

**Benefits of Growth Plan**
While the Growth Plan is for increasing numbers of graduates in an environment of limited domestic demand growth, those increases in the near term are based upon graduation of students who return to their home countries. Thus, they will not compete with domestic graduates to create an oversupply of qualified personnel. In the intermediate- and longer-term time frames, as the hiatus in nuclear power development lessens and disappears, gradually rising domestic demand will follow. We anticipate this domestic growth will complement a decrease in foreign student enrollment in the 5-15 year period when the Department of Nuclear Engineering will have built its educational resources sufficiently to meet the rising domestic demand and to continue its leadership in US nuclear engineering education.
3.2 Undergraduate Retention Plan

I. Data Record and Analysis

Retention of students by the Department is understood as beginning with their registration in the Department. While historically, this began on first admission to the University, the policy of the College of Engineering is being modified to better correspond to that of many other peer institutions. Beginning with the 2014-2015 Academic Year, entering freshmen students will be formally identified only with the College of Engineering until they satisfactorily achieve certain curricular milestones. Those milestones generally correspond to performance levels in the Common Body of Knowledge courses required of all College of Engineering students. In the following discussion, the historical retention record of the Department of Nuclear Engineering is analyzed using these same standards to the extent that a correspondence can be established. Thus, retention for a particular academic year freshmen cohort is based upon the number registered in the department 1 year following their freshman academic year. For example, 36 freshmen were in the freshman cohort entering in AY2004-2005 and 20 of them registered in the department in Fall 2005. Analysis of retention is based upon the subsequent retention of those 20. Ideally, the more stringent standard of elevation to Upper Level Status would be the criterion utilized to identify students with the department because not all entering second year students achieved this status that better corresponds to the policy of the College of Engineering to be implemented in AY 2014-2015. However, this information is more difficult to identify and in any event the greatest fraction of transfers from the department and terminations from the university have already occurred. Table 1 summarizes the historical record of retention based upon the above criteria. Students terminating university enrollment, whether for academic, financial, or personal reasons, as well as students transferring elsewhere in the university account for the decreases from the 2nd Year Enrollment data.

Table 3.1
RETENTION RECORD BY FRESHMAN YEAR COHORT: DATA FOR MAY, 2013

<table>
<thead>
<tr>
<th>AY Entered</th>
<th>AY 04-05</th>
<th>AY 05-06</th>
<th>AY 06-07</th>
<th>AY 07-08</th>
<th>AY 08-09</th>
<th>AY 09-10</th>
<th>AY 10-11</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2nd Yr Enrollment</td>
<td>20</td>
<td>38</td>
<td>50</td>
<td>57</td>
<td>58</td>
<td>64</td>
<td>62</td>
</tr>
<tr>
<td>% Enrolled or Graduated</td>
<td>90%</td>
<td>64%</td>
<td>78%</td>
<td>63%</td>
<td>62%</td>
<td>79%</td>
<td>80%</td>
</tr>
</tbody>
</table>

Analysis of retention of transfer students is generally more straightforward because, in most cases, those students enter with credit for most or all of the CBK courses, which corresponds to initial registration in the department for students entering as freshmen. In Table 2 for transfers, internal and external transfers are aggregated and, again, transfers out and terminations are not differentiated from each other in student retention.

Table 3.2
TRANSFER RETENTION RECORD BY ENTERING YEAR COHORT: DATA FOR MAY, 2013

<table>
<thead>
<tr>
<th>AY Entered</th>
<th>AY 04-05</th>
<th>AY 05-06</th>
<th>AY 06-07</th>
<th>AY 07-08</th>
<th>AY 08-09</th>
<th>AY 09-10</th>
<th>AY 10-11</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Total No. Transfer</td>
<td>8</td>
<td>13</td>
<td>12</td>
<td>28</td>
<td>30</td>
<td>32</td>
<td>34</td>
</tr>
<tr>
<td>% Enrolled or Graduated</td>
<td>63%</td>
<td>69%</td>
<td>75%</td>
<td>61%</td>
<td>57%</td>
<td>91%</td>
<td>98%</td>
</tr>
</tbody>
</table>
The records for both freshman and transfer entrants into the Nuclear Engineering Department nominally at the sophomore level are quite similar. For the AY 09-10 and more recent cohorts, retention has been excellent: nearly 80% and larger for freshman and nearly 90% and larger for transfer students. Similarly, the AY04-05 freshman cohort showed 90% retention while that same year cohort for transfers was somewhat lower. However, the latter suffers from the “statistics of small numbers” since the 63% retention is for 5 graduates, 2 terminated students, and 1 transfer, a record whose deficit is likely dominated by personal considerations of the terminated students.

There are multiple reasons why students leave the Nuclear Engineering Department without graduating, as reflected in Tables 1 and 2. The following listing summarizes observations by the department over a number of years:

1) Students sometimes find they are not comfortable with the nature of the materials covered in nuclear engineering and related fields and/or the methods employed in our major subjects, that are relatively abstract and mathematical compared with most other engineering disciplines. Often students give little thought to these questions or are unaware of how the issues in the field are approached when selecting the major. Once in the department, these issues present themselves for the first time resulting in students’ seeking other majors more suitable to them personally. We consider this part of the self-discovery process that is an important part of university education. These same considerations result in a number of student transfers into our department from other majors.

2) Immaturity manifesting itself in many different ways but resulting in failure to devote the effort to coursework that is necessary to succeed. Conversely, the Nuclear Engineering Department greatly benefits from the return of some very capable, older students whose initial college experiences, whether at Texas A&M or elsewhere, where undermined by their readily admitted earlier immaturity.

3) Financial, family, or personal issues affect students, resulting in their temporary or permanent withdrawal from the university. Each such withdrawal is entered as a termination even if the student returns later.

4) High school or prior college preparation that is inadequate for Texas A&M coursework. While some students manage to overcome their deficiencies in preparation, many other find themselves overwhelmed resulting in substandard performance in required courses.

5) Poor study practices resulting in unsatisfactory coursework performance

6) Insufficient abilities required of a student to succeed in one or more crucial areas of coursework.

7) Questioning of the wisdom of continuing in one of the majors of the department. This uncertainty can arise for multiple reasons including employment prospects in the principal fields for which students are prepared, competitive salaries, and perception of a lack of diversity of opportunities offer by the field.

II. Retention Issues and Plan

The 7 general reasons why students leave the department, as listed above, can not all be affected by actions by the department. Affecting reasons 1) through 3) are beyond the abilities of the department. The following discussion pertains to the remaining reasons.

For observers such as departmental Advisors or others in the department or the College of Engineering, reasons 4) – 6) are indistinguishable at the outset. The earliest possible remediation of reasons 4) and 5) is crucial for retention of those students and similar identification of 6) permits those students to succeed in college by transferring into programs more suitable for their abilities. The Department of Nuclear Engineering currently uses and is planning multiple approaches of information, help, and engagement to address the issues of student preparation, study skills, and abilities which are the issues underlying 4) – 6):
Information: Currently, the department sends tailored letters to different categories of deficient or struggling students immediately following release of grades each fall and spring semester. These letters detail the student’s academic problems, consequences of these problems, and the student’s status, as appropriate. For the past year, a new letter has been added for all students earning a D or F in a required course even if their overall records are satisfactory. The objectives of these letters are twofold: (1) inform students of departmental actions such as the requirement to leave the department due to failure to satisfy upper Level requirements, or requirements in special cases to qualify for Upper Level and (2) outline possible consequences of their current academic deficiencies, particularly if they do not improve. In all cases, counseling with individual students by faculty occurs in an effort to address their academic problems.

Help: In recent years, the college and university have made a number of resources available to assist students in addressing their academic difficulties. This semester, the department will actively inform students in need of help of these resources by including the information regarding these resources in the letters informing the students of departmental deficiencies. The department will also verbally counsel the students and refer them to the Academic Success Center that has been created to assist students with academic challenges. These actions mirror and support the efforts of the Engineering Academic and Student Affairs office.

Engagement: An approach to retaining students whose progress or interest is faltering, 4) – 6) above, and to some degree 7), is to engage them in a broader range of academic activities than strictly classroom work. One example is already a common practice for many students as they engage in “undergraduate research” with faculty. Additional experience-based activities engaging multiple levels undergraduates would make concrete the work of the department for lower level undergraduates work and perhaps stabilize their interests in the department by demonstrating work beyond the classroom. Efforts have begun to implement this engagement through NUEN 101, the introductory freshman course, via the participation of freshmen with seniors in some of their work such as their senior design projects. A potential, additional effort that is currently in its earliest stages of consideration is the introduction of a systems engineering component to the undergraduate education via a partnership with the nuclear industry through Texas A&M’s Nuclear Power Institute.

The final retention issue, 7), is one that confronts all of the smaller or “niche” departments from time to time because of the wide swings in demand. Nuclear engineering is no different as long as its sole focus is power reactor technology. In addition to what we have seen among our students, our annual Senior Exit interview with our graduating seniors has also hinted at the need to grow our education beyond the confines of nuclear power engineering. For this reason, the department is beginning a discussion of how to expand students’ understanding of nuclear engineering to encompass the wide variety of fields for which their education uniquely equips them to make crucial contributions but that are unrelated to power engineering. We anticipate that this will have the effects of emboldening our graduates to seek job opportunities that would not previously have occurred to them, possibly attract new students, and inform potential employers that our education prepares students to address their needs.
3.3 New Instructional Methodologies Plan for Undergraduates

Curricular Enhancement Philosophy within the Department of Nuclear Engineering

A basic philosophy of the Department of Nuclear Engineering regarding curricular enhancement is to let the curriculum develop and grow in response to market needs.

The Department established its core curriculum upon the department’s founding in 1958 and has followed a policy of periodic updating to maintain currency and relevancy. This philosophy supports the retention discussion of the previous section (see the last paragraph in particular) and will be followed during the 25 x 25 Growth Plan.

Recent changes in the nuclear sector that require curriculum reform are an increased importance placed on nuclear safety and security. The Department also anticipates expansion into power plant simulation technologies and nuclear medicine given the rising demand for medical physicists. We also see reduced hiring for domestic undergraduates due to the less-than-expected number of new reactor builds in the US, and conversely, a greater interest in our program from students in countries developing nuclear power programs. Finally, we have a student body that grew up with electronic means of communications and entertainment unavailable to the majority of the faculty during our childhoods. We are endeavoring to modify the academic experience we provide to best teach and prepare these students for the professional world they will encounter.

Current needs

The Department of Nuclear Engineering has identified our current needs for curricular enhancement with respect to new instructional methodologies as:

- Inclusion of additional technical areas to the undergraduate curriculum
- Modernization of teaching methods to best educate the current generation
- Experience at the undergraduate level with working across disciplines
- Placement of our graduates within the nuclear sector

Approaches to meet the identified needs

Inclusion of additional technical areas to the undergraduate curriculum

Nuclear Safety

The US nuclear industry has a remarkable safety record with regard to construction, operation and maintenance of its reactor fleet. However, events such as the September 11 attacks on the World Trade Centers and the 2011 Fukushima Dai-ichi reactor accidents have driven us to elevate our safety standards even further. Our undergraduate students are now expected to have a firm understanding of US and international reactor accidents, their consequences and how to prevent their reoccurrence. Further, our students are asked to make design contributions to safety features of reactors still in the design stage.

Our department proposes to grow the safety and power engineering component of the undergraduate education by incorporating safety lectures into several of the required courses in a coherent and integrated fashion. Such an effort was begun in 2007-2008 with a US Nuclear Regulatory Commission-funded project. This effort will be restored by reviewing the safety content in current courses and integrating the content. For example, since the 2011 accidents in Japan, several courses have added lectures on these accidents without course instructors consulting each other on their content. The overlap in these lectures will be eliminated.

The integration of Nuclear Safety teachings is consistent with the Department’s intention to strengthen the Power Engineering research group.
Advanced Simulation Technologies
The Department of Nuclear Engineering will establish a simulator laboratory for nuclear engineering and broadly college of engineering students. The simulator is based on the industry-standard GSE nuclear power plant simulator which is being used at a number of nuclear power plants and as an educational tool at several peer universities and internationally. The simulator carries both an academic mission for courses involving plant systems and control as well as a research mission in the relevant engineering areas. We expect our simulator laboratory to expand and grow as a multidisciplinary collaboration opportunity in the College of Engineering.

Modernization of teaching methods to best educate the current generation

Use of state-of-the-art equipment for education
The department recently acquired equipment for optical, thermal and ultrasound imaging under a Department of Energy grant. The optical imaging system consists of two high-speed, research-level imagers and a ruggedized high-speed imager for classroom use. The thermal imaging system consists of four major components. The first is a FLIR SC8000HD high speed thermal imaging system with highly sensitive InSb detectors that offer high resolution and cutting edge functionality. The second and third components are handheld thermal imagers, both model FLIR E60BX with video, still, and optical capability. As the fourth component, a blackbody radiator was procured for calibration of the thermal imagers. Finally, a new Olympus 38DL PLUS ultrasonic system integrates into a number of ultrasonic applications that exist within nuclear engineering. This handheld thickness gage is compatible with existing ultrasonic equipment and can be used in applications ranging from wall thinning measurements of internally corroded pipes with dual element probes to thickness measurements of thin or multilayer materials with single element transducers.

For curricular enhancement, new classroom demonstrations and laboratory experiments will be created. The high speed optical camera can be used to acquire images of two-phase thermal hydraulic phenomena and allow for replay at slower speeds for improved student comprehension. The ultrasonic flaw detector can be used to measure liquid film thicknesses in two-phase air-water facilities and aid the students in understanding phase separation and fluid flow concepts. These demonstrations are appropriate for NUEN 406 (Nuclear Engineering Systems and Design) and NUEN 410 (Senior Capstone Design Course), as well as for our graduate courses in power engineering and design – NUEN623 (Nuclear Engineering Heat Transfer and Fluid Flow), NUEN 624 (Nuclear Thermal Hydraulics and Stress Analysis), NUEN 610 (Design of Nuclear Reactors), and NUEN 609 (Nuclear Safety).

The high speed optical camera will be used with scintillators to enhance student conceptualization of nuclear decay in the junior level NUEN 303 (Nuclear Detection and Isotopes).

A classroom demonstration relevant to ultrasonic flaw detection for nuclear material courses is under consideration for NUEN 265 (Material Science Nuclear Engineering Applications).

The thermal imagers can be utilized in a number of the early level general engineering courses, the various thermal-hydraulic courses, and the numerical methods courses. An example of utilizing the thermal imagers would be to visualize and quantify the transient temperature fields of equipment or systems. This can then be compared to analytic and numeric predictions.

Online lecture delivery
Online lecture delivery will be used primarily at the graduate level to promote the Master of Engineering programs. A limited number of courses will be available to the undergraduates. As
one current example, the Nuclear Power Institute (NPI) at Texas A&M University currently offers an online Human Factors course that some of our senior undergraduates take as a technical elective.

Flipped lectures
A faculty member in our department has been successfully employing the teaching technique of “flipped lectures”, in which lectures are made available online and the assigned lecture time is devoted to discussion. For traditional lecture-based classes, this technique promotes active learning in the classroom. Further, it allows presentation of additional material than would be possible if the assigned lecture time were used for “lecture”. Citing the rule-of-thumb that students should spend three hours outside of the classroom for every one hour in, the instructor has reported that the flipped lecture format does not impose additional time requirements on the students. The experience has proven successful and will be promoted, as appropriate, for other classes.

Increased interaction of undergrads of different class years and with graduate students
An important tradition within the Department of Nuclear Engineering is the close-knit nature of the department. All students have a faculty member assigned as an academic advisor and there are many opportunities for graduate students and undergraduate students to work alongside each other. These activities support the retention discussion of the previous section. During the growth program, the department intends to maintain this tradition.

An activity that will be expanded upon is the mentoring of lower-class students by upper class students. Still in the test phase, NUEN 406 (Nuclear Engineering Systems and Design) students mentor NUEN 101 (Introduction to Nuclear Engineering) students on a NUEN 101 project. The effort needs to be updated with respect to mapping of 406 students to 101 students, project content and monitoring of the mentoring.

Currently, faculty members engage undergraduate students in sponsored research projects and the graduate students serve as members. Looking to expand our Master of Engineering program dramatically, we will be able to develop new opportunities for such interactions. For example, with the expected increase in the number of international graduate students, we expect that we will have events for these students that the undergraduate students could also benefit from. These events will include technical lectures and international exchange opportunities where the domestic undergraduates can serve as hosts.

Experience at the undergraduate level with working across disciplines

Senior design projects
The senior design capstone courses were recently modified to accommodate two-semester projects. The four-person student teams are required to include in their project scope three technical areas within nuclear engineering and an additional technical area of their choosing. We intend to bring in other technical areas to the projects by participating in College programs and making better use of our department’s Advisory Council.

For the former, we submitted two applications in June to the College call for multidisciplinary project ideas. The call was in response to an offer of funding from the US Department of State, which had representatives at the College’s Inaugural Showcase.

For the latter, we have been advertising our senior design projects to our department’s Advisory Council. A few Council members served as reviewers at the final presentations in May 2013. The outcome was that they were highly impressed with the quality of the projects and the students. At their May 2013 meeting, the Council concluded that they would like to become more involved with the projects in the following ways: review the projects at the early stages to
help define realistic tasks and methodologies; review the projects at the middle stage; serve as external advisors for some of the projects. The department is pursuing the Council’s offer. With regard to reviews, the final design projects will be scheduled concurrently with the May Council meetings, to enable in-person attendance. For early and mid-stage reviews, the NUEN 406 instructor will add project deliverables to the homework assignments that can be distributed to the Council members. Remote participation in mid-semester presentations will also be looked into.

Multidisciplinary Team Projects

NPI’s mission is to develop the human resources needed to support the growth of nuclear power and STEM focused-industry in general. As part of this mission, NPI works closely with the Department to identify industry needs and develop programs to support Texas. As part of NPI's charter, several programs focused on undergraduate education are supported including the Systems Engineering Initiative (SEI). SEI engages students in real world engineering team projects that are both interdisciplinary and multilevel—that is, teams include students from freshmen to seniors from multiple engineering disciplines. These projects are industry-driven and focused on applied engineering practice versus open-ended research experiences. This program has been highly successful in the development of young engineers as well as supporting industry. NPI also supports a number of activities related to the education goals of the Department including new student recruitment and placement of graduates in industry.

The proposed approach would be to emulate the SEI model in an academic framework within the Department. Specifically, undergraduate students would participate in team projects focused on engineering practice in support of industry needs. Each undergraduate team would consist of students from multiple levels (freshman through senior) and be open to all engineering disciplines (but nuclear engineering-focused). The team would then work with faculty and industry mentors to solve a problem put forward by industry similar to the NPI's SEI program and ESSAP's MEU programs.

The proposed team model would integrate into the existing curriculum by utilizing a one- or two-credit hour per semester course for students. The course could be either a directed studies or follow the practicum/summer practice utilized by other engineering programs. Since the projects would run over the course of a year, students would be expected to enroll for all eight semesters. The lecture portion of the course would consist of a variety of topics related to the problem put forth by industry as well as other professional development topics. Industry mentoring would be provided by frequent teleconferences as well as in class seminars and discussions. A majority of the time would be spent outside of the classroom utilizing the planned undergraduate learning laboratories and working with the faculty mentor/course instructor. Using the common thumb rule of three hours of work for each hour of lecture, a two-credit course would result in approximately eight hours per week focused on the project, which is very close to the 10 hours a week utilized in the SEI model. Since the course would not require a significant amount of development, both tenure and non-tenure track faculty could participate and the potential exists to attract industry partners to augment the faculty as "professor of the practice."

Placement of our graduates within the nuclear sectors

The multidisciplinary projects mentioned above will support job placement for our undergraduates in the nuclear industry. A critical concern is the placement of graduates in industry. The faculty tend to think of our graduates filling "nuclear centric" roles in industry either at utilities, vendors, or within government.

The proposed program would expand the placement of nuclear engineers to non-nuclear focused industries. Nuclear engineering is already a composite discipline with many former students outside the nuclear field. The challenge has typically been to convince the employer of our
graduates’ capabilities. The proposed team program would address placement two ways. First, students would gain strong engineering skills over multiple disciplines working on the projects with industry. Second, the problem being solved is provided by industry along with a mentor that will work with the team. This interaction is much like an internship or "externship" at the university allowing industry to develop a relationship with our students.

Increase participation by the Advisory Council in the senior design projects will also support the job placement initiative.
3.4 Sharing of Large Undergraduate Laboratories

**Software-hardware system for modeling nuclear power plant behavior**
The department will acquire a software-hardware system for modeling nuclear power plant behavior. The software would be valuable for understanding power generation, co-generation, energy systems instrumentation and control, and other power engineering systems.

The system can benefit students from other departments who have an interest in power generation, energy transport and energy systems instrumentation and control. These include Mechanical Engineering, Chemical Engineering, Petroleum Engineering and Energy Engineering.

**Sharing of nuclear facilities for multidisciplinary projects**
The Department has two nuclear reactors\(^1\) and a Radiation Detection Lab that can be made available to students outside of the department. A few courses that could benefit from use of these facilities are senior design teams from other departments and AggiE Challenge. The latter is a College of Engineering program designed to address engineering problems facing society, with teams having multidisciplinary projects.

It should be noted that these laboratories are intended for use by small groups of students.

\(^1\)The US Nuclear Regulatory Commission requires background checks for participants.
4 Graduate Program Growth

4.1 Master of Engineering Growth and Recruitment Plan

Background
To meet the College of Engineering goals by 2025, the Department of Nuclear Engineering will need to enroll approximately 1,200 students.

As part of the growth plan for the Department of Nuclear Engineering and to meet the goals as defined by the College, significant expansion is planned at the graduate level. This contributes in two important ways. It recognizes that “supply and demand” at the baccalaureate level for the U.S. nuclear market is roughly in balance, and that growth of the undergraduate program will develop at the “historical” pace for the Department. In addition, further growth at the undergraduate level may occur by expanding the number of international students in the program. With sixty-one new reactors under construction around the world and some two dozen perspective nuclear “newcomer” countries considering nuclear for the first time, the need for nuclear engineers on a global level is quite significant. Texas A&M could contribute to meeting this demand by growing the number of international students at the baccalaureate level.

A second reason that expansion of the graduate program is advantageous is that it will contribute disproportionately to increasing the number of weighted student credit hours generated by the Department. Most of the courses taken by graduate students are offered by the Department. In addition, the state subvention rates for funding of academic programs heavily favor graduate level scientific and technical programs. As progress towards “25 by 25” goals is assessed, this emphasis should serve the Department and College well.

However, the assumption that the needed growth would come from the traditional offerings through the Master of Science and the Ph.D. programs is not straightforward, and is bounded by at least three limitations.

1) The first is faculty time to serve as research advisors. The burden on the faculty to advise M.S. and Ph.D. students is significant. The probability of adding many more faculty members does not appear to be great, and with approximately 140 graduate students currently enrolled and only 17 tenured/tenure track faculty members, there is little additional capacity to advise more research students.

2) Second is the availability of funding. Support of M.S. and Ph.D. students has traditionally been accomplished through grants and contracts, especially from federal sources. However, due to many factors such as sequestration and deficits, federal budgets are under great pressure. Negative impacts such as reduced allocations or outright cancellation of funded projects have already occurred, and the outlook for significant expansion of funding levels with the accompanying support for graduate students, at least in the near term, is not particularly bright.

3) Third is a need to have research students in rough proximity with their labs and advisors. The availability of space, especially for growth, seems uncertain and more likely dim.

The Master of Engineering Degree in Nuclear Engineering
Considering these issues, to accomplish significant expansion of the Departmental graduate enrollment, new approaches will be needed. An attractive path forward would appear to be the Master of Engineering degree in Nuclear Engineering (MENE). The Department has long had this degree. However, for a number of reasons it has rarely been used. It has probably been regarded by the faculty as a “second class” program. In addition, as the Department grew over the decades both in terms of the number of faculty, the student enrollment, and the availability of
research funding, there was an emphasis on the Master of Science degree in order to get the work done on research and grants, and to feed the Ph.D. program. However, because of the goals of “25 by 25”, pressure on faculty time, funding and space, and opportunities provided by the international expansion of nuclear energy, the MENE option offers a very attractive route. It is further anticipated that students will be self-funded or supported by their employers or other agencies. They will not require assistantships or other funding from the Department.

The Master of Engineering in Nuclear Engineering can be thought of as a practice oriented, industry focused degree. In contrast to the Master of Science, the emphasis will be on industry applications, and primarily, although not necessarily exclusively, on the generation of electricity through nuclear energy. The MENE does not require a research thesis, but is usually capped off by an industry related paper. It is normally regarded as a terminal degree, although the Department does offer a Doctor of Engineering degree as well, which may prove to be another growth opportunity.

To meet the Departmental goal of 1,200 students by 2025, assuming a roughly 8% growth per year growth of the undergraduate enrollment and maintaining the current number of M.S. and Ph.D. students, the Master of Engineering should grow to about 350 students by 2025. The current number is zero.

To achieve the goal, three options for the MENE degree are envisioned: the (1) a “traditional” Master of Engineering in Nuclear Engineering, (2) “Roadmap to Operational Excellence, and (3) a distance delivery MENE degree. Note that these options are not mutually-exclusive. They could be pursued individually or simultaneously.

1. A “traditional” Master of Engineering in Nuclear Engineering:
The Department can offer a traditional version of the Master of Engineering degree. The curriculum calls for a 36 credit hour degree, of which 25 hours are specified as required courses. This allows for 11 hours of electives. One means for implementing this is to make use of existing NUEN courses but with separate sections for MENE and MSNE students. A single well balance degree plan for an MENE degree is shown below:

<table>
<thead>
<tr>
<th>Semester</th>
<th>Course #</th>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td>NUEN 601</td>
<td>Nuclear Reactor Physics</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>NUEN 623</td>
<td>Nuclear Engineering Heat Transfer and Fluid Flow</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>NUEN 611</td>
<td>Radiation Detection and Measurement</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>MATH 602</td>
<td>Partial Differential Equations</td>
<td>3</td>
</tr>
<tr>
<td>Spring</td>
<td>NUEN 604</td>
<td>Radiation Interactions and Shielding</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>NUEN 606</td>
<td>Nuclear Reactor Analysis and Experimentation</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>NUEN 624</td>
<td>Nuclear Thermal Hydraulics and Stress Analysis</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>NUEN 651</td>
<td>Nuclear Fuel Cycle and Safeguards</td>
<td>3</td>
</tr>
<tr>
<td>Fall</td>
<td>NUEN 610</td>
<td>Design of Nuclear Reactors</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>NUEN 612</td>
<td>Radiological Safety and Hazards Evaluation</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>NUEN 661</td>
<td>Nuclear Fuel Performance</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>NUEN 681</td>
<td>Seminar</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>36</td>
</tr>
</tbody>
</table>

This degree plan is intended to be well-balanced and include all of the following topics:
• Nuclear and Atomic Physics
• Radiation Safety, Radiation Protection, and Radiation Shielding
• Radiation Detection
• Reactor Physics
• Reactor Engineering
• Reactor Safety
• Nuclear Fuel Cycles Analysis and Economics
• Nuclear Materials and Nuclear Fuels
• Nuclear Safeguards and Security

This degree program might be developed to be attractive as an opportunity for engineers from other disciplines. Courses could be identified from other departments for some of the 11 hours of electives so that mechanical engineers, electrical engineers, chemical engineers and students in other fields could obtain a strong education in nuclear technology while strengthening their capabilities in their own discipline.

To implement this program, a strong marketing initiative would be in order. This could especially attract students from other countries, so the marketing campaign should have an international focus. Assuming 60 students per year in this program, it would add 120 more graduate students to the Departmental enrollment.

2. The “Roadmap to Operational Excellence”:
In July and August 2012, NPI1 hosted a group of 29 professionals from Kenya for a four-week program in the basics of nuclear energy. The group was composed of engineers and scientists, lawyers, human resource and communication specialists, and policy makers. A principal challenge they laid out was that Kenya aspires to commission new power plants at some point in the future. For that they need a cadre of skilled personnel who have experience in an operating nuclear power plant. But without one, how can this be accomplished?

Working with the various partners, NPI has developed a concept that would utilize the Master of Engineering in Nuclear Engineering. Students would enroll in the MENE degree program in September and take the first two semesters of courses. A specialized internship would be help during the summer utilizing the Texas A&M research and training reactors, Disaster City, the Texas A&M power plant, and tours to the power reactors. During the second year, the students would complete the third and fourth semester. On approximately May 15, the students would go to STP or Comanche Peak for seven months working with plant engineers, taking some of the training courses, and gaining experience at an operating nuclear power plant. They would return to their home country with an extremely valuable background that would serve them well.

---

1 The Nuclear Power Institute was established by the Board of Regents of the Texas A&M University System on December 6, 2007. The mission of NPI is to develop programs in human resources for the nuclear industry. This has been done through a partnership of industry, universities, community colleges, government agencies, high school and junior highs, communities, stakeholders and elected and civic leaders. New programs have been developed at the baccalaureate level through a distance delivery program of five certificate courses created in association with utilities focusing on engineering (mechanical, electrical, chemical, civil, engineering physics and engineering technology) and science (primarily physics), new associate of science degrees to prepare graduates for technician level positions, and outreach to schools, teachers, students, administrators and communities. During the past two years, NPI programs have increasingly come to the attention of the international community. Human resources have been identified as the top priority both among nations with established nuclear programs as well as the “newcomer” countries.
in building their own national programs. Participants in the program would be nominated and funded through a contract with TEES. A similar program is envisioned at the community college level to prepare technicians. The community colleges would also be established as TEES divisions.

A number of challenges must be addressed including the question of unescorted access to relevant parts of the plant as allowed by the NRC and requirements by the Department of State and the National Nuclear Security Administration. Discussions with the various agencies are underway with positive early indications that these can be resolved. Also, other discussions are ongoing with potential participating countries as well as the IAEA about the value of the program. The concept has been received quite enthusiastically. It is anticipated that students enrolled in ROE will be supported by host organizations in their country of original such as utilities or ministries.

Assuming a good resolution of the outstanding issues, the first group of student is expected to be enrolled in the fall semester of 2014. Based on discussions, the nuclear power plants could accommodate a group of 20 students at a reactor site. Assuming that both STP and Comanche Peak would both be involved, at any one time this would result in approximately 120 additional students being enrolled in the Department as part of the ROE program.

3. A distance delivery based MENE degree program:
The Department has experience in Internet and distance delivery based courses. For example, NE participated for a time in the “Big 12” Consortium, and also offered a limited number of courses via the Trans Texas Video Network (TTVN). The Nuclear Security Science and Policy Institute (NSSPI) offers web-based, self-paced short courses. NPI provides five asynchronous and synchronous courses as part of its certificate program on a distance delivery basis. None of these courses are yet part of a degree program in the Department. However they provide a basis to develop a distance delivery MENE program. Assuming 60 incoming students, this would add another 120 graduate students in the Department.

Outcomes
If each of these three programs achieves its targeted enrollment and were implemented together then the NUEN enrollment would increase by 360 students which is above the target value of 350 additional Master of Engineering students. This exceeds the number needed for a total NUEN enrollment (bachelor’s, master’s, and PhD) of 1,200. In fact, each of these options has the potential to have even greater success and with appropriate resources could grow well beyond these numbers. However, each component will need new strategic directions, additional faculty, careful planning, and investment of time resources.

Recruitment Plan
A major component of the growth of the Department of Nuclear Engineering will occur through increased participation in the Master of Engineering program. The enrollment is projected to reach approximately 350 by 2025. By 2018, the target is to have nearly 300 students in the program. The Master of Engineering degree is envisioned to have three components: (1) a “traditional” degree based on the program currently appearing in the catalog, (2) the “Roadmap to Operational Excellence” that extends the program and includes an internship, and (3) a distance delivery based degree. The target will have roughly a balance among these.

The growth in the Master of Engineering in Nuclear Engineering program will draw from two sources—(1) professionals in the employed workforce who want to expand their capabilities, and (2) the international sector to serve the expansion of nuclear around the world. Group one may include the military as well.
For recruitment, the focus will be to inform potential students of these new opportunities. It will be necessary to develop recruiting materials that describe and highlight the various programs. The associated costs need to be established and define what they cover. Program descriptions should be placed on the Departmental website. In addition, to “getting the word out”, the Department has the benefit of a strong reputation and extensive networks that can be utilized to attract students. For the employed professionals, advertisements can be put in *Nuclear News* and other relevant professional publications announcing these new opportunities. There may be forums such as career fairs that would be useful as well.

For the international audience, the Department has MOU’s with various foreign universities. These could be used to inform prospective students. Assuming that many of the international students may be coming from the “nuclear newcomer” countries, it will be possible to link with them through bi-lateral and multi-lateral contacts that have been established by faculty members in the Department, as well as NPI and NSSPI. These programs will also very likely be welcome additions to the Team USA, and perhaps the Infrastructure Development Working Group (IDWG) of the International Framework for Nuclear Energy Cooperation (IFNEC). The Department as well as NPI and NSSPI have multiple ties with the International Atomic Energy Agency. It may be possible to work with IAEA programs to provide information to countries that could provide prospective students.

The steps for recruitment would entail:

1. Develop printed materials on the new programs pointed towards both working professional and international students,
2. Prepare information for the Departmental website,
3. Develop strategies to utilize networks to inform and attract prospective students.

If properly developed, there appear to be significant needs for these new offerings. The programs can be of great value, especially for the newcomer countries that can benefit most from building capacity in the field of nuclear energy.
4.2 M.S. and Ph.D. Growth Plan

The number of Master of Science students will be proportional to the number of tenured/tenure track faculty. Both are expected to increase during this growth plan.

The prediction of the PhD student population growth is the sum of an extrapolation of past growth plus an increase due to additional tenured/tenure track faculty.
4.3 Distance Education Program

Distance delivery of courses offers unique opportunities for the department to reach students in a variety of off-site locations. As noted earlier in this document, much of the growth in nuclear is occurring in other countries. At this point, the expansion is occurring in Southeast Asia, but countries in Africa are increasingly considering nuclear to meet their energy needs. These nations offer promising potential for distance delivery courses and curriculum from the department.

Several issues will need to be resolved in establishing formal distance delivery offerings. One will be the rate used for these courses. Four programs in the College of Engineering—Engineering Technology and Industrial Distribution, Industrial and Systems Engineering, Petroleum Engineering, and Safety Engineering, have set precedents. A uniform rate of $540 is used in each case. This would appear to be appropriate for courses from the Department of Nuclear Engineering.

If courses are to be offered to students overseas, a second issue that may be unique to nuclear engineering is that of export control of technical information. There are strict requirements by U.S. law placed on content in the nuclear field. While generally academic material appearing in the open literature is exempt from restrictions, it is necessary to submit course content for review of appropriate federal authorities. For nuclear technology, the relevant agency is the National Nuclear Security Agency. The review process can often be somewhat lengthy, taking several months, so the process should be initiated well before courses will be offered.

The Certificate Program will be geared toward working professionals who have a need for further education on a particular technical area but are not currently able to commit to pursuing an additional degree.

The Department of Nuclear Engineering currently offers certificate programs to a small number of students. The students are working professionals who come to campus to take tours of nuclear and radiological facilities, attend executive seminars with expert speakers, and work with small teams on security focused simulations. Current course topics are related to nuclear security, nuclear material management and international security policy.

The Department intends to develop programs for transcripted certificates that can grow to accommodate up to 100 international students and a smaller number of domestic students. The topics will evolve from the current certificate courses and may expand to other topics as the market develops.
College/Department Differential Tuition (Once a semester)

<table>
<thead>
<tr>
<th>College/Department</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture &amp; Biological Engineering (Majors: BAEN &amp; AGSM)</td>
<td>$400</td>
</tr>
<tr>
<td>Architecture</td>
<td>$204</td>
</tr>
<tr>
<td>Engineering</td>
<td>$400</td>
</tr>
<tr>
<td>Mays Business School</td>
<td>$412.50</td>
</tr>
<tr>
<td>Veterinary Medicine</td>
<td>$3000</td>
</tr>
<tr>
<td>Education (Majors: TLAC, HLKN &amp; EPSY during JR./SR. year)</td>
<td>$300</td>
</tr>
</tbody>
</table>

Distance Education Differential Tuition

The rate to be charged for distance education courses will range from a minimum of $40/SCH to a maximum of $550/SCH. Each academic department will have an individual rate that will be approved annually by the President of Texas A&M University. The following are the initial rates (only departments above the $40 minimum rate are listed):

**Agriculture**

<table>
<thead>
<tr>
<th>Department</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture Leadership, Education, and Communications</td>
<td>$99</td>
</tr>
<tr>
<td>Entomology</td>
<td>$150</td>
</tr>
<tr>
<td>Ecosystem Science and Management</td>
<td>$60</td>
</tr>
<tr>
<td>Poultry Science</td>
<td>$181</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Department</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil &amp; Crop Sciences</td>
<td>$41</td>
</tr>
<tr>
<td>Wildlife and Fisheries Sciences</td>
<td>$71</td>
</tr>
<tr>
<td>Nutrition &amp; Food Services</td>
<td>$200</td>
</tr>
<tr>
<td>Recreation, Parks &amp; Tourism Science</td>
<td>$262</td>
</tr>
</tbody>
</table>
### Architecture

<table>
<thead>
<tr>
<th>Department</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landscape</td>
<td>$150</td>
</tr>
<tr>
<td>Urban Planning</td>
<td>$320</td>
</tr>
<tr>
<td>Urban and Regional Sciences</td>
<td>$150</td>
</tr>
</tbody>
</table>

### Business

<table>
<thead>
<tr>
<th>Department</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finance</td>
<td>$454</td>
</tr>
</tbody>
</table>

### Education

<table>
<thead>
<tr>
<th>Department</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Educational Administration and Human Resource Development</td>
<td>$133</td>
</tr>
<tr>
<td>Educational Psychology</td>
<td>$153</td>
</tr>
<tr>
<td>Health and Kinesiology</td>
<td>$144</td>
</tr>
<tr>
<td>Teaching, Learning &amp; Culture</td>
<td>$137</td>
</tr>
</tbody>
</table>

### Engineering

<table>
<thead>
<tr>
<th>Department</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineering Technology &amp; Industrial Distribution</td>
<td>$540</td>
</tr>
<tr>
<td>Industrial and Systems Engineering</td>
<td>$540</td>
</tr>
<tr>
<td>Petroleum Engineering</td>
<td>$540</td>
</tr>
<tr>
<td>Safety Engineering</td>
<td>$540</td>
</tr>
</tbody>
</table>

### Bush School

<table>
<thead>
<tr>
<th>Department</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bush School</td>
<td>$503</td>
</tr>
</tbody>
</table>

### Science

<table>
<thead>
<tr>
<th>Department</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics</td>
<td>$53</td>
</tr>
<tr>
<td>Statistics</td>
<td>$69</td>
</tr>
</tbody>
</table>
4.4 Certificate Programs

Certificate programs offer an effective means to provide specialized content to students who have special interests and requirements. Certificates can focus on a particular area of nuclear technology such as safety, non-proliferation, power and other relevant topics. An attraction of certificate courses is that interested individuals may already have appropriate degrees in fields such as nuclear engineering or other appropriate engineering or science disciplines, and do not wish complete an entire degree program. Certificate programs can be offered in several formats, including combinations of traditional courses offered on a semester basis, short courses, intersession or “mini-mester” courses, and web-based, internet or distance delivery courses. Certificate programs expand the impact of the Department and have the potential to attract new students to pursue full undergraduate or graduate programs.

A strategic evaluation will be needed to determine how to best grow the certificate programs. Such an effort will identify what are the topics to be addressed, and the type of program to be offered. The Department has the capability to offer several different types of certificates and in a number of disciplinary areas. The strategies will also include how to identify the potential students to take the various certificate programs and the marketing strategy to attract students into these programs.
5  Research Growth Plan

Two lines of growth are outlined here for the Department of Nuclear Engineering’s research program.

5.1  New Medical Physics Program

We anticipate the addition of a Medical Physics program to the Department’s current line of offerings. The Medical Physics program will produce both Masters and PhD graduates. The Masters students complete a Master of Science degree and a residency to become Medical Physicists. These students generally pay for their education, as opposed to being supported by research contracts; however, they earn a thesis-option MS degree.

The PhD students engage in two years of coursework followed by two years of research. As part of an accredited Medical Physics program, they must complete their degree within four years. These students often move on to employment which involves a heavy research aspect.

5.2  Distance PhD Program

There appears to be a need to offer a PhD program that allows students to continue with full-time employment and simultaneously pursue a PhD degree. For example, at the National Security Affairs Program (NSAP) students are allowed to come to campus to take two courses, followed by two additional courses by distance from Texas A&M while they work fulltime at their employer’s site. Enabling a distance-PhD program would allow further opportunities for advanced education of current professionals.

We envision a program in which the students could link into our classes from their employer’s site while performing research at their employer. The employers would most likely be research institutions including the National Labs and industrial vendors with research branches such as Westinghouse and General Electric-Hitachi. The research could be projects that the students pursue as part of their employment, with enhancement to achieve the necessary academic rigor for a PhD dissertation.

Added benefits of establishing such a program include new and/or enhanced relationships between our faculty and the employers and involvement in their research efforts. Interaction at the level of PhD research is also predicted to generate a new source of Professors of the Practice as we both advise and learn from the off-site research staff.

We anticipate five to ten students a year (two or three new students each year). While a small number that does not appear in our student population growth numbers, the benefits for extending our research could be large and come with minimal effort.
6 Faculty Hiring Plan

The Department has formulated a hiring plan for tenured/tenure track faculty and for non-tenure track (teaching) faculty in accordance with direction from the College of Engineering. The needed numbers in the two categories were estimated independently but were found to comply with the College’s requested one-to-one hiring to increase the fraction of non-tenure track faculty within the college.

6.1 Tenured/Tenure Track Faculty Hiring Plan

The strategy for hiring tenured/tenure track faculty is centered on the need for additional faculty to advise the large number of students coming to the Master of Engineering program and to grow the Department’s research program with additional PhD students.

As of Fall 2013, the Department has 17 tenured/tenure track faculty. We would like to hire seven tenured/tenure track faculty by 2025 for a total of 24 tenured/tenure track faculty.

With 360 Master of Engineering students requiring academic advising and final examination/project guidance, this would amount to 18 Master of Engineering students per faculty. The number of PhD students per faculty would remain constant at about four or five.

6.2 Estimate of Teaching Faculty Needs for Growth Plan

We will make the following assumptions about course sizes and faculty loads:

1. Assume we maintain BS and MS course sizes (maximum of 55 students per section for BS lecture courses and 35 students per section for MS lecture courses)
2. Assume that PhD courses could grow in size some without any increase in teaching faculty needs (most current PhD level courses have less than 10 students in them)
3. Assume we restrict ME course sections to a maximum of 50 students per section and assume that ME students will take on average 8 courses per academic year.
4. Assume we restrict certificate course sections to a maximum of 60 students per section and assume that certificate students on average take 3 courses per year.
5. Assume that tenured/tenure-track faculty have an average course load of 3 courses per year, full-time instructors have an average course load of 5 courses per year, and part-time instructors (those with research responsibilities) have an average course load of 1.5 courses per year.

Based on these assumptions, we can analyze the growth plan student population numbers to assess the number of courses and required teaching faculty to achieve these goals. Table 1 shows the student populations by level as described in the NUEN growth plan based on the assumed market conditions. Table 2 shows the number of course sections that would exist in NUEN given the student populations from Table 1 and the assumptions mentioned above. It should be noted that the values shown for AY12-13 were calculated in the same way as those for AY13-14 and beyond and the AY12-13 numbers match the number of sections that actually existed for AY12-13.
Table 6.1 Growth Plan Student Populations by Level.

<table>
<thead>
<tr>
<th>Level</th>
<th>Fall 2012</th>
<th>Fall 2013</th>
<th>Fall 2018</th>
<th>Fall 2025</th>
</tr>
</thead>
<tbody>
<tr>
<td>Undergraduate</td>
<td>322</td>
<td>322</td>
<td>360</td>
<td>450</td>
</tr>
<tr>
<td>MS</td>
<td>71</td>
<td>78</td>
<td>96</td>
<td>118</td>
</tr>
<tr>
<td>ME</td>
<td>0</td>
<td>0</td>
<td>290</td>
<td>360</td>
</tr>
<tr>
<td>PhD</td>
<td>69</td>
<td>72</td>
<td>82</td>
<td>101</td>
</tr>
<tr>
<td>Certificate</td>
<td>0</td>
<td>50</td>
<td>115</td>
<td>115</td>
</tr>
<tr>
<td>Total</td>
<td>462</td>
<td>522</td>
<td>943</td>
<td>1144</td>
</tr>
</tbody>
</table>

Table 6.2 Number of Course Sections by Level.

<table>
<thead>
<tr>
<th>Level</th>
<th>AY12-13</th>
<th>AY13-14</th>
<th>AY18-19</th>
<th>AY25-26</th>
</tr>
</thead>
<tbody>
<tr>
<td>Undergraduate</td>
<td>39</td>
<td>39</td>
<td>44</td>
<td>55</td>
</tr>
<tr>
<td>MS</td>
<td>18</td>
<td>18</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td>ME</td>
<td>0</td>
<td>0</td>
<td>46</td>
<td>58</td>
</tr>
<tr>
<td>PhD</td>
<td>8</td>
<td>8</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>Certificate</td>
<td>0</td>
<td>3</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Total</td>
<td>65</td>
<td>68</td>
<td>127</td>
<td>154</td>
</tr>
</tbody>
</table>

Table 3 shows the teaching faculty that would be required to cover these courses as well as the course sections covered by each faculty level. The teaching faculty are listed as total FTE’s. It should be noted that we expect to have a teaching deficit in AY13-14 due to the addition of certificate students in Summer 2014. Beyond AY13-14, we should be able to maintain a suitable faculty to manage this growth if we can hire a relatively large number of full-time instructors.

Table 6.3 Number of Faculty Required to Teach the Course Growth.

<table>
<thead>
<tr>
<th>Faculty Level</th>
<th>AY12-13</th>
<th>AY13-14</th>
<th>AY18-19</th>
<th>AY25-26</th>
</tr>
</thead>
<tbody>
<tr>
<td>TT</td>
<td>17</td>
<td>17</td>
<td>19</td>
<td>24</td>
</tr>
<tr>
<td>Full-Time Instructors</td>
<td>1</td>
<td>1</td>
<td>12</td>
<td>14</td>
</tr>
<tr>
<td>Part-Time Instructors</td>
<td>6</td>
<td>6</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td>24</td>
<td>24</td>
<td>39</td>
<td>48</td>
</tr>
</tbody>
</table>

Table 6.4 Number of Course Sections Taught by Faculty by Level.

<table>
<thead>
<tr>
<th>Faculty Level</th>
<th>AY12-13</th>
<th>AY13-14</th>
<th>AY18-19</th>
<th>AY25-26</th>
</tr>
</thead>
<tbody>
<tr>
<td>TT</td>
<td>51</td>
<td>51</td>
<td>57</td>
<td>71</td>
</tr>
<tr>
<td>Full-Time Instructors</td>
<td>5</td>
<td>5</td>
<td>60</td>
<td>70</td>
</tr>
<tr>
<td>Part-Time Instructors</td>
<td>9</td>
<td>9</td>
<td>12</td>
<td>15</td>
</tr>
<tr>
<td>Total</td>
<td>65</td>
<td>65</td>
<td>129</td>
<td>157</td>
</tr>
<tr>
<td>Capacity Excess</td>
<td>0</td>
<td>-3</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>
Additional Space and Equipment Needed

The Department of Nuclear Engineering currently occupies 45,615 square feet for faculty, staff and graduate student office and lab space in Zachry Engineering Center. The amount of office, teaching lab and classroom space needed at 5 years and 10 years into the growth program are shown in the table below.

<table>
<thead>
<tr>
<th></th>
<th>UG 2018</th>
<th>Grad 2018</th>
<th>UG 2025</th>
<th>Grad 2025</th>
</tr>
</thead>
<tbody>
<tr>
<td>71 sq.ft/graduate student</td>
<td>0</td>
<td>14,200 sf</td>
<td>0</td>
<td>10,011 sf</td>
</tr>
<tr>
<td>160 sq. ft/faculty member</td>
<td>0</td>
<td>2,400 sf</td>
<td>0</td>
<td>1,440 sf</td>
</tr>
<tr>
<td>Teaching Lab Space</td>
<td>250 sf</td>
<td>525 sf</td>
<td>440 sf</td>
<td>440 sf</td>
</tr>
<tr>
<td>Classroom Space</td>
<td>30 heads .5 classrooms</td>
<td>200 heads 1.5 classrooms</td>
<td>90 heads 1.0 classroom</td>
<td>141 heads 1.2 classrooms</td>
</tr>
</tbody>
</table>

The space need projections are based on 71 square feet of office space per graduate student and 160 square feet per faculty member. All graduate students will be assigned this amount of space, including Master of Engineering students who will be charged a “space allocation fee”. Graduate students who are TEES employees or are supported by fellowship or are self-supporting MS or PhD students will not be charged. All faculty, including teaching faculty, will be assigned 160 square feet of office space.

In 2018, the number of graduate students is expected to increase by 200 over the Fall 2013 number. Therefore, 14,200 sf of additional space (200 students x 71 sf) will be needed. The faculty number is expected to increase from 24 to 39 (refer to Faculty Hiring Plan), resulting in a need for 2,400 sf of additional space (15 faculty x 160 sf).

Regarding teaching lab space for 2018, the radiation detection labs will require a larger number of stations because the number of students/station is fixed and the number of sections to be offered is limited by the teaching loads on faculty. These factors result in the need for 250 sf for undergraduate teaching labs and 525 sf for graduate teaching labs.
To estimate the additional classroom space needed, one classroom is assumed to be utilized for 10 classes/week, with five class meetings in the room on Monday, Wednesday, Friday and five class meetings on Tuesday, Thursday. Class sizes are limited to 55 students. The Master of Engineering graduate students will enroll in four courses per semester while undergraduates enroll in 6 classes. The 1.5 new classrooms in 2018 for graduate students is calculated as:

\[
(200 \text{ heads}) \times (4 \text{ courses/semester}) / (55 \text{ heads / class}) / (10 \text{ classes/room}) = 1.5 \text{ classrooms} \quad (1)
\]

Similar calculations were performed to estimate the rest of the values in the table.
Progress made under the Department of Nuclear Engineering’s 25x25 growth plan will be reviewed every three years (years 2016, 2019, 2022, 2025) to monitor progress and make necessary changes. Three years is a time duration in which measurable change can be made.

Each component of the plan has metrics, defined below. If the metrics are achieved, that component may proceed unchanged. For those parts of the plan that are not satisfied, the reasons for lack of success will be identified and the plan will be modified based on feedback from lessons learned.

| Table 8.1 |
|------------|------------------|-------------------|
| Component  | Metric            | Numerical Goal for 2016 |
| Student population growth | Number of students |                  |
| Undergraduate |                  |                  |
| MSNE         |                  |                  |
| MENE         |                  |                  |
| PhD          |                  |                  |
| Certificate  |                  |                  |
| Retention plan | Number of students partaking in the “information, help and engagement” steps described in Section 3.2. |                  |
| New Instructional Methodologies | - Number of new lectures developed |                  |
|                  | - Number of weighted student credit hours affected by course modernization efforts |                  |
|                  | - Number of undergraduates participating in multidisciplinary projects |                  |
| Sharing of large labs | Number of students participating in shared laboratories. |                  |
| Recruitment plan for ME’s | Numbers of students matriculating each year for each of the Master of Engineering programs |                  |
| Distance education program | Number of weighted student credit hours |                  |
| Certificate program | Number of weighted student credit hours |                  |
| Research growth | - Number of Medical Physics students matriculating |                  |
|                  | - Number of Distance PhD students |                  |
| Faculty hiring plan | Number of new tenured/tenure track and non-tenure track faculty members |                  |
9 Anticipated Challenges or Delays

9.1 Marketing of the New Graduate Programs

The Department is proposing an ambitious program for growth, particularly at the Master of Engineering level. Included are a few years to ramp up the program to full numbers of 120 new students per year. The numbers provided are best estimates, however we do not have experience in attracting these new student groups.

9.2 Supply of Non-tenure Track Faculty

There is a concern that the number of non-tenure track faculty needed to help with the teaching load described in Section 6.2 is not available.

9.3 Establishment of Distance Learning Programs

The mechanisms for implementing Distance Learning programs are being conceptualized at this time. Without testing or a firm understanding of what resources will be available, the Department can only strive to put our best effort forward.

9.4 Fragmentation of the Department

The Department is to be moved from its current location to one in which it will be separated from most undergraduate student activities. We currently have a highly successful model for undergraduate advising in which all of our undergraduate students are assigned a tenured/tenure track faculty member for their academic advisor. We do not see the proposed model of conducting academic advising in the Zachry Building as efficient or productive if all of our faculty must set advising hours in the Engineering Education Complex (EEC). The logistics of scheduling for all of the faculty to have time and space in the EEC are daunting and the lost time for all faculty to travel back and forth between our new home building and Zachry does not promote efficiency.

Further, the undergraduate students will be separated from our graduate students. Our undergraduate students currently have a high rate of participation in research and mentorship by the graduate students. Further, the graduate students gain experience mentoring. The physical separation between these two groups will discourage such growth.
Appendix F. Nuclear Engineering Fact Sheet
We are:

the largest nuclear engineering program in the U.S.
the only nuclear engineering program with two reactors.
one of the oldest nuclear engineering programs, founded in 1958.
ranked second in undergraduate and graduate programs (among public institutions).

$17.2M Research Expenditures
$6M Research Awards
Fiscal year 2014

225 Undergraduate Students
(excludes freshmen)

174 B.S. Nuclear Engineering
51 B.S. Radiological Health Engineering

157 Graduate Students
68 M.S. Nuclear Engineering
87 Ph.D. Nuclear Engineering
2 M.E. Nuclear Engineering

Fall 2014 Enrollment Data
First choice freshmen:
51 Total students

Incoming graduate students:
38 Total students

Graduate Student Support
68 graduate student research assistants
12 graduate student teaching assistants
14 DOE fellows
3 NRC fellows
9 Texas A&M fellows
6 other external fellowships
(NSF, NEF, INPO, NSBRI, DHS-NF)

Research Areas
Security, Safeguards & Nonproliferation
Fuel Cycles & Materials
Health Physics
Medical Physics
Radiation Transport
Thermal Hydraulics

Degrees offered (awarded in AY 2014)
B.S. Nuclear Engineering (52)
B.S. Radiological Health Engineering (11)
M.E. Nuclear Engineering (3)
M.S. Nuclear Engineering (18)
Ph.D. Nuclear Engineering (8)

Other Degrees with a Nuclear Discipline
M.S. Mechanical Engineering (3)
Ph.D. Mechanical Engineering (2)
M.S. Materials Science & Engineering (1)
Ph.D. Materials Science & Engineering (2)
Ph.D. Physics (1)

Impact
63 Refereed journal articles
75 Selective conference papers
9 Fellows in professional societies
1 Academy Member (NAE)

Service
10 Editorships & editorial board memberships
27 Members of professional society committees

Facilities & Centers
Accelerator Laboratory
AGN-201M Nuclear Reactor Laboratory
Center for Large-scale Scientific Simulations (CLASS)
Fuel Cycle and Materials Laboratory (FCML)
Institute for National Security, Education & Research (INSER)
Interphase Transport Phenomena Laboratory (ITP)
Laser Diagnostics Multiphase Flow Laboratory
Micro-Beam Cell Irradiation Facility

NASA Space Power Center (TEES)
Nuclear Heat Transfer Systems Laboratory
Nuclear Power Institute (NPI)
Nuclear Science Center (1MW Triga Reactor)
(NSC)
Nuclear Security Science & Policy Institute
(NSSPI)
Radiation Detection Measurement Laboratory
Tandem Accelerator Laboratory

For more information, visit: engineering.tamu.edu/nuclear
Appendix G. 2007 Academic Program Review
Preamble

The above-identified individuals completed the Graduate Program Review of the Department of Nuclear Engineering at Texas A&M University on March 26-28, 2007. Professor Brey focused principally on the Health Physics Program while Professors Martin and Turinsky focused on the Nuclear Engineering Program. Attached to this report is the meeting schedule indicating with whom the review team met. In addition to these meetings, the review team reviewed the Academic Program Review Self Study Report and additional information that was provided as requested during the course of the visit.

Extracting from the charge to the review team: “The review team is expected to examine and comment on (1) faculty teaching, (2) the research program, (3) faculty service activities, (4) the present and proposed coursework, (4) the existing facilities and centers, and (5) the strategic vision and future plans for the department. In addition, it would be helpful to receive comments on the competitiveness of graduate student offers, innovative aspects that differentiate our programs from others, and whether or not our programs are meeting national and international needs of the profession.” The review team attempted to address these charges by examining the following five areas in regard to quality, and if appropriate, quantity: faculty, students, facilities, curriculum and research. The focus of the review was restricted to the graduate program. When appropriate, separate review comments about the Health Physics and Nuclear Engineering Programs will be made.

The review team also considered the relationship of the Department of Nuclear Engineering to others at TAMU and to national laboratories. The review team concluded the report by listing both the strengths and weaknesses of the Department of Nuclear Engineering and providing a list of recommendations to enhance its quality. Since there was no indication that a graduate level outcomes-based assessment plan exists, that section of the recommended report content was omitted. The Team’s hope is that the final section providing our assessment of strengths, weaknesses, and suggestions for improvement will make an already strong academic program even stronger.
Status of the Department

Faculty

The department is probably the largest nuclear engineering department in the US with regards to the number of students and the number of faculty. Over the last four years, the department has hired seven faculty members; four new positions became available as a result of the Faculty Reinvestment Program and three positions due to attrition. These faculty members are primarily in the reactor analysis or reactor engineering areas, but several also make contributions to the Health Physics Program as well. This was a prescient faculty decision four years ago given the recent upsurge in the prospects for nuclear energy, the increased opportunities for research funding in reactor-related areas, and the continuing upward trends in undergraduate and graduate enrollments nationwide in nuclear engineering departments. As a result, the department is poised to capitalize on opportunities presented by this “nuclear renaissance” and further enhance their reputation as a leading nuclear engineering department in the US.

The department has invested very well in its nuclear engineering future with its “group of 7”. These new faculty span the spectrum from senior faculty who are nationally and internationally known for their research achievements to junior faculty with considerable promise for outstanding academic careers. Between are mid-career faculty who are already having an immediate impact on the department’s research and teaching activities and have attracted (or brought with them) external research funding and outstanding graduate students. While it may be a few years before the full impact of these new faculty is felt, our collective judgment is that their contribution will be strong and enduring. The portions of the Nuclear Engineering discipline represented by the new faculty include the arenas of severe accident mitigation, separations technology, ion beam irradiations of materials, and reactor simulation, among other areas. The Nuclear Engineering Program encompasses most aspects of nuclear technology and this bodes well for their efforts in the years to come.

The Health Physics Program faculty within the Department of Nuclear Engineering includes nationally and internationally recognized leaders in the discipline. The research effort of the faculty has effectively combined the expertise of many disciplines to provide a unique educational resource that has served the State of Texas and national needs well. The Health Physics Program faculty has effectively used the available capital infrastructure to advance basic and applied science.

Although the health physics faculty mix has been productive there are clear indications that this balance has been jeopardized due to recent resignations. This imbalance will be exacerbated if any pending retirements are experienced in the near term. The impacts of insufficient human resources in the health physics area are already evident among the graduate students who are currently lacking institutional fiscal support and adequate access to advisor guidance. This is an indication of necessary institutional correction. The Health Physics Program is currently understaffed. This is most evident in the lack of an adequate number of faculty with sufficient operational health physics interests. The
needs of the constituency of the Health Physics Program within the State of Texas and nationally are not being adequately addressed at present. Immediate and aggressive actions are necessary to increase the number of Health Physics Program faculty.

**Students**

Student selection criteria for the Department of Nuclear Engineering are appropriate and consistent with those of other similar academic institutions. With the exception of anxiety about continuing financial support for students in the Health Physics Program, graduate students’ morale appears to be high. Graduate students did express concerns about cost of health insurance for spouses, duplication of material found in both undergraduate and graduate courses and laboratories, teaching-skill development opportunities for Ph.D. students, confusion on Ph.D. qualification examination requirements, over reliance on seminar speakers from TAMU, and lack of discipline breadth in the design course, i.e., over emphasis on thermal-hydraulics. Even though this report focuses on the graduate program, note that an ABET EAC criterion is that students be able to work in multidisciplinary teams, which is commonly satisfied via the senior design course project. Based upon student comments, the department may wish to examine whether this criterion is being adequately satisfied.

The number of graduate students who received their undergraduate degree in nuclear engineering from TAMU is about 55%, which seems excessive for a department that aspires to have national visibility. It is perhaps an indication that with regard to bachelor degree graduates planning on attending graduate school, national visibility may not yet be established at the level desired. Also, master to doctorate student enrollment is approximately two-to-one. Nuclear Engineering Programs that TAMU aspires to be a peer with have ratios more like one-to-two. Note that the two-to-one ratio is viewed acceptable for the Health Physics Program given employment opportunities in health physics.

The Health Physics Program within the Department of Nuclear Engineering is nationally renowned for the production of high quality professionals at both the B.S. and M.S. levels. Doctoral alumni of the Health Physics Program are recognized leaders in academic and industrial efforts and represent an important component to the discipline of health physics nationally as evidenced by their many professional contributions. It is notable that these graduates enter the job market with unique strengths reflecting the academically strong Nuclear Engineering Program. These graduates find employment within the nuclear electrical production industry but just as importantly the regulatory and national laboratory sectors. The program is equally strong at preparing graduates for entry into the medical community particularly in medical physics.

**Facilities**

The department has outstanding research facilities for its faculty. Several of the new faculty are experimentalists, and the space and equipment provided for their research laboratories are outstanding. In the review committee’s view, no other university in the
country has the quality and quantity of space and facilities to accommodate such a large number of new faculty at this time. The only drawback that was apparent to the review committee was the geographic dispersion of the department’s laboratories. For example, the laboratory for Professor Vierow, while spacious and with room for expansion is remote from the main campus.

The capital resources and infrastructure available to graduate students and faculty of the Texas A&M Department of Nuclear Engineering in general are notable. The Information Technology capability, accessibility, and applicability are judged to be meritorious. Young faculty in particular seems to have been appropriately supported to develop new research programs.

The Nuclear Science Center is a valuable resource in the education of students in the Department of Nuclear Engineering, particularly at the undergraduate level. Based upon an admittedly cursory review, it did not appear that state of the art instruments associated with reactor beam port experiments were available or being developed.

Although not directly compromising implementation of a successful academic or research program, there is a notable deferred-maintenance in many campus buildings. This may have the impact of reducing graduate enrollment from bachelor’s degree graduates from other institutions due to unfavorable impression during recruiting visits, weakening faculty morale, eroding the institution’s reputation among constituents, and setting examples of less than appropriate expectations among graduates. University administration should carefully consider investments to address deferred-maintenance and modernization during future budget cycles.

Curriculum

The review committee was provided with two years of teaching evaluations for the Department of Nuclear Engineering faculty. The scores on the “learning environment” question were greater than 4.0 out of a possible 5.0 for all courses except two. In addition, the review committee met separately with M.S. and Ph.D. students and they affirmed the quality of the teaching. The students were complimentary of the department’s faculty teaching effort, with the exception noted above. The committee concludes that the department’s faculty is carrying out their teaching mission with dedication and excellence.

The curriculums of the Nuclear Engineering and Health Physics Programs are well established. Based upon the ultimate product of each program, it is clear that the level of technical detail provided is appropriate. Regarding the evolution of each program, and the institutional approach to course development, it appears that the curriculum is generated and modified in a fashion appropriate to accomplish programmatic goals and provide students with adequate intellectual skills to successful execute research. Given the breadth of the Nuclear Engineering Program, which has broadened even further with recent faculty hires, the current fairly prescriptive curriculum regarding courses may
restrict graduate students from taking courses that most benefit their individual professional development.

The review committee did not have an opportunity to visit any of the classrooms or teaching laboratories. As noted in the facilities section, computing support for the graduate students was considered to be outstanding with particular praise for the department’s staff person responsible for maintaining the computing environment.

Research

The major strength of the Nuclear Engineering Program is clearly the area of reactor analysis and computational particle transport. With maybe six faculty involved in this important research area, the Nuclear Engineering Program will be able to make significant contributions to next generation reactor designs as well as advanced particle transport applications in areas as diverse as space plasma physics, medical physics, and reactor shielding. The exciting challenges for advanced reactor applications are multiphysics and multistate simulations. The Nuclear Engineering Program is uniquely qualified to meet this challenge.

The direction of research efforts undertaken by the faculty seems to be entirely appropriate and consistent with perceived industrial trends. The department is well positioned to take advantage of the resurgence in electrical energy generation using nuclear power technology. They are also moving in the correct direction to support the research needs of next generation nuclear technology development. The faculty coverage of topics such as reactor physics and radiation transport, thermal-hydraulics, materials performance, waste disposal processing, and non-proliferation provides the Nuclear Engineering Program with a portfolio of topic coverage that is only matched by a few other Nuclear Engineering Programs.

Health physics research at Texas A&M is currently engaged in seeking answers to many scientifically pertinent questions. Microbeam irradiation capability represents cutting edge technology offered at few institutions. Radiobiological work on the so-called bystander effect may be speculated to elucidate the nature of intracellular communication. Current work involving in vitro systems is novel and pertinent. Efforts to improve high-energy charged particle dosimeter schemes relative to cosmic radiation exposure will be necessary if long duration space flight is to eventually be undertaken. Aerosol science and colloidal chemical-kinetics are important basic science endeavors that may lead to nano-technology advances. The application of aerosol science to environmental transport, atmospheric dispersion, particle inhalation and deposition understanding cannot and should not be underestimated. Further, the applied research conducted at Texas A&M with respect to medical therapy and radiation dose delivery systems is of great importance. These efforts alone and when combined with interest in application of these technologies to the operational engineering questions associated with health physics underscore the relevance and importance of the Texas A&M Health Physics Program to the evolution of the health physics profession.
Relationship of Department to College of Engineering

Nuclear engineering is an interdisciplinary field. Within the TAMU Department of Nuclear Engineering, examples of interdisciplinary intersect includes the following:

1. Computational transport modeling intersects with mathematics, computer science and statistics.
2. Nuclear materials research intersects with materials science, chemical engineering and chemistry.
3. Accelerator physics intersects with material science, physics and biology.
4. Reactor thermal-hydraulics and space energy delivery systems intersect with mechanical engineering and electrical engineering.
5. Health physics intersects with the biological, medical and environmental sciences.
6. Aerosol science intersects environmental and chemical engineering.
7. Nuclear non-proliferation intersects with public policy and political science.

The Department of Nuclear Engineering has a number of existing and planned collaborations with other university groups but there may be further interactions that should be pursued when mutually beneficial to the parties involved. The review committee did not complete a detailed analysis to determine exactly where opportunities may exist among the various universities entities. One such opportunity that appears to be under subscribed concerns utilization of the NSC to support research in other academic units by providing access to and user support of beam port instruments.

The Department of Nuclear Engineering interacts with a number of national laboratories. Research funding is currently received from NASA associated laboratories, several Department of Energy laboratories providing funding and collaborative opportunities including: Idaho, Los Alamos, Lawrence Livermore, Sandia, Argonne and Oak Ridge.

Strengths

1. The current faculty is of high quality. The recently hired faculty appears to have the potential or have already demonstrated their capability to be leaders in their areas of expertise.
2. The faculty age distribution is very healthy for the Nuclear Engineering Program.
3. Recent hires have provided the potential for new faculty teams to be formed in different areas, in particular simulation, materials and thermal-hydraulics, that will enhance individual faculty team member’s capabilities.
4. Distinct signature areas have or are in the process of being developed, which include simulation, accelerator applications to materials science, waste form processing, non-proliferation policy, and micro-beam applications to biological systems.

5. The facilities and space available to support research appears excellent.

6. Staff support, both clerical and technical, appear to be adequate. Of particular note are the computer resources provided to the students.

7. Evaluations of faculty teaching of graduate courses by students indicate with a few exceptions excellence in teaching.

8. Entering graduate student academic credentials appear to be comparable to those of peer institutions.

9. Graduate students appear to interact academically and socially due to the learning environment provided by the department.

10. Faculty interactions appear to be constructive, with faculty striving in unison to enhance the quality of the graduate program.

Weaknesses

1. The faculty size in the Health Physics Program is inadequate for the number of graduate students and to accomplish programmatic objectives.

2. The total graduate enrollment size is appropriate for the faculty size in the Nuclear Engineering Program, but the ratio of Ph.D. to master’s students is too low to conduct the level of research and national visibility desired.

3. The department does not contain a functioning strategic plan. The “proposed Reinvestment/Enhancement Strategy” document authored in 2003 is dated and lacks milestones and associated dates and measurable metrics. The Academic Program Review report indicates several metrics, but they can be improved upon to more appropriately measure the outcomes desired.

4. The fraction of graduate students that completed their undergraduate studies at TAMU is too high. This effects both the reputation of the department and adversely affects the educational experiences of students due to lack of diverse educational backgrounds.

5. The stipend support level is below what is required to be competitive to attract the best students from other universities, even accounting for the lower cost of living.
6. Although the total space available to the department is adequate, the separation of this space, in particular the Riverside Campus, has the potential to adversely affect productivity due to travel time, lack of onsite supporting facilities, and lack of availability of onsite expertise, e.g. fellow graduate students and faculty.

7. The Ph.D. course requirements in both number and specificity for the Nuclear Engineering Program appear excessive. More flexibility in meeting the total credit hour requirements for the Ph.D. degree between course work and research would be advisable to meet the individual student’s educational needs.

8. With the increasing diversity of the faculty, the policy of requiring graduate students to take undergraduate nuclear engineering courses if not taken as an undergraduate should be examined. This requirement could discourage students from other disciplines at the undergraduate level from enrolling, even though their undergraduate education may be very supportive of a faculty member’s interests.

9. Students felt that several graduate courses, both lecture and laboratory based, contain content that is partially redundant with undergraduate courses, in particular when the same instructor teaches the graduate and undergraduate course. Further discussions with the students to clarify this issue are recommended.

10. Faculty average salaries appear somewhat low versus those of institutions that TAMU expires to be a peer of with regard to Departments of Nuclear Engineering.

11. Graduate students appeared confused about the Ph.D. qualification examination process and lack of communication channels to express concerns and receive feedback on departmental activities.

12. The graduate seminar program’s heavy reliance on TAMU speakers limits the potential for graduate students to learn of research activities going on elsewhere and making professional contacts that may prove useful in professional placement.

13. Deferred maintenance of facilities is noticeable in the material condition of buildings. This is very obvious in the Zachry Engineering Center, which is run down, e.g. walls need to be painted, flooring needs to be replaced, roof leaks need to be repaired, and there is a need for modernization. This need has been previously communicated by the College of Engineering department heads to the College. Its current appearance is a detriment to attracting graduate students particularly from other institutions.

14. The pace of progress on appointing a new Department of Nuclear Engineering Head appears slower than desired, which could potentially delay key decisions that need to be made to advance the department.
15. The NSC’s reactor, with regard to supporting research, appears to be under developed and under utilized.

Recommendations

*Note that the order of the following recommendations does not convey priority ranking.*

1. A number of new faculty have been recently added. Special attention needs to be given to mentor these faculty and they need to be provided the time and resources to be professionally successful. If these new faculty develop as expected and senior faculty maintain, or in some cases enhance, their levels of activity, the TAMU Department of Nuclear Engineering will join the academically elite departments in the nation.

2. A strategic plan should be formulated with milestones and associated dates and metrics defined. Suggested metrics include the following:
   - teaching quality
   - research support/faculty-year
   - MS degrees/faculty-year
   - Ph.D. degrees/faculty-year
   - Ph.D./MS graduate student mix
   - University support required
   - mix of TAMU and non-TAMU undergraduate degreed students.

   These metrics should be based upon leading Nuclear Engineering or Health Physics Programs and be program specific.

3. Reexamination of Ph.D. course requirements for the Nuclear Engineering Program should occur.

4. Stipend level should be increased so that the financial support offered does not become an issue in the decision making process of graduate student applicants.

5. A faculty member in the Health Physics Program should be added as soon as possible, preferably in the applied health physics area. In addition, in anticipation of faculty retirement in the Health Physics Program, an additional faculty member should be added to provide a period of overlap allowing sometime for the new faculty member to get established. The ratio of students to faculty in the Health Physics Program will not tolerate a long term reduction in faculty numbers without consequences due to the small size of the associated faculty.

6. More attention needs to be given to the graduate seminar program in regard to bringing in outside speakers.
7. A written graduate student guide, defining requirements and processes, should be provided to all graduate students and used extensively during the orientation of new graduate students.

8. The department leadership should meet with graduate students at least once per semester to communicate information to them, hear their concerns, and respond to actions taken on concerns previously expressed.

9. Given the evolving strength in the materials science area from an experimental viewpoint, consideration of adding a faculty member in the computational materials science area should be considered. This effort will not only complement the experimental materials science area, but also the multi-physics/multi-scale simulation collaboration in which the department has strength.

10. Doctorate students should be provided the opportunity to prepare for the professorate through the Center for Teaching Excellence and teaching experience.

11. Improvement in the maintenance and updating of existing space and increased collocation of department laboratories closer to the main campus should be pursued.

12. Benchmarking of faculty salaries against those of departments of nuclear engineering TAMU’s desires to be peers with should be completed and appropriate actions taken.

13. A plan should be formulated addressing the increased use of the NSC’s reactor in support of research. This plan should identity targeted research areas, and the facilities, faculty and staff development; budget; and potential funding sources for execution. Outside expertise should be enlisted to help in the establishment of this plan.
ACADEMIC PROGRAM REVIEW ITINERARY
Department of Nuclear Engineering
Texas A&M University
March 25-28, 2007

Hotel Reservations: The Reveille Inn
4400 Old College Road, Bryan, TX  77801 * 979.846.0858

SUNDAY, MARCH 25 ~ Arrive College Station

5:55  p.m.    Paul Turinsky, Richard Brey, William Martin arrive on 25 March; Flight #3279
               Yassin Hassan -- escort to Reveille Inn

7:30  p.m.    Dinner at Bell Ranch Steakhouse for the review team with John Poston, Yassin Hassan, and
               William Burchill.
               John Poston -- escort to Bell Ranch Steakhouse.

MONDAY, MARCH 26

7:30 – 8:30 a.m.  Reveille Inn:  Entry meeting with William Perry, Executive Vice President and Provost;
                   Rick Giardino, Dean of Graduate Studies; Jack Vitek, Assistant Dean of Graduate Studies;
                   Martyn Gunn, Dean of Undergraduate Programs; and Jim Calvin, Executive Associate
                   Vice President for Research.  Breakfast served. Dr. Perry provides charge and institutional
                   perspective to reviewers.
                   John Poston -- escort review team to Dean’s Office

9:00 –10:30 a.m.  Meet with Dr. Kem Bennett, Dean of Engineering and Dr. John Niedzwecki, Executive
                   Associate Dean, Engineering, 301 WERC
                   Yassin Hassan -- escort to Zachry Engineering Center Building (Zachry)

10:45–11:45 a.m. Meet with John Poston, Department Head, Conference Room 129, Zachry

12:00 –1:45 p.m.  Lunch with Nuclear Engineering Ph.D. students, Conference Room 129, Zachry

2:00 – 3:45 p.m.  Research Presentations

NUEN Faculty Presentations; Conference Room 129, Zachry

2:00-2:20           Best
2:20-2:40           McDeavitt
2:40-3:00           Vierow
3:00-3:20           Tsvetkov
3:20-3:45           Morel

HP Faculty Presentations; Room 127A Zachry

2:00-2:20           Braby
2:20-2:40           Shao
2:40-3:00           Ford
3:00-3:20           Marlow
3:20-3:45           Reece

3:45 – 5:00 p.m.  Meeting with Nuclear Engineering Master’s students, Conference Room 129, Zachry

5:00 – 6:30 p.m.  Faculty Reception – Terrazzo (Ben Knox Gallery)

6:30 – 8:00 p.m.  Dinner for the review team with Jim Morel and Marvin Adams

8:00 p.m.    Work session for review team
TUESDAY, MARCH 27

6:45 – 7:30 a.m. Breakfast at Reveille Inn  
*John Ford escort to NSC*

8:00 -11:00 a.m. Tour departmental research laboratories  
8:00 – 8:30 a.m. NSC  
8:30 – 9:00 a.m. MicroBeam Facility  
9:00 – 9:45 a.m. Karen Vierow’s lab at Riverside Campus  
*Driver: Karen Vierow*  
10:00 – 11:30 a.m. Fred Best and Lin Shao labs/University Service Bldg.  
*Driver: Lin Shao*

11:30 –1:30 p.m. Meet with departmental graduate committee, Conference Room 129, Zachry  
(J. Poston, M. Adams, F. Best, Y. Hassan, D. Reece)  

Noon -- working lunch for the review team

1:30 –2:30 p.m. Sean McDeavitt and Lin Shao labs in Zachry Engineering Center

2:30 –5:00 p.m. Open time for review team to work on final report, Conference Room 129, Zachry

5:30 p.m. Dinner for review team at Reveille Inn; catered by Epicures  
*John Poston will escort to The Reveille Inn*

Reviewers’ work session; preparation of draft report for debriefing

WEDNESDAY, MARCH 28

7:30 – 9:00 a.m. Reveille Inn: exit meeting with William Perry, Executive Vice President and Provost; Rick Giardino, Dean of Graduate Studies; Jack Vitek, Assistant Dean of Graduate Studies; John Niedzwecki, Executive Associate Dean of Engineering; Martyn Gunn, Dean of Undergraduate Programs; and Jim Calvin, Executive Associate Vice President for Research. Breakfast served. Reviewers present summary of their on-site review.  
*John Poston will escort to Zachry Engineering Center*

9:30 –10:30 a.m. Reviewers brief faculty, Conference Room 129, Zachry

Depart College Station:

11:15 a.m. Paul Turinsky, Richard Brey, William Martin depart on 28 March Flight #3260  
Plane leaves at 12:50 p.m.  
*Jim Morel will escort to McKenzie Terminal, Easterwood Airport*

Nuclear Engineering Faculty Contacts:

<table>
<thead>
<tr>
<th>Name</th>
<th>Phone</th>
<th>Name</th>
<th>Phone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interim Dept. Head:</td>
<td>979.845.4175</td>
<td>Associate Dept Head:</td>
<td>979.845.7090</td>
</tr>
<tr>
<td>John W. Poston, Sr.</td>
<td></td>
<td>Yassan Hassan</td>
<td></td>
</tr>
<tr>
<td>Office:</td>
<td></td>
<td>Office:</td>
<td></td>
</tr>
<tr>
<td>979.696.1573</td>
<td></td>
<td>979.690.7122</td>
<td></td>
</tr>
<tr>
<td>Home:</td>
<td></td>
<td>Cell:</td>
<td></td>
</tr>
<tr>
<td>979.450.1609</td>
<td></td>
<td>979.218.4417</td>
<td></td>
</tr>
</tbody>
</table>
Appendix H. 2011 Academic Program Review Update
MEMORANDUM

TO: Dr. Pamela Matthews
Vice Provost for Academic Affairs

THROUGH: Dr. Christine Stanley
Vice President and Associate Provost for Diversity

THROUGH: Dr. Karen Butler-Perry
Associate Provost, Graduate Studies

THROUGH: Dr. G. Kemble Bennett
Dean, Dwight Look College of Engineering

FROM: Dr. Raymond J. Juzaitis
Department Head

SUBJECT: Academic Program Review: Four-Year Status

The Graduate Program of the Department of Nuclear Engineering was reviewed in March of 2007. Based on the request received from Ms. Katy Williams, I am submitting this Four-Year Status report to satisfy the Academic Program Review guidelines. The post-review meeting, which provided a consensus list of actionable items that I reference in this report, took place on August 30, 2007. These eight items will be addressed in turn.

Size of Health Physics Faculty
The Department placed a high priority on a renewed search for two Health Physics positions. Faculty in these positions would teach undergraduate courses making up the curriculum for the Radiological Health Engineering Program, as well as teach graduate courses in the Health Physics M.S. program. They would also strengthen the base of research in the Health Physics program. The Department hired two faculty members in 2008 to complete the subject action item: Dr. Gamal Akabani (Assoc. Professor) and Dr. Stephen Guetersloh (Asst. Professor). Both of these tenure-track professors have been integrated into our academic programs and have begun to teach Departmental courses. They are also working to develop their individual research programs. Guetersloh is putting an emphasis in radiation biology, and Akabani is developing a new program in Medical Physics, which (if it is developed) will create a very exciting area of research and graduate study aligned with the needs of the contemporary Health Care industry, based on advanced methods of diagnostic and therapeutic radiology. **Action closed.**
Strategic Plan
Very soon after the program review, the College of Engineering launched its Strategic Planning process, and the University as a whole initiated the Academic Roadmap process that addressed strategic directions in Research, Learning, and Engagement. Faculty in the Department of Nuclear Engineering were encouraged to participate actively in both the College and TAMU processes. This, in fact, resulted in strong participation. It was decided that, following these higher-level strategic planning efforts (which took well over two years), the Department would correspondingly issue a formal Strategic Plan of its own, in consonance with (and informed by) the TAMU and College of Engineering Plans. Nuclear Engineering has dedicated its last few retreats to reviewing “mission”, “vision”, “values” in the wake of contemporary changes taking place in the nuclear profession and global nuclear enterprise. The Plan will also articulate specific objectives and strategies (with indicators and metrics) that would be meaningful for the Department, but also referencing issues and commitments identified in the TAMU and College plans. This is currently in process and we expect to publish a formal Strategic Plan at the end of the 2012 Academic Year. As mentioned above, this Plan will be well coordinated and informed by the other University institutional strategic plans. Work in progress.

Graduate Program Recruiting
The fraction of incoming graduate students coming from our own undergraduate program was observed by the program reviewers to be high. Our undergraduate program is currently ranked #2 in the nation among public institutions. Our graduate program is ranked #4 in the nation (#3 among public institutions); thus, it is not surprising that our very best students would try to transition to graduate studies at Texas A&M. Nevertheless, the nationally-recognized strength of our graduate program became my highest priority over the ensuing four years. Whereas the question of “What percentage of an entering cohort is represented by our own graduates?” provokes vigorous debate, we began to generally revitalize recruiting to our graduate program, while simultaneously “raising the bar” on quality of accepted students by methodically tracking GRE and GPA metrics (among others). In parallel, we began to target high-performing undergraduates from our peer institutions. In order to help accomplish this initiative, we hired a dedicated Administrative Assistant to support our Department’s Graduate Program Advisor and we restructured our Graduate Admissions Committee to specifically include representatives from the key research program areas of the Department. Other initiatives were also begun under this “umbrella”. NUEN began to actively participate in the annual “Graduate Invitational” program sponsored by the College of Engineering (hosting about 10-12 prospective graduate students from peer universities every year). We regularly apply for OGS Travel Grants to help defray visiting students’ travel costs. As we have emphasized the research of our faculty as a “drawing card” for recruiting students from beyond TAMU, during this visit we highlight the Department’s faculty and graduate research areas. We have encouraged incoming students to apply for the College Of Engineering’s National Excellence Fellowship (arguably the most important monetary tool for recruiting the best external applicants to our Graduate Program). These efforts have been successful in raising the quality of our applicant base. Several external students have made decisions to pursue their education here as a result of the exposure to faculty research during the Graduate Invitational visits (in one year over half the visiting students matriculated in our Department!). We have also recently had two of our students awarded the National Excellence Fellowships. Whereas the quality of students applying to the Department has increased, the number of applicants still reflects quite a large number of graduates of our own undergraduate program. In 2010, 12
of 35 incoming graduate students came from our own undergraduate program. For this coming fall semester, 12 of 28 incoming graduate students have TAMU undergraduate degrees. Our primary strategic goals are to: (a) increase enrollment of our graduate program to at least 150 graduate students (50% increase relative to 2007); (b) consistently raise the incoming GRE scores, GPR metrics, and the “research readiness” of incoming graduate student population in order to leverage the significant increase in externally-sponsored research funds awarded to NUEN faculty. Work in progress.

Level of Stipends Offered to Graduate Students
We have made an effort to offer more attractive Assistantships to incoming graduate students. Our Assistantships for entering grad students (GAT) were tiered in order to help with recruiting of higher quality students. Tier I students are offered $2,000 per month and Tier II students are offered $1900 per month (students matriculating in Fall of 2011). Unfortunately, Departmental finances are not in a position to offer very much more, given the numbers of students we wish to recruit. State-sponsored “Gold Plate Budget” funds are very limited, and gifts from benefactors to the Department of Nuclear Engineering are relatively rare. In addition, as a result of the recent University budget cuts, we were forced to drop 50% of the GAT positions we had been offering. This reduced the number of Departmentally-sponsored GAT positions from 20 to 10. Thus, only 10 of approximately 30-40 incoming graduate students can obtain GAT awards. We have had to shift our offers of admission to graduate students who either can support themselves or who have demonstrated a capability to do research, thus facilitating admission directly to externally-sponsored GAR positions with our research faculty. Within these constraints, we do everything possible to remain competitive in our ability to recruit graduate students. We compete for (and have been awarded) “Top-Off Funds” that can be used to support GATs or GARs. We also apply for “Diversity and Merit Fellowships” offered by the OGS. The quantity and quality of research work done by the NUEN faculty becomes the single-most important factor in attracting the best graduate students. This year, our faculty expended a total of $9M in externally-sponsored research, and were awarded $15M for current and future research work. This provides a strong base for support of graduate students, but implies that an extra criterion for admission into NUEN’s Graduate Program is an applicant’s demonstrated ability to participate in research. Work in progress.

Research Facilities Available to the Faculty
We are beholden to the College of Engineering, and ultimately to the University for laboratory space that can be made available to our faculty. Although our research labs are located as far away as Riverside Campus and the USB Building, these laboratories are completely adequate from the standpoint of the faculty who have been assigned space there. More recently, the Nuclear Engineering Department has been consolidated under one roof in the Zachry Engineering Center (3rd Floor). In addition to helping to consolidate and improve collaboration and communication within the Department, this move has provided some excellent new laboratory space. However, adequate lab space will always be at a premium for our rapidly expanding faculty research program. We, therefore, totally support the efforts of the Dean of Engineering to secure more University space and facilities to encourage research program development. As a top-ranked Department in the nation, our ranking is at continuing risk due to the adequacy and perceived quality of space from the standpoint of our peer competitors (both inside and outside of the
country). Overall, we are disappointed at the lack of University response to the College’s laboratory space needs. Hopefully in the future, some attention will be given to national ranking of the University’s constituent academic units when resource plans are developed. We see no evidence of this strategic approach at the present time. *Work in progress.*

**Excessive Prescription in Ph.D. Course Requirements**
The Nuclear Engineering faculty engaged in a major review of Ph.D. course requirements, led by an ad hoc faculty committee chaired by Dr. Pavel Tsvetkov. As a result, a formal policy change addressed the course requirements for Ph.D. candidates in 2009. The changes created much more flexibility in the degree plans of doctoral candidates, allowing them to tailor their coursework to align with the emphasis of their dissertation research. These policy changes were welcomed by a clear majority of the faculty and have now been posted on the Department’s web site. All Ph.D. students are now aware of the new policies. *Action closed.*

**Ph.D. Qualifying Examination Procedures**
All confusion related to the QE procedures should have been eliminated. Following a restructuring of our Graduate Program administration, a written Graduate Student Handbook has been developed (with corresponding Web link) and has been available to all entering (and continuing) graduate students. The Qualifying Examination procedures were carefully reviewed and were made more stringent, establishing clear time limits with clearly stated limits to the number of attempts that can be made by prospective Ph.D. candidates to pass the QE in three chosen areas of concentration. Policies are now well socialized and understood. *Action closed.*

**State of Facilities in Zachry Engineering Center**
The state of maintenance in the Zachry Engineering Center had regressed even further than observed at the time of the 2007 Graduate Program Review. Recurring ventilation and air quality issues afflicted faculty and graduate student offices for at least two full years before institutional attention could be mustered to correct the problems. Health concerns resulted in at least two evacuations of the building and demanded an ongoing program of air quality monitoring. Finally, over the past year, concerns were addressed and the air quality situation had improved. With the recent move of our administrative and faculty offices to the third floor of Zachry, this issue will hopefully be brought to closure. However, short of continuing complaints through the Dean’s office, the Department can do little to address ongoing issues related to the lack of institutional attention to maintenance. This is a University problem, but again, one that puts a nationally ranked program at risk. Poor conditions in Zachry began to be observed and mentioned by visiting prospective students. It is only a matter of time before this issue is picked up by the rankings. *Work in progress.*
The Department of Nuclear Engineering at Texas A&M University
Academic Program Review 2015

Supplemental Materials
Curricula Vitae
Course Syllabi
I. Faculty Curricula Vitae

a. Marvin L. Adams
b. Gamal Akabani
c. Frederick Best
d. Leslie A. Braby
e. William S. Charlton
f. Sunil S. Chirayath
g. John Ford
h. Stephen Guetersloh
i. Yassin A. Hassan
j. W. Wayne Kinnison
k. Cable Kurwitz
l. Craig Marianno
m. William H. Marlow
n. Ryan G. McClarren
o. Sean M. McDeavitt
p. Jim E. Morel
q. Kenneth L. Peddicord
r. John W. Poston, Sr.
s. Jean C. Ragusa
t. W. Daniel Reece
u. Lin Shao
v. Pavel Tsvetkov
w. Galina Tsvetkova
x. Karen Vierow
II. Graduate Course Syllabi........................................................................................................ ii

a. NUEN 601, Nuclear Reactor Theory ................................................................. 1

b. NUEN 604, Radiation Interactions and Shielding........................................ 4

c. NUEN 605, Radiation Detection and Nuclear Materials Measurement ................................................................. 10

d. NUEN 606, Nuclear Reactor Analysis and Experimentation.............. 14

e. NUEN 609, Nuclear Reactor Safety .............................................................. 22

f. NUEN 610, Nuclear Reactor Design and Critical Analysis.................. 25

g. NUEN 611, Nuclear Detection and Isotope Technology Lab ............ 34

h. NUEN 612, Radiological Safety and Hazards Evaluation .................. 41

i. NUEN 613, Principles of Radiological Safety ........................................... 47

j. NUEN 615, Microdosimetry ........................................................................ 50

k. NUEN 618, Multiphysics Computations in Nuclear Science and Engineering ........................................................................ 53

l. NUEN 623, Nuclear Engineering Heat Transfer and Fluid Flow ................................................................. 56

m. NUEN 624, Nuclear Thermal Hydraulics and Stress Analysis .......... 60

n. NUEN 625, Neutron Transport Theory ......................................................... 67

o. NUEN 627, Radiation-Hydrodynamics ...................................................... 74

p. NUEN 629, Numerical Methods in Reactor Analysis.......................... 78

q. NUEN 630, Monte Carlo Computational Particle Transport ............ 81

r. NUEN 633, Radiation Measurements and Calibrations ..................... 88

s. NUTR/NUEN/KINE 646, Fundamentals of Space Life Sciences ................................................................. 95

t. NUEN 650, Nuclear Nonproliferation and Arms Control.................... 99

u. NUEN 651, Nuclear Fuel Cycles and Nuclear Material Safeguards ........................................................................ 105

v. NUEN 656, Critical Analysis of Nuclear Security Data.................... 112

w. NUEN 661, Nuclear Fuel Performance ...................................................... 117

x. NUEN 662, Nuclear Materials under Extreme Conditions .......... 121

y. NUEN 663, Fundamentals of Ion Solid Interactions ........................... 123
z. NUEN/BMEN 673, Radiation Biology ........................................ 125
a. NUEN 674, Radiation Carcinogenesis ..................................... 129
b. NUEN 675, Internal Dose Techniques ..................................... 133
c. NUEN 676, Radiation Dosimetry Laboratory (2012) ............... 136
d. NUEN 678, Waste Management in the Nuclear Industry .......... 140
e. NUEN 685, Special Topics in Internal Dose Assessment ........... 144
f. NUEN 689, Introduction to Diagnostic Radiology Physics ....... 148
g. NUEN 689, Introduction to Radionuclide Production and
   Separation Methods ................................................................... 152
h. NUEN 689, Nuclear Emergency Response and Dose
   Assessment ............................................................................... 156
i. NUEN 689, Severe Accident Analysis of Nuclear Facilities ....... 159
j. NUEN 689, Introduction to GEANT4 Monte Carlo Transport .... 167
k. NUEN 689, Probability and Risk Assessment ......................... 170
l. NUEN 689, Special Topics in Uncertainty Quantification in
   Nuclear Science and Engineering .............................................. 174
Book 1
Faculty Curricula Vitae
Name: Marvin L. Adams

Education (degree, discipline, institution, year):
- Ph.D., Nuclear Engineering, U. of Michigan, 1986
- M.S., Nuclear Engineering, U. of Michigan, 1984
- B.S., Nuclear Engineering, Mississippi State U., 1981

Academic experience – institution, rank, title:
- Texas A&M, Professor, 2002-present
- Texas A&M, Assoc. Prof., 1997-2002
- Texas A&M, Assoc. V.P. for Research, 2005-2009
- Texas A&M, Director, Institute for National Security Education and Research, 2007-present
- Texas A&M, Director, Center for Large-scale Scientific Simulations, 2006-2007
- Texas A&M, Assoc. Head of Nuclear Engineering, 1998-1999

Non-academic Experience:
- Lawrence Livermore National Lab, Physicist, 1986-1992
- Tennessee Valley Authority, 1982 (staff) and 1977-80 (co-op)

Professional Registrations: P.E., Texas

Current Professional Society Memberships:
- American Nuclear Society
- American Association for the Advancement of Science
- Society for Industrial and Applied Mathematics
- Phi Kappa Phi

Honors and Awards since 2000:
- Texas A&M Assoc. of Former Students, Distinguished Service Award for Teaching, 2010
- Texas A&M, HTRI Endowed Professorship, 2008-present
- Texas A&M, George Armistead, Jr. ’23 Faculty Fellow, 2006
- Texas A&M, TEES Fellow, 2003
- American Nuclear Society, Fellow, 2001
- American Nuclear Society, Best Paper, Reactor Physics, 2001

Service Activities (within and outside the institution):
- National Academies: Member of CISAC, 2014-present; Review Coordinator of Fukushima Lessons-Learned Study, 2014; Co-Chair of study on Verification, Validation, and Uncertainty Quantification, 2010-2012; Member of several other study committees.
- National Labs: Chaired several panels and committees including: Predictive Science Panel for LLNL and LANL, 2010-2013; Weapons Science Capability Review Committee for LANL, 2009-2011; Applied Physics External Review Committee for LANL, 2005-2006. Have served as member on many other review
and advisory committees for national labs, 1998-present.

**DOE:** Member of Blue-Ribbon Panel on Nuclear Engineering and Research Reactors, 1999-2000.

**ANS:** Math & Comp Div: Chair, Vice Chair, Secretary, and Exec Committee; Assoc. Tech. Prog. Chair of 1995 Topical Meeting; many years on Tech Prog Committee. Reactor Physics Div: years on Tech Prog Committee

**Texas A&M:** Chief Scientist of Multi-Program Research and Education Facility 2012-present; Chair of TAMU Conflict of Interest Committee 2008-09; Chair of Moving Committee 2014-present; Chair of Faculty Search Committee, 2012-12; Chair of Dept. Scholarship Committee, 1998-2002 and 2005-09; Dept. Grad. Program Coordinator, 2002-04; Member of Reactor Safety Board, 1993-present; Member of many other committees

**Important Publications in past 5 years: (* denotes student of M. L. Adams when work was performed)**


**Recent Professional Development Activities:**

See Service Activities

**Consulting, Patents, etc.:**

Consulting: LLNL 1992-present; LANL 1998-present; SNL 2000-present; Mitre Corporation 2006-present
Name: Gamal Akabani

**Education (degree, discipline, institution, year):**
- Doctor of Philosophy, Nuclear Engineering, Texas A&M University, 1990
- Masters of Science, Health Physics, Texas A&M University, 1987
- Bachelors of Science, Physics, National Autonomous University of Mexico, 1985

**Academic experience – institution, rank, title:**
- Assistant Professor of Radiation Oncology, Department of Radiation Oncology, University of Nebraska Medical Center, Omaha, NE. 1995 – 1996. Full time.
- Assistant Professor of Radiology, Department of Radiology, Duke University Medical Center, Durham, NC. 1996-2005. Full time.
- Associate Professor, Department of Nuclear Engineering Texas A&M University, College Station, TX. 2009-present. Full time.

**Non-academic Experience:**
- Senior Staff Fellow, Center for Devices and Radiological Health (CDRH), Center for Drug Evaluation and Research (CDER), Food and Drug Administration, Silver Spring, MD. 2007-2008.

**Certifications or Professional Registrations:**
- Current Professional Society Memberships:
  - American Nuclear Society
  - Society of Nuclear Medicine
  - Society of Radiopharmaceutical Sciences
  - American Association of Physicists in Medicine
  - The Scientific Research Society
  - American Chemical Society

**Honors and Awards:**
- Service Activities (within and outside the institution):
  - TAMU Graduate Merit Fellowship Reviewer, 2010 - present
  - TAMU Graduate Minority Fellowship Reviewer, 2010 - present
  - NSF Graduate Research Fellowship 2012 – present
  - NIH SBIR-STTR Study section 2009 – present
  - NIH Radiation Therapeutics and Biology (RTB) Study Section 2009- present.
  - VA Clinical Science and Development Services Scientific Merit
Important Publications in past 5 years:


Recent Professional Development Activities:

Name: Frederick R. Best

**Education (degree, discipline, institution, year):**
- ME, Manhattan College, NYC, 1968
- SM, MIT, 1969
- PhD, MIT, 1980

**Academic experience – institution, rank, title:**
- Associate Professor and tenure, 1987-2011
- Assistant Professor, Texas A&M Nuclear Eng., 1982 – 1987
- Visiting Professor, MIT 1980 – 1982

**Non-academic Experience:**
- Director, Space Engineering Research Ctr, 1993 - 2011

**Certifications or Professional Registrations:**

**Current Professional Society Memberships:**
- American Nuclear Society
- American Association for the Advancement of Science

**Honors and Awards:**

**Service Activities (within and outside the institution):**

**Important Publications in past 5 years:**

Recent Professional Development Activities:

Consulting, Patents, etc.:
Name: Leslie A. Braby

Education (degree, discipline, institution, year):
Ph.D. Radiological Physics, 1972, Oregon State University
B.A. Physics, 1963, Linfield College

Academic experience – institution, rank, title:
Texas A&M, Research Professor, Nuclear Engineering, 1996 – 2013
Retired 2013, 5% on continuing research

Non-academic Experience:

Certifications or Professional Registrations:
None

Current Professional Society Memberships:
Radiation Research
Health Physics

Honors and Awards:
Service Activities (within and outside the institution):
Chair of International Commission on Radiation Units and Measurements (ICRU) Working Committee on characterizing low level radiation exposure
Emeritus Member of National Council on Radiation Protection and Measurements.
Chair of NCRP committee 1-24 on effects on the central nervous system of radiation in space
Chair of NCRP committee 1-11 on safety considerations for pulsed fast neutron surveillance systems
Chair of 6-5 on safety of cargo inspection systems using high energy photons
Member of several NCRP Committees including 88 on fluence as a basis of a system of radiation protection for astronauts, 1-7 on research needs for deep space missions, and 6-1 on uncertainties in measuring external beam irradiation.

Important Publications in past 5 years:


Braby, L. A., 2011, Quantification of low-level exposure, Health Physics 100, 261


Kulage, Z., Northum, J., Guetersloh, S., and Braby, L., 2013, Dosimetry of the Texas A&M University AGN-201M Research Reactor Under Accident Conditions, Health Physics, 105, 296-300

**Recent Professional Development Activities:**

**Consulting, Patents, etc.:**
Name: William S. Charlton

**Education (degree, discipline, institution, year):**
- B.S., Nuclear Engineering, Texas A&M University, 1995
- M.S., Nuclear Engineering, Texas A&M University, 1997
- Ph.D., Nuclear Engineering, Texas A&M University, 1999

**Academic experience – institution, rank, title:**
- Texas A&M University, Professor, 2014-present
- Texas A&M University, Director (Nuclear Security Science and Policy Institute), 2006-present
- Texas A&M University, Associate Professor, 2003-2014
- University of Texas at Austin, Assistant Professor, 2000-2003

**Non-academic Experience:**
- Los Alamos National Laboratory, Technical Staff Member, 1998-2000

**Certifications or Professional Registrations:**
- None

**Current Professional Society Memberships:**
- Institute of Nuclear Materials Management
- American Nuclear Society
- International Nuclear Security Education Network

**Honors and Awards:**
- Barbara and Ralph Cox ’53 Faculty Fellow for Outstanding Engineering Contributions, TAMU (2013)
- Special Service Award, Institute of Nuclear Materials Management (2010)
- Advisor of the Year Award, Division of Student Affairs, TAMU (2009-2010)
- Dwight Look College of Engineering Faculty Fellow, TAMU (2007)
- George Armistead, Jr. ’23 Faculty Fellow, TAMU (2005-2006)

**Service Activities (within and outside the institution):**
- Chair, Spent Fuel Safeguards Review Committee, NNSA NGSI Program (2011-2014)
- Member, National and Homeland Security Strategic Review Committee, Idaho National Laboratory (2011-2014)
- Member, National Academy of Sciences Committee on Proliferation Risk in Nuclear Fuel Cycles (2011-2012)
- Co-Chair National Security Thematic Area for the Texas A&M Engineering Experiment Station (2014-present)
- Member of the TAMU College of Engineering Tenure and Promotion Committee (2014-present)
- Member of the TAMU College of Engineering Awards Committee (2014-present)
Member of the TAMU College of Engineering National Security Taskforce (2013-2014)
Member of the NUEN Growth Committee (2013-present)
Member of the NUEN Executive Committee (2012-present)
Fellow, Institute for Science, Technology & Public Policy, Bush School of Government and Public Service (2011-present)
Member, Nuclear Solutions Institute Advisory Board (2011-present)
Member of the NUEN Graduate Student Admissions Committee (2008-present)
Member of the TAMU Reactor Safety Board (Fall 2004-present)

Important Publications in past 5 years:


Recent Professional Development Activities:

Consulting, Patents, etc.:
Name: Sunil S. Chirayath

Education (degree, discipline, institution, year):
- Ph.D. (Physics), University of Madras (India), 2005
- M.S. (Physics) 1994, University of Calicut (India), 1994

Academic experience – institution, rank, title:
- Visiting Assistant Professor, Department of Nuclear Engineering, Texas A&M University, Jan. 2009-present.

MS graduate courses taught: One course per semester NUEN 651 & NUEN 630

Full Member of the Graduate Faculty at Texas A&M Univ.:
Advised 9 MS students; Current students: 3 MS, 3 Ph.D. and 1 postdoc.

Non-academic Experience:
  - Co-PI: “Research Internship for Russian Students from Tomsk Polytechnic University”, FY 2014 & 2015 ($200,000)
  - Co-PI for the multi-disciplinary five years research proj. on “Frame Work for Dev. Novel Detection Systems Focused on Interdicting High Enriched Uranium (HEU);” 2007-2012. ($7,500,000)


- R&D works for solving reactor physics & radiation shielding design problems related to Indian Prototype FBR (PFBR-500MWe) and Russian Pressurized Water Reactors (VVERs) constructed in India

- Regulatory inspections of nuclear power plants and nuclear fuel cycle facilities to enforce radiation protection rules of India

Certifications or One year Stipendiary Health Physics Trainee, Bhabha Atomic


Honors and Awards: None

Service Activities (within and outside the institution): None

Important Publications in past 5 years:

8. Total Publications in past five years (2010-2014): 8

Recent Professional Development Activities: None

Consulting, Patents, etc.: None
Name: John Ford

Education (degree, discipline, institution, year):
- Ph.D., Biomedical Sciences, University of Tennessee, 1992
- M.S., Nuclear Engineering, Mississippi State University, 1986
- B.S., Nuclear Engineering, Mississippi State University, 1982

Academic experience – institution, rank, title:
- 2006-present: Associate Professor with Tenure, Department of Nuclear Engineering, Texas A&M University.
- 1999-2006: Assistant Professor, Department of Nuclear Engineering, Texas A&M University.
- 1987-1988: Graduate Research Assistant, University of Tennessee, Oak Ridge National Laboratory.
- 1985-1986: Graduate Research Assistant, Mississippi State University.
- 1983-1985: Graduate Teaching Assistant, Mississippi State University.

Non-academic Experience:
- 1997-1998: Grade I Scientist, Medical Research Council-Radiation & Genome Stability Unit, Harwell, United Kingdom.
- 1995-1997: Postdoctoral Fellow, American Cancer Society, Medical Research Council-Radiation and Genome Stability Unit, Harwell, United Kingdom.

Certifications or Professional Registrations: NONE

Current Professional Society Memberships:
- Health Physics Society
- Radiation Research Society
- Sigma Xi

Honors and Awards:
- 2013-14: ARRO Educator of the Year Award
- 2008: Registered Student Organization Advisor of the Year
- 2007: BP Award for Teaching Excellence

Service Activities (within and outside the institution):
- Reactor Safety Board member 2000-present.
- Goldwater Fellowship Applicant Review Committee 2011-present.
- Engineering Teaching Awards Reviewer, 2009-2012.
Radiation Safety Committee, 2013-present.

**Important Publications in past 5 years:**


**Recent Professional Development Activities:**

IDEA workshop, 2012

Quality Matters Rubric Workshop, 2013

**Consulting, Patents, etc.:**

NONE
Name: Stephen B. Guetersloh

Education (degree, discipline, institution, year):
B.S. Radiological Eng. Texas A&M Univ., 1988
J.D. Law Calif. Western Sch. of Law, 1992
M.S. Health Physics, Texas A&M Univ., 2000
Ph.D. Radiation Phys., Colorado State Univ., 2003

Academic experience – institution, rank, title:
November 1, 2008  Assistant Professor (tenure-track)

Non-academic Experience:
2002-2003  Graduate Training Fellow, NASA Specialized Center of Research and Training (NSCORT), Colorado State University.
2003-2006  Postdoctoral Research Associate, Lawrence Berkeley National Laboratory, Life Sciences Division.
2006  Radiation Physicist, Stanford Linear Accelerator.

Certifications or Professional Registrations:
State Bar of California

Current Professional Society Memberships:
Health Physics Society, American Geophysical Union

Honors and Awards:

Service Activities (within and outside the institution):

Important Publications in past 5 years:


**Recent Professional Development Activities:**

**Consulting, Patents, etc.:**

Lawrence Berkeley National Laboratory 2006 to Dec. 2009:
Fragmentation of heavy ion beams on elemental targets
<table>
<thead>
<tr>
<th>Name:</th>
<th>Yassin A Hassan</th>
</tr>
</thead>
</table>
| Education (degree, discipline, institution, year): | Ph.D., Nuclear Engineering, University of Illinois, 1980  
M.S., Mechanical Engineering, University of Virginia, 1985  
M.S., Nuclear Engineering, University of Illinois, 1975  
B.S., Engineering, University of Alexandria, Egypt, 1968 |
| Academic experience – institution, rank, title: | Professor, Department of Nuclear Engineering, Texas A&M University, September 1990-present.  
Professor, 2003–present, Department of Mechanical Engineering, Texas A&M University, Joint appointment.  
Dept. Head and Sallie & Don Davis ’61 Professor of Nuclear Eng., 2013-present, Dept. of Nuclear Eng., Texas A&M Univ.  
Interim Head, 2012-2013, Department of Nuclear Engineering, Texas A&M University.  
Adjunct Professor 2009–present, The University of Texas of the Permian Basin.  
Associate Head, 2002-2012, Department of Nuclear Engineering, Texas A&M University.  
Graduate Program Coordinator, September 1990 - 2002, Department of Nuclear Engineering, Texas A&M University.  
Associate Professor, Department of Nuclear Engineering, Texas A&M University, September 1986–August 1990.  
Adjunct Professor, Xi'an Jiaotong Univ., China, 2013- present. |
| Non-academic Experience: | Principal Engineer, Nuclear Power Division, Babcock & Wilcox Co., Virginia, 1984-1986  
| Certifications or Professional Registrations: | Registered Professional Engineer, Texas # 74645 |
| Current Professional Society Memberships: | The American Assoc. for the Advancement of Science (Fellow)  
The American Nuclear Society (ANS) (Fellow)  
The American Society of Mechanical Engineers (Fellow)  
The International Energy Foundation (Fellow)  
The American Institute of Chemical Engineers (Senior member)  
The American Institute of Physics  
The European Mechanics Society  
The International Association for Hydraulic Research (IAHR) |
| Honors and Awards: | 2008 American Nuclear Society Seaborg Medal |
Best Paper at Thermal Hydraulic Session of Young Professionals, ANS Winter Meeting, (advisee Steve Fortenberry), Nov. 2008
2004 Thermal Hydraulics Tech. Achievement Award of ANS for significant contributions in thermal hydraulics & reactor safety
2003 Arthur Holly Compton Award
2001 Glenn Murphy Award of the Am. Assoc. for Eng. Education
1992 Texas Engineering Experiment Station Senior Fellow
1991-1992 Texas Engineering Experiment Station Fellow
1990-1991 Texas Engineering Experiment Station Fellow
Certificate of Recognition from the French Nuclear Society for Managing as US Technical Chair, 9th Internat. Conf. on Nuclear Engineering (ICONE-9), April 2001
Certificate of Appreciation at ICONE-7, Tokyo, Jap., April 1999.
Certificate of Appreciation at ICONE-6, May 1998

**Service Activities (within and outside the institution):**

Editor-in-Chief, Nuclear Eng. & Design Journal, 2008-present

Sworn in 2007, part-time Technical Judge, Atomic Safety & Licensing Board Panel (ASLB), U.S. NRC, Wash. DC.
Member of the Governing Board of the European Union Thermal-Hydraulics of Innovative Nuclear Systems (THINS) project

**Important Publications in past 5 years:**

According to the science Citation Index, publications authored or coauthored by Y.A. Hassan have been cited more than 2010 times (h-index=22, i10-index =52).

Number of refereed journal publications: 129; Number of refereed papers & conf. proceedings: 265; Summaries in transaction: 301; Number of reports: 30; Editorships: 54; Chs. in books: 7; Keynote Addresses, Invited Speaker or Seminar Speaker: 110; The number of ANS summaries authored by his students & him are more than 300 summaries (the largest for any ANS member since the establishment of the ANS in 1950).

**Recent Professional Development Activities:**

Consulting, Patents, etc.:
Name: W. Wayne Kinnison

Education (degree, discipline, institution, year):
- Ph. D. Physics – University of Chicago, 1979
- M.A. Physics – University of Texas, Arlington, 1972
- B.S. Physics – University of Texas, Arlington, 1971

Academic experience – institution, rank, title:
- 2013 – Present: Nuclear Power Institute, Texas A&M University, Research Scientist
- 2006-2013: Texas A&M University-Kingsville, Associate Professor

Non-academic Experience:
- 2000-2006: Owner of internet consulting company, Austin, Texas
- 1979-1999: Los Alamos National Laboratory, Staff Scientist and various management positions

Current Professional Society Memberships:
- Member of Sigma Xi since 1970
- Member of Sigma Xi Sigma Honor Society since 1971
- Member of American Society of Physics since 1979

Service Activities (within and outside the institution):
- 2011 University Health & Safety Committee, Texas A&M University-Kingsville
- 2008-2010 Research Council, Texas A&M University-Kingsville
- 2007 Faculty Search Committee, Texas A&M University-Kingsville
- Staff Member, Physics Division, Los Alamos National Laboratory, 1994-1999
- Group Leader, Particle Physics Group, Los Alamos National Laboratory, 1991-1994
- Deputy Group Leader, Particle Physics Group, Los Alamos National Laboratory, 1989-1991
- Staff Member, Particle Physics Group, Paul Scherrer Institute, Villigen, Switzerland, 1988-1989
- Staff Member, Physics Division Office, Los Alamos National Laboratory, 1982-1989
- Postdoctoral Fellow, Medium Energy Physics Division, Los Alamos National Laboratory, 1979-1982

Important Publications:


Name: Cable Kurwitz

Education (degree, discipline, institution, year):
PhD, Nuclear Engineering, Texas A&M University, 2009

Academic experience – institution, rank, title:
Texas A&M University, Senior Lecturer, 2010-current, full time

Non-academic Experience:
TEES Associate Research Engineer, Director and Laboratory Manager, May, 1998 – 2009, Full Time.
Commonwealth Edison, System Engineer, Reactor Engineering Group May, 1997 – May, 1998,

Certifications or Professional Registrations:
Professional Engineer – State of Texas – LIC. # 93005

Current Professional Society Memberships:
AIAA, ASTM

Honors and Awards:
Excellent Undergraduate Student Research Advisor, Harbin Engineering University, China, 2014

Service Activities (within and outside the institution):
IAEA Consultancy on the Development of a Nuclear Management Masters Program, 2013-current
NPI-Kenyan Nuclear Engineering Summer School, Instructor, 2012, 2013
Gulf Nuclear Energy Infrastructure Initiative GNEII, Instructor, 2011-2015
NPI-UK nucleargraduates, Instructor, Texas A&M, 2012
ASTM E10 Nuclear Metrology Standards Committee, 2013
Aerospace Thermal Workshop – Thermophysics Workshop Technical Committee, 2013
Important Publications in past 5 years:


Recent Professional Development Activities:

- Fundamentals of Teaching Online
- Captivate Tutorials
- Getting Started with eCampus

Consulting, Patents, etc.:

- Battelle Northwest Division, Pacific Northwest Laboratory, 2012 Technology Disclosure, Automated Prediction of High Dimensional Data, 2010
- Technology Disclosure, Multichambered Gas/Liquid Separator, 2010
- Technology Disclosure and License, Liquid-Gas Separation in Microgravity, 2000, 2008
Name: Craig M. Marianno

Education (degree, discipline, institution, year):
- B.S., Physics, University of California at Davis, 1993
- M.S., Radiological Health Sciences, Colorado State University, 1996
- Ph.D., Radiation Health Physics, Oregon State University, 2000

Academic experience – institution, rank, title:
- Texas A&M University, Visiting Assistant Professor (2009 – Present)

Non-academic Experience:
- 2000 – 2009 Title: Manager for the Nuclear Instrumentation Section/Senior Scientist
- Institution: National Securities Technology at the Remote Sensing Laboratory (National Nuclear Security Administration contractor)
- Responsibilities: Manage 15 person engineering team in software and hardware design for unique equipment employed by the Department of Energy’s Nuclear Emergency Response teams.
  - Member of the Federal Radiological Monitoring and Assessment Center (FRMAC) Dose Assessment Working Group.
  - Lead developer for data products for all nuclear power plant exercises and other Federal Level exercises in which the CMRT participates, 10/03 to 10/09.
  - Worked with and conduct briefings to members of the Radiological Assistance Program, Federal Bureau of Investigation, Military Explosive Ordinance teams, and other Federal agencies.
  - Provide scientific support toward the development of new equipment.
    - Led the development team for the NNSA’s gamma directional backpack
    - Led the development team of the Tactical Radiation and Characterization System (TRACS) used by the New York City Police Counter Terrorsisms Unit
  - Other duties include:
    - Deployed in multiple missions is support of the Nation Nuclear Security Administration’s Emergency Response teams from 2000 - 2009
    - Deployable member and team lead for the Search Response Team (SRT), Consequence Management Response Team (CMRT), Ariel Measurements System (AMS)
    - Captain for the Radiological Assistance Program.
    - Dose Assessment Scientist for the CMRT

Certifications or Professional: Certified Health Physicist
Registrations:

Current Professional Society Memberships:

Honors and Awards:
Inducted into the Oregon State University Council of Outstanding Early Career Engineers (2005)

Service Activities (within and outside the institution):
- NE Department Safety Committee
- NE Curriculum Development Committee
- Member of the International Atomic Energy Agency’s International Nuclear Security Education Network (INSEN) (2010 – Present)
  • Working Group II Chairman 2012 – 2013
- Executive Committee Member for the Health Physics Society’s Homeland Security Section (2009 – Present)
- Youth Soccer Coach College Station Youth Soccer league (2010 - 2014)

Important Publications in past 5 years:


Recent Professional Development Activities: N/A

Consulting, Patents, etc.:
**Name:** William H. Marlow

**Education (degree, discipline, institution, year):**
- Ph.D., Physics, University of Texas at Austin, 1973
- B.S., Physics, Massachusetts Institute of Technology, 1966

**Academic experience – institution, rank, title:**
- Associate Professor, 1986-1996
- Research Engineer (Visiting), Civil Eng. Dept., 1985-1986

**Non-academic Experience:**
- Assistant Physicist, Associate Physicist, Physicist, Environmental Chemistry Division, Department of Applied Science, Brookhaven National Laboratory, 1975-1986
- Post-Doctoral Research Associate, Department of Environmental Sciences and Engineering, School of Public Health, University of North Carolina at Chapel Hill, 1973-1974

**Certifications or Professional Registrations:**

**Current Professional Society Memberships:**
- American Physical Society
- European Aerosol Society

**Honors and Awards:**
- 2000 Japan Society for the Promotion of Science Fellow. Chemical Eng. Dept., Univ. of Hiroshima, Hiroshima, Japan
- 2000 Wenner Gren Visiting Professor of Solid State Physics, Ångstrom Lab. of Materials Science, Uppsala Univ., Uppsala, Sweden
- 1996 Faculty Fellow of the College of Eng., Texas A&M Univ.

**Service Activities (within and outside the institution):**
- 2001-2014: Head of Undergraduate Programs and Lead Undergraduate Advisor for Nuclear Eng. Dept.
- Served on numerous major and minor committees of the Dept., of the College of Eng., and of inter-College concerns

**Important Publications in past 5 years:**
- Nie, Chu, Jun Geng, W. H. Marlow, 2008. The free energy of


**Recent Professional Development Activities:**

Consulting, Patents, etc.:

*October 2014: Discussions with governmental technical personnel in Wuhan China regarding sampling of airborne radioactivity with possibility of consulting


Name: Ryan G. McClarren

Education (degree, discipline, institution, year):
- Ph.D., Nuclear Engineering and Radiological Sciences, University of Michigan, Ann Arbor, MI, 2007
- M.S.E., Nuclear Engineering and Radiological Sciences, University of Michigan, Ann Arbor, MI, 2004
- B.S.E., Nuclear Engineering and Radiological Sciences, University of Michigan, Ann Arbor, MI, 2003

Academic experience – institution, rank, title:
- Texas A&M University, Assistant Professor, 2011-Present

Non-academic Experience:
- Los Alamos National Laboratory, Computational Physics Group, Technical Staff Member, 2008, Postdoctoral Research Associate, 2007

Certifications or Professional Registrations:

Current Professional Society Memberships:
- American Nuclear Society, Society of Applied and Industrial Mathematics

Honors and Awards:
- Texas A&M University, Institute for Applied Mathematics and Computational Science Fellow (2009-2011)
- Los Alamos Awards Program, Team Award Recipient (2007)
- Department of Energy, National Undergraduate Research Fellow (2002)
- Department of Energy, Energy Research Undergraduate Fellow (2001)

Service Activities (within and outside the institution):
Guest Scientist, Los Alamos National Laboratory, (2008-Present)
Dept. Graduate Admissions Committee (2011-Present)
Emerging Learning Technologies Advisory Council –
Department Rep. 2014-Present
Junior Engineering Faculty Advisory Council - Department Rep.
2014-Present

Important Publications in past 5 years:

Recent Professional Development Activities:
Center for Teaching Excellence, Fall 2014 Faculty Teaching Academy
Edward Tufte “Presenting Data and Information” Course, Jan 2012.
Name: Sean M. McDeavitt

Education (degree, discipline, institution, year):
B.S., Nuclear Engineering, Purdue University, 1987
M.S., Nuclear Engineering, Purdue University, 1990
Ph.D., Nuclear Engineering, Purdue University, 1992

Academic experience – institution, rank, title:
2011-present, Texas A&M University, Associate Professor, Nuclear Engineering.
2006-2011, Texas A&M University, Assistant Professor, Nuclear Engineering.
2003-2006, Purdue University, Associate Professor (untenured), Nuclear Engineering.
Fall 2002, Purdue University, Visiting Associate Professor, Nuclear Engineering.
1990, Purdue University, Instructor, Nuclear Engineering.

Non-academic Experience:
2014-present, Int. Director, TEES Nuclear Science Center, Texas A&M Engineering Experiment Station, College Station, TX.
1999-2003, Section Manager, Argonne National Laboratory, Chemical Technology Division, Argonne, IL.
1992-1999, technical Staff, Argonne National Laboratory, Chemical Technology Division, Argonne, IL.
1991-1992, Lab-Grad Student Appointment, Argonne National Laboratory, Materials and Components Technology Division, Argonne, IL.

Certifications or Professional Regs.:
N/A

Current Professional Society Memberships:
American Nuclear Society (ANS)
The Minerals, Metals, and Materials Society (TMS)

Honors and Awards:
2014 TEES Faculty Fellow, Texas A&M Engineering Experiment Station (TEES)
2012 American Nuclear Society, Materials Science and Technology Division, “2010 Significant Contribution Award.”
2010 Charles H. Barclay Jr. '45 Faculty Fellow from Texas A&M University College of Engineering.
2004 American Nuclear Society, Materials Science and Technology Division, “2002 Significant Contribution Award.”
2002 Argonne National Laboratory, “Critical Skills” Award.
1996 American Nuclear Society Literary Award (“Best Paper”) from the ANS Materials Science and Technology Division.
1995 Argonne National Laboratory Pacesetter Award.
| Service Activities (within and outside the institution): | 2014 | College of Engineering Committee: Center for Advanced Materials for Energy Applications |
| | 2012 to present | ANS Materials Science and Technology Division Executive Committee |
| | 2013 | College of Engineering Faculty Hiring Committee |
| | 2012 | College of Engineering ad hoc committee to consider the formation of a Department of Materials Science & Engineering |
| | 2012 | College of Engineering Strategic Plan Research Subcommittee |
| | 2012 | NUEN Department Head Search Committee |
| | 2011 to 2013 | NUEN Safety Committee |
| | 2009 to present | NUEN Faculty Search Committees (including NSI positions) |
| | 2009 to 2014 | NUEN: Space & Facilities Committee (Chair) |
| | 2007 to present | NUEN: PhD Qualifying Exam Committees |
| | 2007 to 2014 | TEES: Reactor Safety Board |

**Important Publications in past 5 years:**


*Indicates student, postdoc, or staff working for S. McDeavitt

**Recent Pro. Dev. Act.:**

N/A

**Consulting, Patents, etc.:**

- Consultant to TerraPower (Belleview, WA), 2009 to present
Name: Jim E. Morel

Education: (degree, discipline, institution, year):
- Ph.D., Nuclear Engineering, University of New Mexico, 1979
- M.S., Nuclear Engineering, Louisiana State University, 1974
- B.S., Mathematics, Louisiana State University, 1972

Academic experience – institution, rank, title:
- Texas A&M University, Professor, (2005 - ), full time
  - Associate Department Head (2013 - ),
  - Director, Center for Large Scale Scientific Simulations (2007 -)

Non-academic Experience:
  - Group leader, team leader, staff member
- Sandia National Laboratories, (1976-1984), staff member
  - Nuclear research officer

Certifications or Professional Registrations:
- None.

Current Professional Society Memberships:
- ANS, SIAM

Honors and Awards:
- LANL Distinguished Performance Award, 1992.

Service Activities (within and outside the institution):
- Associate Department Head (2013 - )
- Graduate Advisor (2010-2012)
- Department P&T Committee Chair, (2008 - )
- Journal Reviews, NSE, JCP, JQSRT, TTSP/JTCT, SISC
- Member, Editorial Board, TTSP/JCTT
- Proposal Reviews, DOE, NEUP, INCITE, NSF

Important Publications in past 5 years:
- Peter G. Maginot, Jean C. Ragusa, Jim E. Morel, “Discontinuous


**Recent Professional Development Activities:** None.

**Consulting, Patents, etc.:** Consultant, Transpire, Inc. (2009-2014)
<table>
<thead>
<tr>
<th>Name:</th>
<th>Kenneth L. Peddicord</th>
</tr>
</thead>
</table>
| **Education (degree, discipline, institution, year):** | B.S., Mechanical Engineering, University of Notre Dame, 1965  
M.S., Nuclear Engineering, University of Illinois, 1967  
Ph.D., Nuclear Engineering, University of Illinois, 1972 |
| **Academic experience – institution, rank, title:** | Texas A&M University, Professor of Nuclear, 1983-present |
| **Non-academic Experience:** | Director, Texas A&M Engineering Experiment Station, 2007-2009  
Director, Nuclear Power Institute, 2007-present |
| **Certifications or Professional Registrations:** | Registered Professional Engineer, State of Texas |
| **Current Professional Society Memberships:** | American Nuclear Society  
American Society of Mechanical Engineers  
American Society for Engineering Education |
| **Honors and Awards:** | Fellow, American Nuclear Society |
| **Service Activities (within and outside the institution):** | Texas A&M University:  
Department of Nuclear Engineering, Chair, ABET Committee 2  
Chair, Post Tenure Review Committee  
Chair, RHEN Program Evaluation Committee |
| | U.S. Government:  
Nuclear Waste Technical Review Board, Member, 2012-present  
DOE Nuclear Energy Advisory Committee International Subcommitte, 2011-present |
| | Los Alamos National Security/Lawrence Livermore National Security:  
Board of Governors Science and Technology Committee, 2010-present |
| | Laboratory for Reactor Physics and Systems Behavior, Paul Scherrer Institutut, 2003-2012 |
| | Department of Nuclear Energy and Safety, Paul Scherrer Institutut, 2010-2012 |
| **Important Publications in past 5** | K. L. Peddicord, Tami Davis Hollar, John Poston, Paulo |


**Recent Professional Development Activities:**


**Consulting, Patents, etc.:**

Idaho National Laboratory, 2010-14

Pacific Northwest National Laboratory, 2009-13
Name: John W. Poston, Sr., Professor

Education (degree, discipline, institution, year):
- B.S., Mathematics, Lynchburg College, Lynchburg, VA, 1958
- M.S., Nuclear Engineering, Georgia Institute of Technology, Atlanta, GA, 1969
- Ph.D., Nuclear Engineering, Georgia Institute of Technology, Atlanta, GA, 1971
- Special Training: Oak Ridge School of Reactor Technology (ORSORT) 1964-65.

Academic experience – institution, rank, title:
- Associate Professor, Department of Nuclear Engineering, Georgia Institute of Technology, Atlanta, GA, January 1977-December 1985
- Professor, Department of Nuclear Engineering, Texas A&M University, January 1985 – present (served 10-year term and Department Head)

Non-academic Experience:
- Research Staff Member and Section Head, Health Physics Division, Oak Ridge National Laboratory, January 1964- January 1977.

Certifications or Professional Registrations:
- None

Current Professional Society Memberships:
- American Association for the Advancement of Science-Fellow
- American Nuclear Society-Fellow
- American Society for Engineering Education-Fellow
- Health Physics Society-Fellow
- The Society of Sigma Xi
- International Nuclear Energy Academy – elected September 2010

Honors and Awards:
- American Association for the Advancement of Science-Fellow
- American Nuclear Society-Fellow
- Health Physics Society-Fellow
- Professional Excellence Award, ANS Radiation Protection and Shielding Division - 2014

Service Activities (within and outside the institution):
- Presidential Appointment (President George Bush), Advisory Board on Radiation and Worker Health (2006-present)
- NCRP Vice President for Program Area 3 on Nuclear and Radiological Security and Safety (2007 – present)
- Associate Editor, Health Physics Journal (July 2004-present)
Chair, E. P. Blizard Fellowship Selection Committee (ANS – Radiation Protection Division, 2007-present)
Member, ANS Fellowship Selection Committee, 2007-present
Chair, Texas A&M University Radiation Safety Committee

Important Publications in past 5 years:


Recent Professional Development Activities:

Workshop on Decommissioning of Nuclear Facilities, Texas Commission on Environmental Quality, March 2014.
Update on the CAP-88 Code, Health Physics Society Continuing Education course – July 2013
Current Situation of Internal Dosimetry, , Health Physics Society Continuing Education course – July 2013
Update on the Use of MCNP code, , Health Physics Society Continuing Education course – July 2013

Consulting, Patents, etc.:

Member, Operations Review Committee, Comanche Peak Nuclear Power Plant, Luminant Power, Glen Rose, TX (1990-present).
Name: Jean C. Ragusa

Education (degree, discipline, institution, year):
- Ingénieur, Physics, Ecole Nationale Supérieure de Physique de Grenoble, France, 1996.
- M.S., Nuclear Engineering, Texas A&M University, 1996.

Academic experience – institution, rank, title:
- 2010-present: Associate Professor, Nuclear Engineering, Texas A&M University.
- 2004-2010: Assistant Professor, Nuclear Engineering, Texas A&M University.
- 2001: Visiting Assistant Professor, Nuclear Engineering, Purdue University.

Non-academic Experience:
- 2009-present: Associate Director, Institute for Scientific Computation, Texas A&M University.
- 2001-2004: R&D Engineer, CEA (Commissariat à l’Energie Atomique) Saclay, France.
- 1998-2000: Graduate Research Assistant, CEA (Commissariat à l’Energie Atomique) Saclay, France.
- 1997: R&D Engineer, CEA (Commissariat à l’Energie Atomique) Bruyères-le-Châtel, France.

Certifications or Professional Registrations:
N/A

Current Professional Society Memberships:
- American Nuclear Society (ANS)

Honors and Awards:
- 2009 TEES Faculty Fellow, Texas A&M Engineering Experiment Station (TEES)
- Excellence in Research Award, Department of Nuclear Engineering, Texas A&M University (2012).

Service Activities (within and outside the institution):
- 2014-present: Chair, NUEN Faculty Search Committee
- 2006, 2012: Member, NUEN Department Head Search Committee
- 2004 to present NUEN PhD Qualifying Exam Committees (Chair and member)
- 2007-present: Member, Departmental Undergraduate Affairs Committee
- 2009: Departmental Ph.D. Curriculum Committee.
- 2009: Member, Departmental Graduate Affairs Committee
- 2005-present: Technical Program Committee Member for the
International Conferences on Mathematics and Computational Methods
2011: Publication Chair, International Conference on Mathematics, Computational Methods and Reactor Physics, Rio de Janeiro, Brazil,
2009-present: Technical Program Committee Member for the International Conferences on Transport Theory
2006-2009 and 2014-present: Executive Committee Member for the Mathematical and Computation Division of the ANS

Important Publications in past 5 years:


Recent Professional Development Activities:
N/A

Consulting, Patents, etc.:
Lightbridge: 2013-2014
Parapower: 2014
Name: W. Daniel Reece

Education (degree, discipline, institution, year):
- Ph.D., Nuclear Engineering, Georgia Tech, 1988
- M.S., Nuclear Engineering, Georgia Tech, 1980
- B.S., Chemical Engineering, Georgia Tech, 1971

Academic experience – institution, rank, title:
- 1990-2013, Director, Nuclear Science Center, Texas A&M Univ.

Non-academic Experience:
- 1982–1990, Staff Scientist, Battelle Pacific National Labs, WA
- 1977–1979, Partner, Carothers-Hurka Laboratory, GA
- 1982 – 1990, Department Head, Law & Company, GA

Certifications or Professional Registrations:
na

Current Professional Society Memberships:
- American Nuclear Society
- American Society for Engineering Education
- Health Physics Society

Honors and Awards:
- AFS Distinguished Teaching Award 1997
- Induction into Phi Kappa Phi. April, 1998
- Sigma Xi, 1992 Induction to membership
- ASEE- Best Session Paper Award, June 1991
- TEES Fellow 1991-92

Service Activities (within and outside the institution):
- Designed & reviewed experimental design of exps. at the NSC.
- Developed manufacturing processes for nuclear materials, including injectable brachytherapy sources, radioactive gas handling systems, and many other systems.
- Experience as an analytical and consulting chemist, including radiochemistry techniques.
- Reviewer of proposals for NASA, DOE, etc.

Important Publications in past 5 years:
na

Recent Professional Development Activities:
na

Consulting, Patents, etc.:
na
Name: Lin Shao

Education (degree, discipline, institution, year):
- Ph.D, Physics, University of Houston, 2001
- B.S., Nuclear Physics, Peking University, 1997

Academic experience – institution, rank, title:
- Texas A&M University, Associate Professor, 2012-
- Texas A&M University, Assistant Professor, 2006-2012

Non-academic Experience:
None

Certifications or Professional Registrations:
None

Current Professional Society Memberships:
- American Nuclear Society
- American Physical Society

Honors and Awards:
- The BP Teaching Award, TAMU, 2012
- TEES Selected Young Faculty Award, TAMU, 2011
- NSF Career Award, US National Science Foundation, 2009
- IBMM 2008 Prize (inaugural), Dresden, Germany, 2008

Service Activities (within and outside the institution):
- Academic Editor of AIP Advances (since 2013)
- Executive Editorial Member of International Electronic Journal of Nuclear Safety and Simulation (since 2014)
- Proposal Reviewer or Review Panelist for
  - Electronic and Photonic Materials Program, National Science Foundation, 2011 and 2013
  - Basic Energy Science, DOE, 2013
  - NEUP Program, DOE, 2012 and 2013
  - INL ATR User Facility, 2012 and 2013
  - Graduate Student Fellowship Program, NSF, 2011
  - Materials and Surface Engineering Program, NSF, 2010
Member of User Committee of Advanced Test Reactor at Idaho Nat. Lab, since 2011.
Committee Member, or Session Chair of 19th, 20th, 21st International Conference of Application of Accelerators in Research and Industry (CAARI), and Topic Editor of 23rd CAARI.
Chair or Committee Member for degree plans of 62 graduate students (from Nuclear Engineering, Physics, Electric Engineering and Materials Science & Engineering Programs at TAMU)
Faculty Advisor for TAMU American Nuclear Society Student Chapter (since 2011)
Member of Engineering Faculty Advisor Committee (since 2010)
Committee Member of (within Materials Science & Engineering Department), the Ph.D Qualifying Exam Policy Committee and the Growth Committee
Committee Member of (within the Nuclear Engineering Department), the Space and Facilities Committee, the Graduate Admission Committee, the Department Head Search Committee, and the Faculty Search Committee

**Important Publications in past 5 years:**


**Recent Professional Development Activities:**

None

**Consulting, Patents, etc.:**

“Metal nanoparticles grown on an inner surface of open volume defects within a substrate”, M. Martin and L. Shao, U.S. Patent application filed on Sep. 12, 2014
Name: Pavel V. Tsvetkov

Education (degree, discipline, institution, year):
- M.S. (equiv.), Nuclear Engineering, Moscow State Eng. Phys. Institute (Technical University), Moscow, Russia, 1995
- Ph.D., Nuclear Engineering, Texas A&M University, 2002

Academic experience – institution, rank, title (all listed – full time):
- 09/11 – Associate Professor, Nucl. Eng., Texas A&M University
- 09/05 – 09/11 Assistant Professor, Nucl. Eng., Texas A&M Univ.
- 02/03 – 09/05 Vis. Assist. Prof., Nucl. Eng., Texas A&M Univ.

Non-academic Experience (all listed – full time):
- 02/03–08/03 Ass. Res. Engineer, Nucl. Eng., Texas A&M Univ.
- 09/97–09/99 Senior Staff, Cntr. Sci. Eng. Inst., Moscow, Russia
- 01/96–01/97 Fellow, Reactor Phys., IRI, TU Delft, Netherlands

Certifications or Professional Registrations:
- N/A

Current Professional Society Memberships:
- American Society of Mech. Eng., USA, Member since 2002
- American Nuclear Society, Member since 2001
- American Society for Engineering Ed., USA, Member since 2007

Honors and Awards:
- Phi Kappa Phi, National Interdis. Honor Soc., USA, since 2004
- Alpha Nu Sigma, Nat. Nucl. Eng. Honor Soc., USA, since 2001
- International Peer Reviewer Certificate, Shota Rustaveli National Science Foundation, 2013-2014

Service Activities (within and outside the institution):
- Vice Chair, Book Publishing Committee, ANS, since 2014
- Vice Chair/Chair-Elect, Reactor Physics Division, ANS, 2014
- Project Lead, Bifrost, Icarus Interstellar 100 Starship Program
- Member, Graduate Committee, Nucl. Engr., Texas A&M
- Undergraduate Program Advisor, Nucl. Engr., Texas A&M
- Member, Dep. search comm., Nucl. Engr., Texas A&M
- Advisor, Undergraduate Research, College of Eng., Texas A&M
- Judge, Student Research, College of Eng., Texas A&M
Member, Int. Systems Engineering, College of Eng., Texas A&M
Member, COE Honors & Awards, College of Eng., Texas A&M
Reviewer – NSF, DOE, DOD, Estonian Science Foundation, Georgian Science Fdn., peer reviewed Elsevier & ANS journals

Books:

Important Publications in past 5 years:

Recent Professional Development Activities:
- TEES Online training courses
- Online training on use of distance education tools
- ANL Fuel Cycle Meetings in April and August of 2013
- TEES and COE Workshops, ‘Community of Respect’ (2014)

Consulting, Patents, etc.: N/A
**Name:** Dr. Galina Tsvetkova

**Education (degree, discipline, institution, year):**

1995 Engineer-Physicist (Equivalent of US Master of Science Degree in Physics) in from Faculty of technical physics, Department of Molecular Physics, Moscow State Engineering Physics Institute (MEPhI) (Technical University), Major field of study: Molecular physics and physics of kinetic phenomena

2003 Ph.D. Nuclear Engineering, Department of Nuclear Engineering, Texas A&M University System

**Academic experience – institution, rank, title:**

Mar 2008- Jan 2009 Postdoctoral Research Associate. The Texas A&M University System, Texas Engineering Experiment Station. Preparation of proposals, assistance in preparing course syllabuses and supporting educational materials, outreach activities, part time

Jan 2009 -to Current: Senior research Associate / Lecturer at The Texas A&M University System, Texas Engineering Experiment Station, 337 Zachry Engineering Center, College Station, TX, 77843 – 3133, USA. Curriculum development. Syllabuses preparation. Preparation and teaching of face-to-face and online classes: Analytical and Numerical Methods, Reactor Physics, Nuclear Power Plant Fundamentals, Reactor Operations, Process Control, Nuclear Reactor Kinetics and Control classes, full time

**Non-academic Experience:**

-Aug 2004- Febr 2005 Postdoctoral researcher. The Texas A&M University System, Texas Engineering Experiment Station. Analysis of experimental data and correlations describing advanced fuel performance at high temperatures for space reactor applications, full time


-June 2002- Aug 2002 Research Assistant. Nuclear Engineering Division Argonne National Laboratory, 9700 South Cass Avenue, Building 208, Argonne, IL, 60439. Reactor physics study of the advanced and innovative nuclear systems with fast neutron spectrum, full time
Certifications or Professional Registrations: Certification in Online Teaching, Curriculum development, TAMU Department of Instructional Technology Services, 2012


Project management Fundamentals from Lynda.com, Jan, 2014

Consulting, Patents, etc.: Students research papers review, student class and research projects consulting
<table>
<thead>
<tr>
<th>Name:</th>
<th>Karen Vierow</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Education (degree, discipline, institution, year):</strong></td>
<td>Ph.D., Quantum Engineering and System Sciences, University of Tokyo</td>
</tr>
<tr>
<td></td>
<td>M.S., Nuclear Engineering, University of CA at Berkeley</td>
</tr>
<tr>
<td></td>
<td>B.S., Nuclear Engineering, Purdue University</td>
</tr>
<tr>
<td><strong>Academic experience – institution, rank, title:</strong></td>
<td>2009-present Associate Professor with Tenure, Department of Nuclear Engineering, Texas A&amp;M University</td>
</tr>
<tr>
<td></td>
<td>2006-2009 Untenured Associate Professor, Department of Nuclear Engineering, Texas A&amp;M University</td>
</tr>
<tr>
<td></td>
<td>2001-2006 Assistant Professor, Department of Nuclear Engineering, Purdue University</td>
</tr>
<tr>
<td></td>
<td>1988-1990 Research Assistant, Dept. of Nuclear Engineering, University of CA at Berkeley</td>
</tr>
<tr>
<td><strong>Non-academic Experience:</strong></td>
<td>1993-2000 Assistant Chief Engineer, Nuclear Power Engineering Corporation (NUPEC), Tokyo Japan</td>
</tr>
<tr>
<td></td>
<td>1990-1993 Engineer, General Electric Nuclear Energy</td>
</tr>
<tr>
<td></td>
<td>1987-1988 Visiting Researcher, Hitachi Energy Research Laboratory</td>
</tr>
<tr>
<td><strong>Certifications or Professional Registrations:</strong></td>
<td>None.</td>
</tr>
<tr>
<td><strong>Current Professional Society Memberships:</strong></td>
<td>American Nuclear Society</td>
</tr>
<tr>
<td></td>
<td>American Society of Mechanical Engineers</td>
</tr>
<tr>
<td></td>
<td>Alpha Nu Sigma Honor Society of the American Nuclear Society</td>
</tr>
<tr>
<td><strong>Honors and Awards:</strong></td>
<td>Texas Engineering Experiment Station (TEES) Select Young Faculty Award (2007-2008)</td>
</tr>
<tr>
<td></td>
<td>Dwight Look College of Engineering Faculty Fellow for 2008-2009 (2009)</td>
</tr>
<tr>
<td><strong>Service Activities (within and outside the institution):</strong></td>
<td>Member, ANS Book Publishing Committee, 2001-2010</td>
</tr>
<tr>
<td></td>
<td><strong>Chair,</strong> ANS Book Publishing Committee, 2003-2007</td>
</tr>
<tr>
<td></td>
<td><strong>President,</strong> ANS Alpha Nu Sigma Honor Society, 2004-2007</td>
</tr>
<tr>
<td></td>
<td><strong>Chair,</strong> ANS Thermal Hydraulics Div., 2009-2010</td>
</tr>
<tr>
<td></td>
<td><strong>Chair,</strong> ANS Thermal Hydraulics Div. H&amp;A Comm., 2013-2014 Faculty Advisor, Alpha Nu Sigma Honor Society, 2006-current</td>
</tr>
<tr>
<td></td>
<td><strong>Chair,</strong> NUEN Scholarship/Fellowship Committee, 2007-2010</td>
</tr>
<tr>
<td></td>
<td>Member, Reactor Safety Board, 2007-current</td>
</tr>
<tr>
<td></td>
<td>Faculty Advisor, Women in Nuclear (WIN) Chapter, 2009-curr.</td>
</tr>
<tr>
<td></td>
<td><strong>Chair,</strong> Graduate Admissions Committee, 2011-current</td>
</tr>
<tr>
<td></td>
<td><strong>Chair,</strong> NUEN Growth Committee, 2013</td>
</tr>
</tbody>
</table>
Important Publications in past 5 years:


Recent Professional Development Activities:


Panelist, Roadmap for a Successful Academic Career Workshop, Work Life Balance Session, ADVANCE Center, April 7, 2014.

Consulting, Patents, etc.:

U.S. Nuclear Regulatory Commission, Chair of State-of-the-Art Reactor Consequence Analyses (SOARCA) Project Peer Review Panel (2009-2012)


U.S. Department of Energy, consultant to provide guidance on severe accident modeling with codes such as MAAP and MELCOR (2014-2015)
Book 2
Course Syllabi
NUCLEAR REACTOR THEORY

NUEN 601

Fall Semester 2013

Meeting time and location: Tuesday & Thursday 2:20pm-3:35 pm, Zachry 105C

Instructor: Dr. Ryan G. McClarren

Office: ZACH 335W, (979) 862-1779
Email: rgm@tamu.edu
Office hours: Wednesdays 3-4:30pm, and by appointment or serendipity

Assistant: Hyocheol Lee lhc@tamu.edu

Text

1. Your Lecture Notes: The notes you take in class will be an invaluable resource.


Course Policy, Assignment Submission Guidelines and Grading Policy

1. Academic Integrity Statement: “An Aggie does not lie, cheat, or steal or tolerate those who do.” For additional information please visit http://www.tamu.edu/aggiehonor

2. Professional Behavior: An important attribute of your professional development is that you act and speak in a respectful manner.

3. Assignments (HW solution sets):

   • Preparation (grade penalty up to a full assignment worth for not following the guidelines): Each HW solution set: (1) give assignment number and attach assignment as a cover, (2) use only front side of each page, (3) provide brief problem statements, (4) be neat and legible and present work logically to allow Teaching Assistant easy follow-up, (5) if asked for a numerical result, give formula and number with units, (6) staple your set.

   • Submission of the HW solution sets:

     HW solution sets: Work together is encouraged. The participating classmates must be listed on the first page. However, the final submitted assignments must be individual work efforts. If
blatant copying is detected, the score will be 0 for all students involved
ALL assignments are due at the start of class on the due date!
NO late assignments accepted without creditable excuse/explanation for delay!
NO assignments will be accepted after the last day of classes! (see the course schedule provided in this syllabus)

**LATE SUBMISSION (1 WEEK TO EXPLAIN AND ASK FOR A NEW DUE DATE):**
If a student cannot submit the assignment by the due date, said student has 1 week after the due date to explain the reasons for the delay and ask for a new due date. Depending on the provided explanation and the assignment submission history of a student, the new due date will be assigned or denied. No grade penalty will be assessed in this case.
If the student fails to contact instructor within 1 week after the due date, the delayed work will not be accepted. No exceptions!
No late submission of the HWs after **2 weeks** of original due date

4. **Lecture and Homework Problem Transcription:** Each student will be required to transcribe the notes from a lecture in **\LaTeX**. I will provide a sample template to help you get started. **\LaTeX** is an important tool for scientific communication: learning it will make your life easier when you go to write journal articles, theses, resignation letters, etc.

Additionally, one student will be assigned to submit the "gold standard" homework solution that will be provided to the rest of the class. These will also be typeset in **\LaTeX**, and will be part of your homework grade.

PC Users can find a **\LaTeX** installation from [miktex.org](http://miktex.org). Mac users can get it from [www.tug.org/texlive/]. Linux people can are savvy enough to figure it out on their own.

5. **Structure of final course score:**

<table>
<thead>
<tr>
<th>Course Element</th>
<th>Element Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homework Problem Sets</td>
<td>30%</td>
</tr>
<tr>
<td>Lecture Transcription</td>
<td>10%</td>
</tr>
<tr>
<td>Midterm Exam</td>
<td>30%</td>
</tr>
<tr>
<td>Final Exam</td>
<td>30%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
</tr>
</tbody>
</table>

6. **Final grade ranges:**

<table>
<thead>
<tr>
<th>Course Score</th>
<th>Course Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>90% and above</td>
<td>A</td>
</tr>
<tr>
<td>80-89.5%</td>
<td>B</td>
</tr>
<tr>
<td>70-79.5%</td>
<td>C</td>
</tr>
<tr>
<td>60-69.5%</td>
<td>D</td>
</tr>
</tbody>
</table>
Scholastic Dishonesty and the Aggie Honor Code: “An Aggie does not lie, cheat, or steal or tolerate those who do.” The Code forbids the following:

- Cheating: Attempting to use unauthorized materials, information, notes, study aids or other devices or materials in any academic exercise.
- Fabrication: Making up data or results; submitting fabricated documents.
- Falsification: Manipulating results such that research is not accurately represented in the research record.
- Multiple Submissions: Submitting substantial portions of the same work (including oral reports) for credit more than once without authorization from instructors.
- Plagiarism: Using another person’s ideas, work, processes, results, writings, words, etc. without giving appropriate credit.
- Complicity: Intentionally or knowingly helping, or attempting to help, another to commit an act of academic dishonesty.


Americans with Disabilities Act (ADA): The Americans with Disabilities Act (ADA) is a federal antidiscrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please tell your instructor or contact the Department of Student Life, Services for Students with Disabilities, in Cain Hall, or call 845-1637.

Religious Holidays: If you are a member of a religious faith that has one or more holidays which require you to be absent from any class listed above, please tell your instructor at least two weeks in advance of your absence and make arrangements to make-up the class.

Copyrights: The handouts used in this course are copyrighted. By "handouts" we mean all materials generated for this class, which include but are not limited to syllabuses, lab problems, in-class materials, review sheets, and additional problem sets. Because these materials are copyrighted, you do not have the right to copy the handouts, unless the author expressly grants permission.
NUEN 604 – RADIATION INTERACTIONS AND SHIELDING
Fall Semester, 2014

Instructor: Dr. Pavel V. Tsvetkov
Zachry 335A, (979) 845-7078, tsvetkov@tamu.edu
Office Hours: MWF 1 pm – 3 pm,
Welcome to E-mail and stop by!
Office hours are limited. I recommend using E-mail as the primary means of communication and to schedule specific meeting times.

Schedule: MWF, 08:00 am – 08:50 am, Zachry 223A

Texas A&M Graduate Catalog Data

Credits: NUEN 604-601 (3-0) Radiation Interactions and Shielding. Credit 3.

Description: Basic principles of radiation interactions and transport, especially as related to the design of radiation shields. Radiation sources, nuclear reactions, radiation transport, photon interactions, dosimetry, buildup factors and fast neutron shielding.

Prerequisites: NUEN 302 or equivalent; MATH 308; BS in engineering or physical sciences. Graduate student classification or approval of instructor.

Text 1. Lecture Materials: Radiation Interactions and Shielding, lecture materials (The main information source for course subjects is a combination of
(1) comprehensive course materials distributed to the class,
(2) textbook and reference books, and
(3) RSICC, ANS, ASME, DOE, IAEA and other technical documents).

2. Textbook:

3. References:
• RSICC, ANS, ASME, DOE, IAEA and other technical documents
• Other supplemented materials and handouts to be distributed in class
Course Objective

NUEN604 is a 1st-year-level, 3-hour graduate course. Within the Master of Science degree curriculum, it relates the fundamental physical principles of radiation interactions with matter, associated concepts and modeling techniques to analysis and design of radiation shielding.

This course is intended to provide the graduate students with description of the evaluation techniques and computational methods for radiation interactions with matter in nuclear engineering applications.

By the end of the course, the graduate students will be able to perform analytical and numerical calculations necessary for evaluations of radiation interactions with matter and shielding studies.

Desirable Background Knowledge by Topic

1. Special theory of relativity, derivation and use of Einstein’s formulas, explain mass-energy equivalence in the analysis of physical problems and relativistic time dilation to the estimation of half-lives of nuclei and elementary particles.
2. Blackbody radiation.
3. Role of Planck’s radiation formula and its implications for the description of light as quanta.
4. Description of absorption and emission of thermal radiation to account for energy gain and loss.
5. Discrete description of electromagnetic radiation to account for photoelectric interactions and Compton scattering.
6. Results of empirical spectroscopy, structure of elements of matter-Rutherford scattering and Millikan’s measurement of the electric charge, explain the implications of Rutherford scattering experiments and empirical spectroscopy for the development of the Bohr atom.
7. Explain the de Broglie identification of wave behavior of matter, its experimental verification, and the use of mathematics to describe wave-like properties.
8. Derivation of the Schrödinger equation.
9. Explain the basic concepts of probability theory and their utilization with the wave-like solutions of Schrödinger’s equation describing the properties of simple, one-dimensional systems.
10. Vector analysis, systems of linear equations, eigenvalues, eigenvectors.
11. Ordinary differential equations (ODE)

Topics Covered

1. Review of energy and units, fundamental physics background, special relativity.
2. Review of basic nuclear and atomic physics, radioactive decay, and radioactivity
   - Atoms and nuclei, nuclear structure and data files, relative stability and energy conservation.
   - Radioactivity, nuclear stability, radioactive decay, decay chains.
5. Neutron interactions, neutron reactions and neutron cross sections, interactions of neutrons with matter and neutron activation.
7. Nuclear data and evaluated nuclear data files.
8. Radiation effects and damage.
10. Radiation dose and dosimetry.
11. External exposure.
12. Internal exposure.
13. Radiation safety.
15. Basic methods for radiation dose calculations.
16. Special techniques for photons, neutrons and charged particles.
17. The shielding of radiation and buildup factors.
18. Differential and integral radiation transport in absorbing media, the point kernel method.
19. The Monte Carlo method for calculating dose through a shield.
20. Gamma-ray shielding and dose evaluations.
22. Internal dose evaluations.

**Course Outcomes**

Students who successfully complete this course should be able to:

1. Calculate energy equivalent of mass defect, nuclear binding energy, binding energy per nucleon; liquid drop model characteristics.
2. Calculate Q-value of reaction and use to determine threshold, production or consumption of energy, and conditions on collisions for reaction to occur. Calculate Coulomb barrier and evaluate its roles in suppressing endoergic and exoergic reactions.
3. Describe neutron interactions with matter from thermal to high energies, employ microscopic and macroscopic cross-sections in calculating the penetration and reactions rates of neutron beams passing through materials.
5. Access nuclear structure files and nuclear data files and analyze nuclear data.
6. Describe and evaluate charge particle interactions with matter.
7. Describe and evaluate photon interactions with matter.
8. Solve complex problems involving charge particles, photons and neutrons.
9. Understand best practices in regards to shielding, perform shielding calculations and design.
10. Understand Build-up and how it pertains to shielding.

**Computer Usage**

All of the material for this course will be maintained on the University’s eCampus system. This includes an electronic copy of this syllabus, the course schedule, all lecture materials, and homework assignments. Students should check their email often to keep updated on current messages.

The course assignments require analytical and numerical solutions. Appropriate use of the general software packages (for example, MATLAB, etc.) is encouraged.

Numerical solutions assume use of the existing nuclear engineering codes and development of algorithms followed by implementation in the form of a computer program. A working knowledge of at least one programming language is expected.
Course Structure

This course consists of the academic elements as defined below. The purpose and content of each academic element are:

1. **Lectures and lecture materials.** Lectures and lecture materials will cover the course topics and will be made as self-sufficient as reasonably achievable.

2. **Homework problem (HW) sets**
   
   Homework problem (HW) sets will be assigned and graded weekly. See the Course Policy, Assignment Submission Guidelines and Grading Policy defined later in this syllabus.

3. **Short express quizzes**
   
   Short express quizzes will be given to facilitate and enhance the learning process. Each quiz will consist of theoretical questions based on the material from the preceding lectures and will be designed for approximately 15 min of class time (open book). The short express quizzes will be given randomly and without any prior notice.

4. **Two major midterm examinations**
   
   Two mandatory midterm examinations will be given (closed book & notes, no calculators) as following:

   **Exam 1 – Written midterm examination** (in class, see the course schedule provided later in this syllabus);

   **Exam 2 – Oral midterm examination** (each student will be assigned a 30 minutes time lot, see the course schedule provided later in this syllabus). The oral exam will be conducted by a committee of several professors from the department chaired by the course instructor.

   Both exams will be comprehensive with respect to the corresponding preceding material. Depending on the actual progress, the midterm exams are planned for the beginning/middle of October and November. **Exam 1 & Exam 2 may include take-home parts.**

5. **Final examination options:**
   
   **Option 1 Oral Exam**

   Prerequisite – course score: 95%-100% by the last day of classes.

   Oral final exam (closed book, closed notes, no calculators) will be comprehensive with respect to the entire course material.

   To be eligible - top scores (over 95%) must be achieved for all assignments; and all assignments must be submitted.

   **Option 2 Written Exam Optional Oral Exam**

   Mandatory written final examination (closed book, closed notes, no calculators) will be comprehensive with respect to the entire course material.

   Optional comprehensive oral exam will be offered following the mandatory written exam to facilitate fairness of the assessment. The decision of taking the optional oral exam is entirely up to a student.
Course Policy, Assignment Submission Guidelines and Grading Policy

1. Academic Integrity Statement: “An Aggie does not lie, cheat, or steal or tolerate those who do.”
   For additional information please visit http://www.tamu.edu/aggiehonor

2. Professional Behavior: An important attribute of your professional development is that you act and speak in a manner that will not offend others giving particular care to diversity issues.

3. Attendance policy
   - Regular lectures – attendance is very important and highly recommended.
   - Midterm Exams 1,2 and Final Exams are explicitly scheduled. Reasonable attempts to accommodate exceptions will be made (if your schedule conflicts due to other exams, etc.). If alternative date for the individual exam is identified, it is assumed that the exam content will be equivalent but may differ in details of questions/problems.
   - NO ATTENDANCE ROLLS WILL BE TAKEN.

4. Assignments (HW solution sets and reports):
   - Preparation (grade penalty up to a full assignment worth for not following the guidelines):
     Each HW solution set: (1) give assignment number and attach assignment as a cover, (2) use only front side of each page, (3) provide brief problem statements, (4) be neat and legible and present work logically to allow easy follow-up, (5) if asked for a numerical result, give formula and number with units, (6) staple your set
     Reports and materials: (1) up to 5 pages (no handwriting) including contents, lists of figures and tables, introduction, problem description, model development, results, conclusions, etc., (2) if you created auxiliary materials – list them in the Appendix and E-mail actual materials, (3) provide the list of references at the end of your report
   - Submission of the HW solution sets and reports and materials:
     HW solution sets, report and materials: Work together is encouraged. The participating classmates must be listed on the first page. However, the final submitted assignments must be individual work efforts. If blatant copying is detected, the score will be 0 for all students involved
     ALL assignments are due at the start of class on the due date!
     NO late assignments accepted without creditable excuse/explanation for delay!
     NO assignments will be accepted after the last day of classes! (see the course schedule provided in this syllabus)
     LATE SUBMISSION (1 WEEK TO EXPLAIN AND ASK FOR A NEW DUE DATE):
     If a student cannot submit completed work by the due date, there is a 1 week after the due date to explain the reasons for the delay and ask for a new due date.
     Depending on the provided explanation and the assignment submission history of a student, the new due date will be assigned or denied (the delayed work will not be accepted in this case).
     NO GRADE PENALTY.
     If the student fails to contact instructor within 1 week after the due date, the delayed work will not be accepted. No exceptions!
   - Re-submission of HW sets, reports and materials:
     If you re-do your assignment, you can increase your grade by at least 10% of the original worth (up to 100% depending on the originality).
     ONLY ONE RESUBMISSION OF EACH ASSIGNMENT IS PERMITTED.
5. Structure of final course score:

<table>
<thead>
<tr>
<th>Course Element</th>
<th>Element Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homework Problem Sets</td>
<td>30%</td>
</tr>
<tr>
<td>Short Express Quizzes</td>
<td>10%</td>
</tr>
<tr>
<td>Exam 1 (Written Midterm Examination)</td>
<td>20%</td>
</tr>
<tr>
<td>Exam 2 (Oral Midterm Examination)</td>
<td>20%</td>
</tr>
<tr>
<td>Final Exam</td>
<td>20%</td>
</tr>
<tr>
<td><strong>TOTAL Final Course Score</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

6. Final course grade ranges:

<table>
<thead>
<tr>
<th>Final Course Score</th>
<th>Final Course Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>90% and above</td>
<td>A</td>
</tr>
<tr>
<td>80 - 89.5%</td>
<td>B</td>
</tr>
<tr>
<td>70 - 79.5%</td>
<td>C</td>
</tr>
<tr>
<td>60 - 69.5%</td>
<td>D</td>
</tr>
</tbody>
</table>

Prepared by: Dr. Pavel V. Tsvetkov. Date: August 31, 2014

Scholastic Dishonesty and the Aggie Honor Code: "An Aggie does not lie, cheat, or steal or tolerate those who do." The Code forbids the following:

- **Cheating**: Attempting to use unauthorized materials, information, notes, study aids or other devices or materials in any academic exercise.
- **Fabrication**: Making up data or results; submitting fabricated documents.
- **Falsification**: Manipulating results such that research is not accurately represented in the research record.
- **Multiple Submissions**: Submitting substantial portions of the same work (including oral reports) for credit more than once without authorization from instructors.
- **Plagiarism**: Using another person’s ideas, work, processes, results, writings, words, etc. without giving appropriate credit.
- **Complicity**: Intentionally or knowingly helping, or attempting to help, another to commit an act of academic dishonesty.

If you have questions regarding scholastic dishonesty and the Aggie Honor Code, please visit [http://www.tamu.edu/aggiehonor](http://www.tamu.edu/aggiehonor) for the Honor Council Rules and Procedures, and [http://student-rules.tamu.edu](http://student-rules.tamu.edu) for the Texas A&M University Student Rules.

Americans with Disabilities Act (ADA): The Americans with Disabilities Act (ADA) is a federal antidiscrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please tell your instructor or contact the Department of Student Life, Services for Students with Disabilities, in Cain Hall, or call 845-1637.

Religious Holidays: If you are a member of a religious faith that has one or more holidays which require you to be absent from any class listed above, please tell your instructor at least two weeks in advance of your absence and make arrangements to make-up the class.

Copyrights: The handouts used in this course are copyrighted. By "handouts" we mean all materials generated for this class, which include but are not limited to syllabi, lab problems, in-class materials, review sheets, and additional problem sets. Because these materials are copyrighted, you do not have the right to copy the handouts, unless the author expressly grants permission.
NUEN 605: Radiation Detection and Nuclear Materials Measurement  
Fall 2014  
Lecture Monday 13:50 – 15:20, ZACH 119B  
Laboratories: Section 600 Tuesday 12:45 – 15:45, ZACH 133 labs  
Section 601 Wednesday 12:40 – 15:40, ZACH 133 labs  
Section 602 Thursday 12:45 – 15:45, ZACH 133 labs

COURSE DESCRIPTION  
To teach graduate level students in nuclear engineering and health physics the theory and technology behind detectors, sensors, and source technologies. Interactions of radiation with matter and the behavior of various nuclear radiation detectors will be studied both theoretically and experimentally in the laboratory. The properties of radionuclides useful to industry and medicine will be considered and evaluated from an engineering point of view. This course is meant to provide the student a foundation of understanding into the radiation detection technologies used in non-proliferation and other cutting edge applications. By developing knowledge in this area, the student will able to understand advantages and challenges of radiation detection technologies used in challenging environments.

This class is meant for graduate students with a background in Nuclear Engineering, Physics or some related field.

INSTRUCTORS  
Professor Teaching Assistant  
Craig Marianno, Ph.D.  
Office: 335M Zachry  
Phone: (979) 845-6093  
Email: marianno@tamu.edu  
Office Hours: Friday 9:00 – 11:00

CLASS TIME AND LOCATION  
Lecture: Mondays 13:50 – 15:20 ZACH 119B  
Laboratories: Tuesdays 12:45 – 15:45 ZACH 133 A, B, C  
Wednesdays 12:40 – 15:40 ZACH 133 A, B, C  
Thursdays 12:45 – 15:45 ZACH 133 A, B, C
TEXTBOOKS
There is 1 required text for the course:

The instructor’s notes will be the principle source of information for the course. These notes will be supplied to the students in MS PowerPoint format. The following textbook will be provided to the students in electronic format for a reference:


METHOD OF EVALUATION
The student’s grade will be based on the following criteria:

5% - Participation – Attendance is mandatory for both the lab and lectures. Also, the student’s interactions between themselves, their peers and the instructor will be taken into account.

10% - Lab Brief – These are typed assignments associated with most labs. The assignments will focus on important areas of the experiment. The information for your assignments will come from your lab notebooks.

10% – Editor – Each student will be called upon to act as the editor for a classmate’s writing assignments. Each edited document will be returned to the instructor. The editor’s performance will be evaluated on how well they scrutinized the original report. The student should provide grammatical and technical comments.

15% - Midterm – 10/13/2014. This will be a midterm to verify that you know basic electronics and some of the concepts discussed in class.

15% - Lab reports – There will be 1 to 2 formal lab reports. These reports will be approximately 10 pages in length (including tables and graphs). These will be concise descriptions of how the lab was completed and the results. Formatting guidelines will be available electronically. Labs will be due in two rounds: an initial first draft and the final draft after a round-robin editorial peer review.

20% - Notebook – The student will be required to keep a scientific notebook for the class. Rules for notebook maintenance will be provided. The instructor will evaluate the notebook twice during the semester to verify that laboratory information is being properly recorded and that standard notebook protocols are being met. The second review will be weighted higher than the first review.

25% - Homework/Writing assignments – Some homework assignments will be assigned during the lecture portion of the class. In addition some laboratories will have writing assignments that are associated with the labs. Formatting guidelines will be available electronically. Writing assignments will be due in two rounds: an initial first draft and the final draft after a round-robin editorial peer review.
Homework Policy: All assignments are due at the beginning of class. An assignment may be turned in by 9 AM the next day, but at a cost of 25% of the grade. Draft lab reports will be given to the instructor in final form (i.e. outlines will be unacceptable).

DO NOT ASK THE INSTRUCTOR TO PRINT UP YOUR ASSIGNMENTS FOR YOU!!!!

The grades will be determined on the following scale:
A - 90.00-100.00
B - 80.00-89.99
C - 70.00-79.99
D - 60.00-69.99
F - 0.00-59.99

ONLINE COURSE MATERIAL
All of the material for this course will be maintained on Texas A&M University’s eCampus. This includes an electronic copy of this syllabus, the course schedule, all lecture notes, laboratory procedures, supplemental readings, and assignments. **The instructor will use campus email to communicate with students. If you would like me to use another email system, let me know!** Students should check their email often to keep updated on current messages. The eCampus system can be accessed through [http://ecampus.tamu.edu/](http://ecampus.tamu.edu/). If you are unfamiliar with this system, instruction will be provided.

ADA STATEMENT
The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact the Department of Student Life, Services for Students with Disabilities in Room B118 of Cain Hall. The phone number is 845-1637.

COPYRIGHTS
The handouts used in this course are copyrighted. By "handouts" we mean all materials generated for this class, which include but are not limited to syllabi, lab problems, in-class materials, review sheets, and additional problem sets. Because these materials are copyrighted, you do not have the right to copy the handouts, unless the author expressly grants permission.

SCHOLASTIC DISHONESTY
As commonly defined, plagiarism consists of passing off as one's own the ideas, work, writings, etc., that belong to another. In accordance with this definition, you are committing plagiarism if you copy the work of another person and turn it in as your own, even if you have the permission of that person. Plagiarism is one of the worst academic sins, for the plagiarist destroys the trust among colleagues without which research cannot be safely communicated. If you have questions regarding plagiarism, please consult the latest issue of the Texas A&M University Student Rules [http://student-rules.tamu.edu/], under the section "Scholastic Dishonesty."
<table>
<thead>
<tr>
<th>Module</th>
<th>Date</th>
<th>Subject</th>
<th>Due</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introq. Propagation</td>
<td>9/1/2014</td>
<td>Lecture 1: Class Introduction</td>
<td></td>
</tr>
<tr>
<td></td>
<td>9/3/2014</td>
<td>No Lab Lecture 2: Lecture Stats and Detection</td>
<td></td>
</tr>
<tr>
<td>Basic Electronics</td>
<td>9/6/2014</td>
<td>Lecture 3: Basic Electronics</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lab Laboratory 1: Basic Detection Electronics</td>
<td></td>
</tr>
<tr>
<td>Gas Filled Detectors</td>
<td>9/15/2014</td>
<td>Lecture 4: Gas Filled Detectors and Detector</td>
<td>LB 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lab Laboratory 2: Gheiger Muller detector, Counting Statistics and Dead Time</td>
<td>Draft Introduction</td>
</tr>
<tr>
<td>Alpha Spectroscopy</td>
<td>9/22/2014</td>
<td>Lecture 5: Alpha Spectroscopy</td>
<td>LB 2, Draft Intro back to authors</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lab Laboratory 3: Alpha Spec. Lab</td>
<td>Final Intro</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lab Laboratory 4: Sodium Iodide and LaBr Detector</td>
<td>Draft M&amp;M for lab #3</td>
</tr>
<tr>
<td></td>
<td>10/5/2014</td>
<td>Lecture 7: Semiconductor Gamma Detectors</td>
<td>Draft back to Authors</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lab Laboratory 5: High Purity Germanium Detectors, U Quantitative Gamma Spec</td>
<td>LB 4</td>
</tr>
<tr>
<td></td>
<td>10/13/2014</td>
<td>Midterm</td>
<td>Notebook Due, Final M&amp;M due</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lab Laboratory 6: ID unknown/ Half life</td>
<td>Draft R&amp;D Lab #5</td>
</tr>
<tr>
<td>Neutron Detection</td>
<td>10/20/2014</td>
<td>Lecture 8: Neutron Detection</td>
<td>LB 6 (for group), Draft R&amp;D #5 back to Authors</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lab Laboratory 7: Neutron Detection He-3, BF-3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10/27/2014</td>
<td>Lecture 9: Total Neutron Counting</td>
<td>Final R&amp;D due</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lab Laboratory 8: Total Neutron Counting</td>
<td>Draft Report Lab #7</td>
</tr>
<tr>
<td></td>
<td>11/3/2014</td>
<td>Lecture 10: Radioisotopic Identifiers (RIIDs)</td>
<td>Draft #7 back to Authors</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lab Laboratory 9: RIIDs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>11/10/2014</td>
<td>Lab 9 RIIDs</td>
<td>LB 8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lab 9 RIIDs</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lab 10 Field project</td>
<td></td>
</tr>
<tr>
<td></td>
<td>11/24/2014</td>
<td>Lab 10 Field project</td>
<td></td>
</tr>
<tr>
<td></td>
<td>11/26/2014</td>
<td>Thanksgiving</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12/1/2014</td>
<td>Lab 10 Field project</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lab Field Projects Presentation</td>
<td>Field project Reports, Final Notebook Due</td>
</tr>
<tr>
<td></td>
<td>12/8/2014</td>
<td>Redefined Day --- Friday Classes--No class</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12/9/2014</td>
<td>Redefined Day --- Thursday Classes -- No Class</td>
<td></td>
</tr>
</tbody>
</table>
NUEN 606 Nuclear Reactor Analysis and Experimentation
Spring 2014
Lecture TR 8:00-9:15 in CHEN 111
Lab R 11:10-2:10 in ZACH 2B (Section 600)

Catalog Description

Perturbation theory; delayed neutrons and reactor kinetics; lattice physics calculations; full core calculations; analysis and measurement of reactivity coefficients; analysis and measurement of flux distribution; analysis and measurement of rod worths; critical and subcritical experiments.

Detailed Course Description

NUEN 606 is a 1st-year graduate-level course. Within the Nuclear Engineering Master of Science degree curriculum, it relates nuclear reactor theory to reactor experimentation using nuclear system modeling practices. This course is focused on the theoretical analysis, numerical simulation, and experimental measurement of fundamental nuclear engineering parameters and concepts.

The course will require the student to synthesize information from theoretical, computational, and experimental results to assess physical quantities (such as criticality, scalar flux, reactivity, prompt neutron lifetime, and reactivity feedback). The student will learn advanced techniques for analyzing the behavior of nuclear reactors, conducting reactor experiments, and predicting and understanding the outcomes of those experiments. Topics addressed in the course include:
1. criticality,
2. analyzing reactor behavior during transients including delayed neutrons and reactor kinetics,
3. application of perturbation theory,
4. lattice physics calculations used to generate detailed neutron distributions in local regions of a reactor and how the results of those calculations feed into full-core calculations,
5. experimental measurement of reactions rates and fluxes, and
6. reactivity coefficients and control rod worths.

The student will acquire practical experience in the safe operation of nuclear reactors using a research reactor and this experience will be applicable to larger power reactors, experimental reactors, space reactors, and other nuclear systems. The student will develop an understanding of how instrumentation is used in the control and operation of nuclear reactors and how and why various materials are chosen for the design of different nuclear systems. The student will learn (both theoretically and practically) the fundamental measurements performed to test the physics of nuclear systems following a core reload.

This course will aid in increasing the student’s understanding of the physics of nuclear reactors and nuclear data. The student will also gain experience in writing technical reports and in producing summaries of technical information. Lastly, the student will develop their skill in critical analysis of technical information.

Class Time and Location

This course will meet three times per week. The course consists of three hours of in-class lecture and three hours of laboratory. The lectures will be held in the CHEN 111. The laboratories will be held at the TAMU Nuclear Science Center, the AGN Reactor Room (ZACH 61), or in ZACH 2B. Attendance to all classes and scheduled laboratories is mandatory. Only University approved excuses will be accepted.
Prerequisites

Students entering this course should have successfully completed NUEN 601 or its equivalent or by approval of the instructor.

Students will be expected to already have a working knowledge of many of the theoretical concepts employed in this class. For example, students should have had some previous introduction to the following topics:

1. Basic nuclear physics
2. Systems of linear equations, eigenvalues, eigenvectors, ordinary differential equations (ODE), and partial differential equations (PDE)
3. Fundamentals of nuclear systems including, buildup and decay problems, criticality of nuclear systems, the definitions of scalar fluxes and cross sections, neutron slowing down, definition of reactivity, coefficients of reactivity
4. Neutron moderation, reactor kinetics and dynamics, core composition changes during reactor operation
5. Mathematical description of physical phenomena including neutron transport theory, monoenergetic and multi-group diffusion theory, the Point Reactor Kinetics Equations, the Monte Carlo method, and introduction to perturbation theory
6. Nuclear data and cross-section processing
7. Modern reactor analysis methods and codes
8. Nuclear reactor design principles and applications of modeling techniques to reactor design
9. Radiation detection systems (specifically, the operating characteristics of ion chambers, fission chambers, and HPGe detectors).

Students will be required to present their results in written format. Students should have some competence in technical writing.

Course Learning Objectives

In completion of this course, the student should develop experimental expertise in the use of nuclear reactors and nuclear radiation as well as analytical and computational capabilities in modeling reactor-based experiments.

Students who successfully complete this course should be able to:

1. Synthesize information from theoretical, computational, and experimental results to assess physical quantities (such as criticality, scalar flux, reactivity, prompt neutron lifetime, and reactivity feedback)
2. Use stochastic and deterministic techniques to analyze the behavior of nuclear reactors,
3. Design, conduct, and analyze nuclear experiments and use simulation techniques to predict and understand the outcomes of those experiments
4. Evaluate sources of errors in experiments and simulations
5. Explain the operation of modern radiation detection systems (specifically, the operating characteristics of ion chambers, fission chambers, and HPGe detectors) and apply these detectors in nuclear experiments
6. Present results in written format and verbally
7. Explain the origin of the cross section libraries used in reactor simulations
8. Explain how lattice codes use fine-group cross sections to generate broad-group homogenized parameters for whole-core calculations
9. Explain how whole-core codes use broad-group libraries to determine the flux distribution and multiplication factor in a reactor
10. Use the solutions of reactor-analysis calculations to compute reaction rates, leakage rates, peaking factors, multiplication factors, and other measures of reactor performance, and to predict experimental results
Instructor Information

Name: William S. Charlton, Ph.D.
Title: Associate Professor, Nuclear Engineering Department
       Director, Nuclear Security Science and Policy Institute
Telephone Number: (979) 845-7092
Email address: wcharlton@tamu.edu
Office Hours: M 2:00-4:00 or by appointment
Office Location: Zachry Engineering Center Room 336E

You are welcome to stop by at any time I am available, but office hour times are rather limited. Thus, it is suggested that you use email as the primary means of contact for the instructor. This will provide for a record of the communication and allow for scheduling of a more specific time to meet discussing any issues you have in class. If you need to schedule an appointment with the instructor, please call my assistant (Gayle Rodgers) at 979-845-7092.

Teaching Assistants

A teaching assistant is available for help with this course. Please see the TA for any questions you have or contact the course instructor

Name: Ryan Coogan
Email: coogann1@tamu.edu
Office Hours: W 9:00-11:30
Office Location: ZACH 334C

Textbook and/or Resource Materials

Lecture Notes
The primary reference for this course is a set of lecture notes which will be provided in electronic format to the students via the university’s eCampus system. The students should print these notes and bring them to class for each lecture session. The lecture notes provided to the students will include blank spaces which will need to be filled in by the students during the lecture.

Required Text
The required text for this class is:


Reading assignments will be provided for most lecture sessions. The students should read these assignments prior to the lecture.

Laboratory Procedures
For each laboratory session, a set of laboratory procedures will be provided in electronic format to the students via the university’s eCampus system. The students should print these procedures and study them prior to each laboratory session.

Supplemental (or Optional) Texts
Due to the vast amount of information covered in this class, the student may find it useful to obtain some of the following texts as supplemental information:


Specific reading assignments from these texts will not be provided; however, reading from these texts may prove useful if the student does not fully comprehend the information provide in lecture or in the required text (Stacey).
Grading Policies

Final grades will be assigned based on the following scale:

- A - 90.00-100.00
- B - 80.00-89.99
- C - 70.00-79.99
- D - 60.00-69.99
- F - 0.00-59.99

The student’s final grade will be determined using the following percentages:

- Homework: 20%
- Pre-Lab Quizzes: 5%
- Laboratory Reports: 20%
- Lab Report Technical Editing: 10%
- Executive Summaries: 10%
- Mid-Term Examination: 15%
- Final Examination: 20%

Homework
Homework assignments will consist of short problem sets (generally 4-5 problems per assignment). These assignments are intended to exercise the student’s understanding of both lecture and reading material. Homework will be assigned approximately every other week and will be due according to the schedule at the end of this syllabus.

Each homework submitted should (1) give the assignment number, (2) use only the front side of each page, (3) provide a brief problem statement, (4) be neat and legible and present work logically to allow the reader to follow the solution progression, (5) provide units for solutions where applicable, and (6) be stapled together.

Pre-Lab Quizzes
Pre-lab quizzes must be completed prior to the start of each laboratory session. These quizzes are designed to take approximately 10 minutes to complete. The quiz must be completed through the University’s eCampus system (http://ecampus.tamu.edu) by 11:00 AM on the day of the laboratory. Pre-lab quizzes must be completed individually. Students should not discuss the quiz questions or answers until after all quizzes have been graded and returned to the student. The purpose of the pre-lab quizzes is to assess levels of preparation including theory, procedure, and experimental design to ensure that the student is prepared to conduct the laboratory.

Laboratory Reports
The results and analysis for each laboratory will be submitted for credit via a laboratory report. Laboratory reports will be less than twenty pages in length (not counting appendixes). These reports will include detailed theory, procedures, and results sections and provide the reader with sufficient information to repeat the laboratory themselves with a reasonable expectation of acquiring the same results as the student. The reports must be typed.

The student should view these reports as if they were technical manuscripts submitted to a technical journal for publication. The purpose in these reports is to allow for assessment of the student’s understanding of the laboratory technical material and to exercise the student’s technical writing skills.

The student must submit the laboratory report by the due date shown in the schedule at the end of this syllabus (each report must be submitted on time, no exceptions). Each report will then be submitted by the instructor to a different student in class for editing by that student (this will include both grammar and writing style editing as well as editing for technical content). The edited versions must be returned to the instructor by the due date shown in the schedule at the end of this syllabus. The instructor will then return the edited version of the report to the original student who submitted the report. The student will then complete the suggested edits and produce a final report. The corrected final report will be due to the instructor on the due date shown in the schedule at the end of the syllabus.
The student’s grade on laboratory reports will be based 5% on format, 60% on technical content, and 25% on grammar and writing style. The remaining 10% will be assessed on completeness of the initially submitted report.

A guideline for writing laboratory reports including an example of the proper report format will be provided to the student via the eCampus system. Laboratory reports must be completed individually.

**Laboratory Report Technical Editing**

For each laboratory report, the student will be required to perform technical editing of another student’s lab report. Editorial assignments will be made randomly. The purpose in this editorial correcting of the laboratory reports is to help both the student doing the editing as well as the author of the report in exercising their technical writing skills. A secondary purpose of this editing is to help improve the technical content of the report and to exercise the student’s skills in critical analysis of technical work. Each student will be assessed a grade on their technical editing of each lab report. The students grade on technical editing will be based 70% on grammar and writing and 30% on technical evaluation of the report.

**Executive Summaries**

The students will submit 1-page executive summaries for each laboratory performed. These summaries must be submitted via the schedule shown at the end of this syllabus. For a few of the laboratories, laboratory reports will not be required and only the executive summaries will be used to evaluate student performance in the lab. The purpose in these executive summaries is to both provide assessment of the laboratory results and analysis as well as to exercise the student’s skill at distilling detailed technical information into a concise format. An example of an executive summary will be provided to the student via the eCampus system. The student’s grade on executive summaries will be based 5% on format, 65% on technical content, and 30% on grammar and writing style. Executive summaries must be completed individually.

**Mid-Term Examination**

A written mid-term examination will be conducted according to the schedule below. This exam will be an in-class, closed-book, closed-notes exam and will cover all matter up to the date of the exam.

**Final Examination**

A final examination for the class will be scheduled according to the approved University Final Examination Schedule. This exam will be comprehensive and cover all information discussed in lectures, laboratory sessions, laboratory reports, and homework. A review sheet will be provided to the student to aid in studying for this exam.

**Lateness Policy**

No credit will be given for any lab reports not submitted by the due date shown on the schedule at the end of this syllabus. Late summaries and homeworks will be deducted 10% per day after the due date.

**Other Pertinent Course Information**

All of the material for this course will be maintained on the University’s eCampus system. This includes an electronic copy of this syllabus, the course schedule, all lecture notes, all laboratory procedures, data tables, example lab reports, example summaries, supplemental readings, and homework assignments. The instructor will use the eCampus email system and discussion board to communicate important messages to the students. Students should check their email often to keep updated on current messages. Also, the student’s grades will be posted on the eCampus system, and the students can use this system to check their grades at any time. The eCampus system can be accessed through [http://eCampus.tamu.edu](http://eCampus.tamu.edu). If you are unfamiliar with this system, instruction will be provided.
Americans with Disabilities Act (ADA)

The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact Disability Services, in Cain Hall, Room B118, or call 845-1637. For additional information visit http://disability.tamu.edu

Religious Holidays

If you are a member of a religious faith that has one or more holidays which require you to be absent from any class listed above, please tell your instructor at least two weeks in advance of your absence and make arrangements to make-up the class.

University Writing Center

The University Writing Center (UWC), located in Evans Library 1.214 (second floor), offers help to writers at any stage of the writing process including brainstorming, researching, drafting, documenting, revising, and more; no writing concern is too big or too small. These sessions are highly recommended but are not required and will not directly affect your final grade. While the UWC consultants will not proofread or edit your papers, they will help you improve your own proofreading and editing skills. If you visit the UWC, take a copy of your writing assignment. To find out more about UWC services or to schedule an appointment, call 458-1455, browse the web page at http://writingcenter.tamu.edu, or stop by the center.

Academic Integrity

All students at Texas A&M University are bound by the Aggie Honor Code:

“An Aggie does not lie, cheat or steal, or tolerate those who do.”

For more information, the student is referred to the Honor Council Rules and Procedures on the web at http://www.tamu.edu/aggiehonor.

As commonly defined, plagiarism consists of passing off as one’s own the ideas, work, writings, etc., that belong to another. In accordance with this definition, you are committing plagiarism if you copy the work of another person and turn it in as your own, even if you have the permission of that person. Plagiarism is one of the worst academic sins, for the plagiarist destroys the trust among colleagues without which research cannot be safely communicated. If you have questions regarding plagiarism, please consult the latest issue of the Texas A&M University Student Rules [http://student-rules.tamu.edu/], under the section “Scholastic Dishonesty.”
<table>
<thead>
<tr>
<th>Module</th>
<th>Week</th>
<th>Session</th>
<th>Individual Topics Covered</th>
<th>Readings</th>
<th>Assignment Due</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>1</td>
<td>Syllabus, Overview of Reactor Criticality</td>
<td>1.1-1.6</td>
<td></td>
<td>14-Jan</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td></td>
<td>MCNP Tutorial</td>
<td>2.1, 2.2, 9.12</td>
<td></td>
<td>16-Jan</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td></td>
<td>MCNP Practical and Intro to NSCR and AGN</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>1</td>
<td>Reactor Instrumentation and One-Speed Neutron Diffusion</td>
<td>3.1-3.7</td>
<td></td>
<td>21-Jan</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td></td>
<td>Subcritical Multiplication and the 1/M Method</td>
<td>2.3, 2.4</td>
<td>Homework 01</td>
<td>23-Jan</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td></td>
<td>Lab 1a: Approach to Critical</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>7</td>
<td></td>
<td>Time-Dependent Diffusion without Delayed Neutrons</td>
<td>3.8-3.10</td>
<td></td>
<td>28-Jan</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td></td>
<td>Model Validation and Uncertainty Quantification</td>
<td></td>
<td>Homework 02</td>
<td>30-Jan</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td></td>
<td>Lab 1b: MCNP Simulations Predicting Critical Rod Heights Laboratory</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>4</td>
<td>10</td>
<td>Neutron Energy Distributions and Lethargy-Dependent Diffusion Theory</td>
<td>4.1-4.4, 10.1-10.4</td>
<td>Lab 1 Report</td>
<td>4-Feb</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td></td>
<td>Resonance Absorption and Thermal Absorption</td>
<td>11.1-11.6</td>
<td>Lab 1 Report Edits</td>
<td>6-Feb</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td></td>
<td>Lab 2a: MCNP Simulation for Predicting $\phi(E)$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>13</td>
<td></td>
<td>Neutron Thermalization and Low-Energy Calculations</td>
<td>12.1-12.6</td>
<td>Final Lab 1 Report</td>
<td>11-Feb</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td></td>
<td>Foil Activation and Neutron Spectrum Unfolding</td>
<td></td>
<td>Homework 03</td>
<td>13-Feb</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td></td>
<td>Lab 2b: Foil Activation and Unfolding for $\phi(E)$</td>
<td></td>
<td>Lab 1 Summary</td>
<td>13-Feb</td>
</tr>
<tr>
<td>C</td>
<td>6</td>
<td>16</td>
<td>2-D Diffusion</td>
<td></td>
<td>Lab 2 Report</td>
<td>18-Feb</td>
</tr>
<tr>
<td></td>
<td>18</td>
<td></td>
<td>Lab 3a: MCNP Rod Worth Simulation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>19</td>
<td></td>
<td>Approximate Point Kinetics</td>
<td></td>
<td>Final Lab 2 Report</td>
<td>25-Feb</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td></td>
<td>Measurement of Reactivity and Review for Mid-Term Exam</td>
<td>5.1-5.6</td>
<td>Homework 04</td>
<td>27-Feb</td>
</tr>
<tr>
<td></td>
<td>21</td>
<td></td>
<td>Lab 3b: Rod Worth Measurements and Inverse Reactivity</td>
<td></td>
<td>Lab 2 Summary</td>
<td>27-Feb</td>
</tr>
<tr>
<td>D</td>
<td>8</td>
<td>22</td>
<td>Mid-Term Examination</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>23</td>
<td></td>
<td>Dynamics with Prompt Feedback</td>
<td>5.7-5.12</td>
<td>Lab 3 Report</td>
<td>6-Mar</td>
</tr>
<tr>
<td></td>
<td>24</td>
<td></td>
<td>Lab 4a: MCNP Simulation for $\alpha_T$, $\Lambda$, and $\beta_{eff}$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>26</td>
<td></td>
<td>Numerical Simulation of a Pulse</td>
<td>5.13</td>
<td>Homework 05</td>
<td>20-Mar</td>
</tr>
<tr>
<td></td>
<td>27</td>
<td></td>
<td>Lab 4b: Pulsing Laboratory Measurement for $\alpha_T$ and $\Lambda$</td>
<td></td>
<td>Final Lab 3 Report</td>
<td>20-Mar</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----</td>
<td>---</td>
<td>=================================================================</td>
<td>---</td>
<td>=================================================================</td>
<td>-----</td>
<td></td>
</tr>
<tr>
<td><strong>E</strong></td>
<td>10</td>
<td>28 Integral Transport Theory and Collision Probabilities</td>
<td>3.12, 9.1-9.5</td>
<td>Lab 3 Summary Lab 4 Report</td>
<td>25-Mar</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>29 Introduction to TransLAT and Method of Characteristics</td>
<td></td>
<td>Lab 4 Report Edits</td>
<td>27-Mar</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>30 Lab 5a: TransLAT Simulation of NSCR Fuel</td>
<td></td>
<td></td>
<td>27-Mar</td>
<td></td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>31 Fuel Burnup with TransLAT and MCNPX/CINDER</td>
<td>6.1-6.4</td>
<td>Final Lab 4 Report</td>
<td>1-Apr</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>32 Fuel Assembly Transport Calculations</td>
<td></td>
<td></td>
<td>3-Apr</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>33 Lab 5b: TransLAT Simulation of NSCR Fuel Burnup</td>
<td></td>
<td></td>
<td>3-Apr</td>
<td></td>
</tr>
<tr>
<td><strong>F</strong></td>
<td>12</td>
<td>34 Homogenization Theory</td>
<td>14.1-14.5</td>
<td>Lab 5 Report</td>
<td>8-Apr</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>35 Chemical Shims and Burnable Absorbers</td>
<td>14.6-14.8</td>
<td>Lab 5 Edits</td>
<td>10-Apr</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>36 Lab 6: Reactor Physics Benchmark with TransLAT</td>
<td></td>
<td></td>
<td>10-Apr</td>
<td></td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>37 Multi-Group Diffusion</td>
<td>4.4</td>
<td>Final Lab 5 Report</td>
<td>15-Apr</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>38 Nodal and Synthesis Methods</td>
<td>3.11, 15.1-15.3</td>
<td></td>
<td>17-Apr</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>39 Lab 7: Fuel Assembly Homogenization with TransLAT</td>
<td></td>
<td></td>
<td>17-Apr</td>
<td></td>
</tr>
<tr>
<td><strong>G</strong></td>
<td>14</td>
<td>40 Differential Transport Theory</td>
<td>9.6-9.11, 10.5</td>
<td>Lab 6 Summary</td>
<td>22-Apr</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>41 Adjoint Operators and Adjoint Functions</td>
<td></td>
<td></td>
<td>24-Apr</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>42 Review for Final Exam</td>
<td></td>
<td></td>
<td>24-Apr</td>
<td></td>
</tr>
<tr>
<td><strong>H</strong></td>
<td>15</td>
<td>43 Final Examination (1:00 P.M. – 3:00 P.M.)</td>
<td></td>
<td></td>
<td>5-May</td>
<td></td>
</tr>
</tbody>
</table>
Text: All reading will be via handouts.

Films used in course: Semiscale red/blue water experiment (circa 1971); steam relief valve blowdown; stratified flow; others.

Instructor: Richard R. Schultz, Ph.D., P.E. (CV on web site)

Course Abstract: The factors which both define (govern) and otherwise influence nuclear reactor safety are studied. A portion of the course will be devoted to the history of nuclear safety, including a discussion of the “defining” transients such as the large break loss-of-coolant accident (LOCA), the small break LOCA, and selected severe accidents. The evolution from a deterministic analysis approach to a combination deterministic-probabilistic analysis approach is outlined. An important fraction of the course will be devoted to giving a clear understanding of how the nuclear industry developed and validated the numeric analysis tools required to analyze the very complex transients that define each plant design’s operational/accident envelopes. Subsequently a summary of the evolution of nuclear safety analysis thermal-hydraulic tools from systems analysis to computational fluid dynamics-based tools will be touched on. Discussions on the present “nuclear safety construct” and a proposed “new nuclear safety construct” will be held. Finally, a summary of typical system analysis techniques used to analyze a plant state will be given.

Course grading: 30% homework; 20% each for two mid-term examinations; and 30% for final examination.
<table>
<thead>
<tr>
<th>Week</th>
<th>Topics</th>
<th>Reference &amp; Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>8/28</td>
<td>Introduction, description of course content, summary of grading, class schedule; discussion of reactor safety systems that influence a plant's operational/transient envelopes, working fluids, and typical flow behaviors during both operational and accident conditions. First discussions on final safety analysis reports.</td>
</tr>
<tr>
<td>2</td>
<td>9/4</td>
<td>Historical perspective on nuclear safety: cycle of complex technologies; half-century of nuclear experience; etc.</td>
</tr>
<tr>
<td>3</td>
<td>9/11</td>
<td>Discussion on key phenomena (and figures-of-merit) for the large break loss-of-coolant scenarios that must be fully investigated if a nuclear power plant (NPP) is to be licensed. First discussion on practices and procedures used to validate analytical tools (software) required to analyze NPP behavior.</td>
</tr>
<tr>
<td>4</td>
<td>9/18</td>
<td>Discussion of key phenomena (and figures-of-merit) for the small break loss-of-coolant scenarios that must be fully investigated if a nuclear power plant (NPP) is to be licensed. Outline of methodology used to qualify and validate TH analysis tools (software) used to calculate the behavior of NPPs.</td>
</tr>
<tr>
<td>5</td>
<td>9/25</td>
<td>Going beyond the Design Basis: defense-in-depth; deterministic approach to achieve defense-in-depth; probabilistic approach to achieve defense-in-depth.</td>
</tr>
<tr>
<td>6</td>
<td>10/2</td>
<td>Accident prevention and core cooling: the principal safety strategy and the overriding safety function.</td>
</tr>
<tr>
<td>7</td>
<td>10/9</td>
<td>Managing the unexpected—the human performance.</td>
</tr>
<tr>
<td>8</td>
<td>10/16</td>
<td>Probabilistic Risk Analysis—lectures 1 &amp; 2</td>
</tr>
<tr>
<td>9</td>
<td>10/23</td>
<td>Probabilistic Risk Analysis—lectures 3 &amp; 4</td>
</tr>
<tr>
<td>10</td>
<td>10/30</td>
<td>Managing all risks.</td>
</tr>
<tr>
<td>11</td>
<td>11/6</td>
<td>Systems analysis: break flow rate</td>
</tr>
<tr>
<td>12</td>
<td>11/13</td>
<td>Systems analysis: decay heat and integrated power—steam generation from decay heat</td>
</tr>
<tr>
<td>13</td>
<td>11/20</td>
<td>Systems analysis: Mass balance</td>
</tr>
<tr>
<td></td>
<td>Date</td>
<td>Topic</td>
</tr>
<tr>
<td>---</td>
<td>------------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>14</td>
<td>11/27</td>
<td>Systems analysis: Shutdown margin &amp; natural circulation</td>
</tr>
<tr>
<td>15</td>
<td>12/4</td>
<td>Summary and Preparation for Final Examination</td>
</tr>
<tr>
<td>16</td>
<td>12/7, 10-12</td>
<td>Final Examinations</td>
</tr>
</tbody>
</table>

References:

AS = Arkal Shenoy, presentation on gas-cooled reactors, 2005.
CP-FSAR = Commanche Peak Final Safety Analysis Report
GG-FSAR = Grand Gulf Final Safety Analysis Report
RP = Ronald Paton, Incompressible Flow, Wiley & Sons, Chapter 2 excerpts
RS1 = R. Schultz, Deterministic Analyses of LWR Plant Scenarios, class handout.
NUEN 610 – NUCLEAR REACTOR DESIGN AND CRITICAL ANALYSIS

Fall Semester, 2014

Primary Instructor: Dr. Pavel V. Tsvetkov ZACH 335A, (979) 845-7078, tsvetkov@tamu.edu
Office Hours: MWF 1:00 – 3:00 pm,
Welcome to E-mail and stop by!
Office hours are limited. I recommend using E-mail as the primary means of communication and to schedule specific meeting times.

Secondary Instructor: Dr. William S. Charlton ZACH 336E, (979) 845-7092, wcharlton@tamu.edu
Office Hours: T 2:00 – 4:00 pm

Schedule: MW, 10:20 am – 11:10 am, Zachry 119B and F, 09:30 am – 11:10 am, Zachry 119B

Texas A&M Graduate Catalog Data

Credits: NUEN 610 (4-0) Nuclear Reactor Design. Credit 4.

Description: Application of fundamentals of nuclear physics and reactor theory with engineering fundamentals to design and evaluation of nuclear energy systems.
The course includes a semester-long team project.

Prerequisites: Graduate student classification or approval of instructor

Text 1. Lecture Materials: Nuclear Reactor Design and Critical Analysis, lecture materials (The main information source for course subjects is a combination of (1) comprehensive course materials prepared by the instructor and distributed to the class, (2) textbook and reference books, and (3) RSICC, ANS, ASME, DOE, and IAEA technical documents)

2. Textbook:

3. References:
Course Objective

NUEN610 is a 4-hour graduate course. It is intended to provide the graduate students with a description of nuclear energy systems including the performance and operation principles as well as methods for the design and critical analysis of these systems.

The focus is on the nuclear engineering design and analysis methodology that synthesizes principles of reactor physics, thermal fluidics, radiation interaction, radiation shielding, radiation detection, and engineering system evaluation methods to the design of nuclear energy systems. The class includes semester-long design and evaluation projects. The course involves synthesis of data and analysis methods learned in the student’s other classes as well as developing the ability to learn new techniques when needed.

Various techniques are presented on how to effectively manage a research, design, or analysis project and to help critique data sources.

Also included are presentations on methods to analyze creatively, how to employ inductive and deductive reasoning in analysis, how to recognize gaps and blind-spots and ways to determine when to cease analysis.

Desirable Background Knowledge by Topic

1. Nuclear physics as applied to nuclear engineering, cross-section data, evaluated nuclear data files
2. Thermodynamics fundamentals
3. Fundamentals of fluid mechanics & heat transfer as applied to behavior of ideal & real fluids including single-phase and two-phase flows.
4. Reactor physics analysis principles
5. Conduction, convection and radiation separately and in combination, steady/unsteady states
7. Basics of heat transfer mathematical modeling
8. Nuclear engineering systems
9. Radiation detection
10. Radiation shielding and interaction of radiation with matter
11. Nuclear nonproliferation and arms control
**Topics Covered**

1. Structure and attributes of a research project, literature review
2. Critical thinking and critical analysis
3. System and system design, design optimization of engineering systems
4. Fundamentals of nuclear systems, concepts, classification, systems, requirements and design methodology
5. Inductive/deductive reasoning and inverse analysis
6. Critical success factors and gap analysis
7. Nuclear reactor design principles (heat generation and removal, transient analysis and control, fuel assembly and core design, optimization)
8. Nuclear plant design principles (power cycles, plant characteristics influenced by thermal-hydraulic considerations, nuclear power plant components and operational aspects, optimization)
9. Principles and approaches to achieve proliferation resistance by design
10. Overall nuclear power plant design integration and optimization (power unit)
11. Safety analysis, considerations and approaches
12. Risk and accident analysis approaches
13. SWOT Analysis, Gantt Charts, PERT Charts, and Critical Path Analysis, Decision Tree Analysis
14. Sensitivity and uncertainty analysis and its applications for nuclear system development
15. Estimating confidence in quantitative and qualitative data
16. Estimating confidence in results
17. Protected and unprotected transients, severe accidents
18. History of nuclear accidents
19. Nuclear energy system and design optimization
20. Nuclear fuel cycle
21. Analyzing technological capabilities of countries and organizations
22. The role of the red team
23. Sustainable development of nuclear energy, nuclear systems and fuel cycles, waste management
24. Design, operation, nuclear power marketing and deployment
25. Design of Light Water Reactors – PWRs
26. Design of Light Water Reactors – BWRs
27. The future for LWRs (LWR sustainability)
28. CANDU
29. Design of very high temperature reactors
30. Design of advanced fast reactors
31. Design of molten salt reactors
32. Design of small modular reactors
33. Licensing of nuclear systems
34. Economics of nuclear systems
35. Nuclear power global markets and deployment
36. Nuclear archaeology
37. Physical protection
38. Nuclear forensics
39. Data fusion
40. When to cease analysis
41. Nuclear reactor design and sustainable development

**Course Outcomes**

Students who successfully complete this course should be able to:

1. Design and organize a detailed project plan for a research, design, or analysis project.
2. Analyze diverse datasets using technical skills and facilities available in the scientific community.
3. Use quantitative and qualitative assessment techniques to provide estimates of data reliability.
4. Perform forward and inverse analyses and understand the limitation of these analyses in terms of uncertainties and uniqueness of solutions.
5. Synthesize results from analyses of multiple datasets to draw conclusions including eliminating incorrect hypotheses and supporting likely hypotheses.
6. Assess the risks associated with low-probability, high-consequence events.
7. Make decisions when data supplied has various degrees of uncertainty.
8. Critique a project to identify gaps in datasets and data needs.
9. Present the results of a project both orally and via writing.
10. Present a critical analysis of someone else’s technical work both orally and via writing.
11. Actively participate in Red Team exercises to aid in the development of technical conclusions.
12. Perform a self-assessment to understand the limit of one's knowledge.
13. Perform assessment of reactor and energy system concepts and develop new concepts including preliminary optimization evaluations of system-level performance characteristics.
14. Analyze issues associated with nuclear fission reactors and their fuel cycles including performance, applications, operation, safety, security, and waste management options and strategies.
15. Assess licensing issues, safety and security aspects of various reactors and energy systems.
16. Develop models and methodologies for design evaluations towards specific applications.

**Computer Usage**

All of the material for this course will be maintained on the University’s eCampus system. This includes an electronic copy of this syllabus, the course schedule, all lecture materials, and homework assignments. Students should check their email often to keep updated on current messages.

The course assignments require analytical and numerical solutions. Appropriate use of the general software packages (for example, MATLAB, etc.) is encouraged.

Numerical solutions assume use of the existing nuclear engineering codes and development of algorithms followed by implementation in the form of a computer program. A working knowledge of at least one programming language is expected.

Students will also make occasional use of electronic resources available on the Nuclear Safeguards Educational Portal (http://nsspi.tamu.edu/NSEP) maintained by the Nuclear Security Science and Policy Institute at TAMU. The instructor will direct you to this resource when necessary.

**Course Structure**

This course consists of the academic elements as defined below. The purpose and content of each academic element are:

1. **Lectures and lecture materials.** Lectures and lecture materials will cover the course topics and will be made as self-sufficient as reasonably achievable.

2. **Homework problem (HW) sets and in-class exercises – 20% of the course effort**
   - **HW sets** - Homework problem (HW) sets will be assigned and graded on a weekly schedule. See the Course Policy, Assignment Submission Guidelines and Grading Policy defined later in this syllabus. Some of the HW assignments may require in-class presentations.
   - **In-class exercises** – In-class exercises will be focused on the chosen system concepts. These exercises will be an integral part of the design marketing studies for the chosen concepts throughout the system design project. They will facilitate deployment domain and commercialization studies of the system design.

   HW-based activities will be designed to support and facilitate system design project efforts by providing relevant practical evaluation experiences and by creating a step-by-step schedules.

3. **Short express quizzes – 5% of the course effort.** Short express quizzes will be given to facilitate and enhance the learning process. Each quiz will consist of theoretical questions based on the material from the preceding lectures and will be designed for approximately 10 min of class time (open book). The short express quizzes will be given randomly and without any prior notice.
4. **One major midterm examination — 15% of the course effort.** One mandatory midterm examination will be given (closed book & notes, no calculators) in class, see the course schedule provided later in this syllabus. The exam will be comprehensive with respect to the corresponding preceding material. Depending on the actual progress, the midterm exam is planned for October. **This exam may include take-home parts.**

5. **Written final examination — 15% of the course effort.** The comprehensive final examination will be given (closed book & notes, no calculators) in class at the end of the course, see the course schedule provided later in this syllabus. Oral exams for students scoring over 95% might be offered. To be eligible - top scores (over 95%) must be achieved for all assignments; and all assignments must be submitted.

6. **System design and analysis project (SDAP) — 45% of the course effort.** System design and analysis projects (SDAP) will be assigned early in the semester: proposal – 10%, final presentation – 15%, final report – 20%.

**System design and analysis project**

System design and analysis projects (SDAP) are assumed to be team efforts. Each student will participate in a team that will perform a nuclear energy systems design followed by an analysis of this design based on a hypothetical series of events. The events will be provided by the instructors following the mid-term exam. The project topics and team memberships will be decided early in the semester. **The first homework assignment will be asking students to develop individual project proposals according to their interests. The team project topics and project teams will be derived from the individual student proposals.**

Each project will be focused on a system design and will include the following **mandatory elements (changes must be approved by the course instructors):**

1. Systems design (design elements for relevant reactor and power unit components and system optimization for intended applications),
2. Safety systems,
3. Radiological safety/emergency response,
4. Physical security system design,
5. Safeguards systems,
6. Integration including licensing considerations, economics and marketing.

Within each project team, team members will have individual responsibilities supporting one or more of the mandatory elements according to their interests. Team leaders will be elected by the team members.

**Status updates during the semester.** Some of the weekly homework assignments will be designed to provide intermediate project status updates – 60% of the HW score will be for its written content and 40% for the in-class presentation. Contributions of team members must be clearly identified.

**The SDAP deliverables are:**

1. **Proposals – 10%**. Student teams will develop and submit proposals for design projects for systems of their choice.
   Each team proposal will be evaluated on the basis of its written content (60%) and in-class team presentations (40%) (Initial presentations) justifying chosen systems and applications. Contributions of team members must be clearly identified.

2. **Final project reports – 20%**. Following completion of the design and analysis efforts, the teams will submit their final design and analysis reports including all steps and results for the design, clearly identifying contributions of team members.
   The grade for the final design report is based 75% on technical content, 15% on technical writing, and 10% on format.

3. **Final project presentations – 15%**. Student teams will present their final designs and analyses in class at the end of the semester.
Course Outline (all schedule details are subject to change depending on the actual course progress)

<table>
<thead>
<tr>
<th>Week</th>
<th>Date</th>
<th>Lecture</th>
<th>Topics</th>
<th>Assignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/15</td>
<td>09/01/14 (M)</td>
<td>Course overview, syllabus</td>
<td>1. Structure and attributes of a research project, literature review</td>
<td>HW1 – individual project proposal</td>
</tr>
<tr>
<td></td>
<td>09/03/14 (W)</td>
<td>2/45</td>
<td>2. Critical thinking and critical analysis</td>
<td>HW1 due</td>
</tr>
<tr>
<td></td>
<td>09/05/14 (F)</td>
<td>3/45</td>
<td>3. System and system design, design optimization of engineering systems</td>
<td>Project team/topic formation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4/45</td>
<td>Fundamentals of nuclear systems, concepts, classification, systems, requirements and design methodology</td>
</tr>
<tr>
<td>2/15</td>
<td>09/08/14 (M)</td>
<td>5/45</td>
<td>5. Inductive/deductive reasoning and inverse analysis</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>09/10/14 (W)</td>
<td>6/45</td>
<td>6. Critical success factors and gap analysis</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>09/12/14 (F)</td>
<td>Team proposals and initial presentations</td>
<td>-</td>
<td>HW2 due – team proposals</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7/45</td>
<td>7. Nuclear reactor design principles - heat generation and removal</td>
<td>HW3 assigned</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8/45</td>
<td>Nuclear reactor design principles - transient analysis and control</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>9/45</td>
<td>Nuclear reactor design principles – fuel assembly and core design, optimization</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>10/45</td>
<td>Nuclear plant design principles - power cycles</td>
</tr>
<tr>
<td>3/15</td>
<td>09/15/14 (M)</td>
<td>11/45</td>
<td>11. Safety analysis, considerations and approaches</td>
<td>HW3 due</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>12/45</td>
<td>Nuclear plant design principles - nuclear power plant components and operational aspects, optimization</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>13/45</td>
<td>Principles and approaches to achieve proliferation resistance by design</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>14/45</td>
<td>Overall nuclear power plant design integration and optimization (power unit)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>15/45</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>16/45</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Status update team presentations 1</td>
<td>-</td>
<td>Status update team memos and presentations</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>17/45</td>
<td>-</td>
</tr>
<tr>
<td>Week</td>
<td>Date</td>
<td>Lecture</td>
<td>Topics</td>
<td>Assignment</td>
</tr>
<tr>
<td>------</td>
<td>-----------</td>
<td>---------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>6/15</td>
<td>10/06/14</td>
<td>17/45</td>
<td>13. SWOT Analysis, Gantt Charts, PERT Charts, and Critical Path Analysis, Decision Tree Analysis</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(M)</td>
<td></td>
<td>14. Sensitivity and uncertainty analysis and its applications for nuclear system development</td>
<td>HW5 due</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>15. Estimating confidence in quantitative and qualitative data</td>
<td>HW6 assigned</td>
</tr>
<tr>
<td></td>
<td>10/08/14</td>
<td>18/45</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(W)</td>
<td></td>
<td>16. Estimating confidence in results</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>10/10/14</td>
<td>19/45</td>
<td>17. Protected and unprotected transients, severe accidents</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(F)</td>
<td></td>
<td><strong>10/15/14 (W)</strong> Midterm Exam (closed book, closed notes, no calculators)</td>
<td>HW6 due</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>18. History of nuclear accidents</td>
<td>HW7 assigned</td>
</tr>
<tr>
<td></td>
<td>10/17/14</td>
<td>22/45</td>
<td>19. Nuclear energy system and design optimization</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(F)</td>
<td></td>
<td><strong>8/15</strong> 20. Nuclear fuel cycle</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>10/20/14</td>
<td>24/45</td>
<td>21. Analyzing technological capabilities of countries and organizations</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(M)</td>
<td></td>
<td><strong>10/14/14 (W)</strong> HW6 due</td>
<td>HW6 assigned</td>
</tr>
<tr>
<td></td>
<td>10/22/14</td>
<td>25/45</td>
<td>22. The role of the red team</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(W)</td>
<td></td>
<td>23. Sustainable development of nuclear energy, nuclear systems and fuel cycles, waste management</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>10/24/14</td>
<td>26/45</td>
<td><strong>9/15</strong> 24. Design, operation, nuclear power marketing and deployment</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(F)</td>
<td></td>
<td>25. Design of Light Water Reactors – PWRs</td>
<td>HW7 due</td>
</tr>
<tr>
<td></td>
<td>(M)</td>
<td></td>
<td>27. The future for LWRs (LWR sustainability)</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>11/03/14</td>
<td>32/45</td>
<td><strong>10/15</strong> 28. CANDU</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(M)</td>
<td></td>
<td>29. Design of very high temperature reactors</td>
<td>HW8 - Memo 2 due</td>
</tr>
<tr>
<td></td>
<td>11/05/14</td>
<td>33/45</td>
<td><strong>11/07/14 (F)</strong> Status update team presentations 2</td>
<td>HW9 assigned</td>
</tr>
<tr>
<td></td>
<td>(W)</td>
<td></td>
<td><strong>11/15</strong> 30. Design of advanced fast reactors</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>31. Design of molten salt reactors</td>
<td>HW 9 due</td>
</tr>
<tr>
<td></td>
<td>11/10/14</td>
<td>34/45</td>
<td>32. Design of small modular reactors</td>
<td>HW10 assigned</td>
</tr>
<tr>
<td></td>
<td>(M)</td>
<td></td>
<td>33. Licensing of nuclear systems</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>11/12/14</td>
<td>35/45</td>
<td><strong>11/14/14 (F)</strong> 34. Economics of nuclear systems</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(W)</td>
<td></td>
<td>35. Nuclear power global markets and deployment</td>
<td>HW10 - Red Team Report due</td>
</tr>
<tr>
<td></td>
<td>11/17/14</td>
<td>38/45</td>
<td><strong>11/21/14 (F)</strong> Red Team evaluation presentations of the proposed designs</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(M)</td>
<td></td>
<td>36. Nuclear archaeology</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>11/19/14</td>
<td>39/45</td>
<td>37. Physical protection</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(W)</td>
<td></td>
<td><strong>12/15</strong> Thanksgiving Holiday</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>11/24/14</td>
<td>40/45</td>
<td>38. Nuclear forensics</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(M)</td>
<td></td>
<td>39. Data fusion</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>11/26/14</td>
<td>41/45</td>
<td>40. When to cease analysis</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(W)</td>
<td></td>
<td>41. Nuclear reactor design and sustainable development</td>
<td>Final report due</td>
</tr>
<tr>
<td></td>
<td>11/28/14</td>
<td>42/45</td>
<td><strong>12/16/14 (T)</strong> Final Exam (Closed Book, Closed Notes, No Calculators), 8 – 10 a.m.</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(F)</td>
<td></td>
<td></td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>12/01/14</td>
<td>43/45</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(M)</td>
<td></td>
<td></td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>12/02/14</td>
<td>44/45</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(W)</td>
<td></td>
<td></td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>12/05/14</td>
<td>45/45</td>
<td></td>
<td>-</td>
</tr>
</tbody>
</table>
Course Policy, Assignment Submission Guidelines and Grading Policy

1. **Academic Integrity Statement:** “An Aggie does not lie, cheat, or steal or tolerate those who do.”
   For additional information please visit [http://www.tamu.edu/aggiehonor](http://www.tamu.edu/aggiehonor)

2. **Professional Behavior:** An important attribute of your professional development is that you act and speak in a manner that will not offend others giving particular care to diversity issues.

3. **Assignments (HW solution sets and SDAP reports):**
   - **Preparation (grade penalty up to a full assignment worth for not following the guidelines):**
     - Each HW solution set: (1) give assignment number and attach assignment page as a cover, (2) use of only front side of each page will be strictly enforced, (3) if hand-written be neat and legible, and (4) present work logically.
     - SDAP report and materials: (1) no limit on the total number of pages (100 pages is recommended as a reasonable maximum) (no handwriting, single space, 12 pt. font) including contents, lists of figures and tables, introduction, concept description, design approach and applicable models, results, conclusions, etc., (2) if you created auxiliary materials – list them in the Appendix and E-mail actual materials, (3) provide the list of references at the end of your report
   - **Submission of the HW solution sets and the SDP reports and materials:**
     - HW solution sets, SDP report and materials: Work together is encouraged. The participating classmates must be listed on the first page. However, the final submitted assignments must be individual work efforts.
     - NO late assignments accepted without creditable excuse/explanation for delay per the late-submission policy as described below!
     - NO assignments will be accepted after the last day of classes! (see the course schedule provided in this syllabus)
   - **LATE SUBMISSION (1 WEEK TO EXPLAIN AND ASK FOR A NEW DUE DATE):**
     - If a student cannot submit HW by the due date, each student has 1 week after the due date to explain the reasons for the delay and ask for a new due date.
     - Depending on the provided explanation and the HW assignment submission history of a student, the new due date may be assigned with NO GRADE PENALTY or the request may be denied (the delayed HW will not be accepted in this case).
     - If the student fails to contact instructor within 1 week after the due date, the delayed HW will not be accepted. No exceptions!
   - **Submissions of final project reports for informal reviews are encouraged in advance of the final report submission deadline.**
   - **Re-submission of HW sets:**
     - If you re-do your HW assignment, you can increase your grade by at least 10% of the original worth (up to 100% depending on the originality). **ONLY ONE RESUBMISSION OF EACH HW ASSIGNMENT IS PERMITTED.**
     - **DESIGN PROJECT REPORTS CANNOT BE RE-SUBMITTED. HOWEVER, THE DRAFT REPORTS MIGHT BE REVIEWED PRIOR TO OFFICIAL SUBMISSIONS (BEFORE THE DEADLINE THE REPORT IS DUE)**
4. Structure of final course score:

<table>
<thead>
<tr>
<th>Course Element</th>
<th>Element Score % of the Course Effort</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homework problem (HW) sets</td>
<td>20.0</td>
</tr>
<tr>
<td>System Design and Analysis Project</td>
<td>10.0</td>
</tr>
<tr>
<td>Proposals</td>
<td></td>
</tr>
<tr>
<td>Final Project Report</td>
<td>20.0</td>
</tr>
<tr>
<td>Final Project Presentation</td>
<td>15.0</td>
</tr>
<tr>
<td>Short Express Quizzes</td>
<td>5.0</td>
</tr>
<tr>
<td>Written Midterm Exam</td>
<td>15.0</td>
</tr>
<tr>
<td>Final Exam</td>
<td>15.0</td>
</tr>
<tr>
<td>TOTAL Final Course Score</td>
<td>100.0</td>
</tr>
</tbody>
</table>

5. Final course grade ranges:

<table>
<thead>
<tr>
<th>Final Course Score</th>
<th>Final</th>
</tr>
</thead>
<tbody>
<tr>
<td>90% and above</td>
<td>A</td>
</tr>
<tr>
<td>80 - 89.5%</td>
<td>B</td>
</tr>
<tr>
<td>70 - 79.5%</td>
<td>C</td>
</tr>
<tr>
<td>60 - 69.5%</td>
<td>D</td>
</tr>
<tr>
<td>Below 60%</td>
<td>F</td>
</tr>
</tbody>
</table>

Scholastic Dishonesty and the Aggie Honor Code: "An Aggie does not lie, cheat, or steal or tolerate those who do." The Code forbids the following:

- **Cheating**: Attempting to use unauthorized materials, information, notes, study aids or other devices or materials in any academic exercise.
- **Fabrication**: Making up data or results; submitting fabricated documents.
- **Falsification**: Manipulating results such that research is not accurately represented in the research record.
- **Multiple Submissions**: Submitting substantial portions of the same work (including oral reports) for credit more than once without authorization from instructors.
- **Plagiarism**: Using another person’s ideas, work, processes, results, writings, words, etc. without giving appropriate credit.
- **Complicity**: Intentionally or knowingly helping, or attempting to help, another to commit an act of academic dishonesty.

If you have questions regarding scholastic dishonesty and the Aggie Honor Code, please visit [http://www.tamu.edu/aggiehonor](http://www.tamu.edu/aggiehonor) for the Honor Council Rules and Procedures, and [http://student-rules.tamu.edu](http://student-rules.tamu.edu) for the Texas A&M University Student Rules.

Americans with Disabilities Act (ADA): The Americans with Disabilities Act (ADA) is a federal antidiscrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please tell your instructor or contact the Department of Student Life, Services for Students with Disabilities, in Cain Hall, or call 845-1637.

Religious Holidays: If you are a member of a religious faith that has one or more holidays which require you to be absent from any class listed above, please tell your instructor at least two weeks in advance of your absence and make arrangements to make-up the class.

Copyrights: The handouts used in this course are copyrighted. By "handouts" we mean all materials generated for this class, which include but are not limited to syllabi, lab problems, in-class materials, review sheets, and additional problem sets. Because these materials are copyrighted, you do not have the right to copy the handouts, unless the author expressly grants permission.
COURSE DESCRIPTION
This course provides further study of the purposeful interaction of radiation with matter. Behavior of various nuclear radiation detectors and design of detector systems will be emphasized both theoretically and experimentally in the laboratory. Properties of radioisotopes useful to many industries are considered and evaluated from an engineering point of view. Prerequisites: ECEN 215 and NUEN 309.

OBJECTIVES
The specific objectives of this course are the following:

- Students will become familiar with safe radioisotope laboratory procedures.
- Students will be able to set up, calibrate and operate a radiation detection system, whether the desired outcome is pulse counting, current/charge measurement, pulse-height analysis (spectroscopy), or timing analyses.
- Students will be able to assess a radiation detection problem based on a consideration of the principles of radiation interactions with matter, available radiation detection techniques, and the characteristics of various nuclear radiation detectors to design an appropriate system;
- Students will be able to build detection systems based on their own design to provide observation of radiation interaction phenomena;
• Students will be able to perform any required statistical analysis of results derived with any of the systems discussed above;
• Students will develop communication skills, particularly technical writing.
• Students will enhance research and computer skills.

REQUIRED TEXTS


ISBN: **020530902**

OR

Williams, Joseph M. *Style: toward clarity and grace*, University of Chicago Press, 1995.
ISBN: **0226899152**

SUPPLEMENTARY TEXTS AND MATERIALS

Chart of the Nuclides 16th Edition
Scientific Calculator

Electronic Books and References (all books are provided in PDF format)


ASSIGNMENTS AND GRADES (TENTATIVE)

Table 1: Assignments and Weights

<table>
<thead>
<tr>
<th>Assignment</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formal Lab Reports</td>
<td>400</td>
</tr>
<tr>
<td>Quizzes</td>
<td>120</td>
</tr>
<tr>
<td>Design Project Report and Presentation</td>
<td>100</td>
</tr>
<tr>
<td>Practical Examination</td>
<td>100</td>
</tr>
<tr>
<td>Homework</td>
<td>180</td>
</tr>
<tr>
<td>Final Examination: May 11, Tuesday 3:30 p.m.-5:30 p.m.</td>
<td>100</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>1000</strong></td>
</tr>
</tbody>
</table>

Table 2: Calculation of Final Grades

<table>
<thead>
<tr>
<th>Point Range</th>
<th>Final Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>900-1000</td>
<td>A</td>
</tr>
<tr>
<td>800-899</td>
<td>B</td>
</tr>
<tr>
<td>700-799</td>
<td>C</td>
</tr>
<tr>
<td>600-699</td>
<td>D</td>
</tr>
<tr>
<td>0-599</td>
<td>F</td>
</tr>
</tbody>
</table>

Americans with Disabilities Act
The Americans with Disabilities Act (ADA) is a federal antidiscrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact the Department of Student Life, Services for Students with Disabilities in Room 126 of the Koldus Building, or call 845-1637.

Copyrights
The handouts used in this course are copyrighted. By "handouts" we mean all materials generated for this class, which include but are not limited to syllabi, lab problems, in-class materials, review sheets, and additional problem sets. Because these materials are copyrighted, you do not have the right to copy the handouts, unless the author expressly grants permission.
PLEASE NOTE:
1. AGGIE HONOR CODE: “An Aggie does not lie, cheat, or steal or tolerate those who do.” For additional information please visit: www.tamu.edu/aggiehonor/
2. PROFESSIONAL BEHAVIOR: An important attribute of your professional development is that you act and speak in a manner that will not offend others giving particular care to diversity issues.
3. DISABILITY ACCOMMODATION: If you believe you have a disability requiring an accommodation, please tell your instructor or contact the Department of Student Life, Services for Students with Disabilities, in Cain Hall or call 845-1637.
4. RELIGIOUS HOLIDAYS: If you are a member of a religious faith that has one or more holidays which require you to be absent from any class listed above, please tell your instructor at least two weeks in advance of your absence and make arrangements to make-up the class.

Scholastic Dishonesty and the Aggie Honor Code

AGGIE HONOR CODE: "An Aggie does not lie, cheat, or steal or tolerate those who do." The Code forbids the following:
- Cheating: Attempting to use unauthorized materials, information, notes, study aids or other devices or materials in any academic exercise.
- Fabrication: Making up data or results; submitting fabricated documents.
- Falsification: Manipulating results such that research is not accurately represented in the research record.
- Multiple Submissions: Submitting substantial portions of the same work (including oral reports) for credit more than once without authorization from instructors.
- Plagiarism: Using another person's ideas, processes, results, or words without giving appropriate credit.
- Complicity: Intentionally or knowingly helping, or attempting to help, another to commit an act of academic dishonesty.

For additional information see http://www.tamu.edu/aggiehonor/definitions.php.
GRADING/COURSE POLICIES

• Formal lab reports are to be no longer than twenty pages **MAXIMUM**, including tables and figures. Appendices should include only raw data and other supporting materials. All documents should be typed in twelve-point Times New Roman font, use Space-and-a-Half spacing, and with a minimum of one-inch margins.

• Lab reports should be submitted with the highest professional standards in mind. Students should retain copies of their work. Plots and Figures should be done with Sigma plot® or MATLAB® or Excel® and embedded in the text.

• Spelling, grammar, punctuation, neatness, and adherence to format are all graded and lack of attention to these details will adversely affect grades (at least **50% of the total grade**).

• Students are encouraged to take advantage of the services provided by the University Writing Center and on their web site (http://writingcenter.tamu.edu/).

• References: **web sites, web pages, etc. may not be cited as references** unless you can prove that the cited work has been peer reviewed. You are required to cite a minimum of three references in each formal report submission.

• Drafts of formal lab reports are due at the **beginning** of the next lab period (one week). They will be graded and handed back promptly and the student will have an opportunity to improve the grade with a final draft of the report.

• Quizzes will cover the assigned reading and laboratory procedures.

• Homework is due one week after it is assigned. Neatness and the use of engineering paper are mandatory. Please be sure to include your section number with your name.

• Work is considered late if not handed in by the beginning of class on the due date. Late work will have 50% of the total score deducted.

• The instructor will return graded papers within one week after the submission date.

• Grade disputes will be handled in the instructor’s office on a case-by-case basis.

• Attendance is mandatory for all lectures and laboratories. Absences must be for University-approved excuses only. No exceptions. Unexcused absences exceeding three lectures or two laboratories can result in automatic failure of the course.

• Any act of cheating or plagiarism can result in a grade of **F** in the course and a referral to the Department Head for further action.
<table>
<thead>
<tr>
<th>SUBJECT</th>
<th>READINGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course Introduction / Lab 1 Handout</td>
<td>Ch. 1,2</td>
</tr>
<tr>
<td><strong>No Lab but we will do a safety walkthrough</strong></td>
<td></td>
</tr>
<tr>
<td>Technical Writing, Counting Statistics</td>
<td></td>
</tr>
<tr>
<td>More Counting Statistics</td>
<td></td>
</tr>
<tr>
<td><strong>Lab 1: Geiger Detector Counting Statistics</strong></td>
<td>Ch. 3</td>
</tr>
<tr>
<td>Even More Fun With Statistics</td>
<td></td>
</tr>
<tr>
<td>Statistics, Statistics, Statistics</td>
<td></td>
</tr>
<tr>
<td>No formal lab, writing critique and exercises in class</td>
<td>Ch. 16</td>
</tr>
<tr>
<td><strong>Counting Statistics Draft Memo Due</strong></td>
<td></td>
</tr>
<tr>
<td>Properties of Electronics</td>
<td></td>
</tr>
<tr>
<td>Detector Electronics</td>
<td></td>
</tr>
<tr>
<td><strong>Lab 2: Detector Electronics</strong></td>
<td>Ch. 17</td>
</tr>
<tr>
<td>Draft Counting Statistics Memo Returned for Improvement</td>
<td></td>
</tr>
<tr>
<td>Properties of an Ideal Radiation Detector</td>
<td></td>
</tr>
<tr>
<td>Detector Design</td>
<td></td>
</tr>
<tr>
<td><strong>No Formal Lab:</strong></td>
<td>Ch. 4, 5</td>
</tr>
<tr>
<td>Detector Electronics - Draft Report Due</td>
<td></td>
</tr>
<tr>
<td>Final Counting Statistic Memo Due</td>
<td></td>
</tr>
<tr>
<td>Gas-filled detectors</td>
<td></td>
</tr>
<tr>
<td>Gas filled Detectors, part 2</td>
<td></td>
</tr>
<tr>
<td><strong>Lab 3: Gas-Flow Detection,</strong></td>
<td>Ch. 6,7</td>
</tr>
<tr>
<td>Detector Electronics Draft returned for improvement</td>
<td></td>
</tr>
<tr>
<td>Final Counting Statistics Memo Due</td>
<td></td>
</tr>
<tr>
<td>Scintillation Detectors</td>
<td></td>
</tr>
<tr>
<td>Semiconductor Detectors</td>
<td></td>
</tr>
<tr>
<td>Topic</td>
<td>Chapters</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>---------------</td>
</tr>
<tr>
<td><strong>No formal Lab</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Detector Electronics Final Report Due (Report 1)</strong></td>
<td>Ch. 8, 9</td>
</tr>
<tr>
<td>Radiation Spectroscopy</td>
<td></td>
</tr>
<tr>
<td>Spectroscopy II</td>
<td></td>
</tr>
<tr>
<td><strong>NaI Scintillation Detection</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Final Gas-Flow Lab Due (Report 2)</strong></td>
<td></td>
</tr>
<tr>
<td><strong>SPRING BREAK</strong></td>
<td></td>
</tr>
<tr>
<td>HPGE Detection</td>
<td></td>
</tr>
<tr>
<td>Neutron and Other Detection Methods</td>
<td></td>
</tr>
<tr>
<td><strong>Lab 5: High Purity Germanium Detectors, NaI lab Due (Report 3)</strong></td>
<td>Ch. 12, 13</td>
</tr>
<tr>
<td><strong>HPGe Lab Due (Report 4)</strong></td>
<td></td>
</tr>
<tr>
<td>Self designed project</td>
<td></td>
</tr>
<tr>
<td>Self designed project</td>
<td></td>
</tr>
<tr>
<td>Practice for Practical Examinations, project</td>
<td></td>
</tr>
<tr>
<td>Individual Practical Examinations</td>
<td></td>
</tr>
<tr>
<td><strong>Reading Day</strong></td>
<td></td>
</tr>
<tr>
<td>Individual Practical Examinations</td>
<td></td>
</tr>
<tr>
<td><strong>Comprehensive Final Exam – 3:30 a.m.-5:30 p.m.</strong></td>
<td></td>
</tr>
</tbody>
</table>
**NUEN 612**  
Radiological Safety and Hazards Evaluation

Spring Semester 2014  
Zachry 119B  
TR 8:00-9:15 AM  
j-poston@tamu.edu

**TEXT:** Handout material provided by instructor.

<table>
<thead>
<tr>
<th>DATE</th>
<th>ASSIGNMENT OR ACTIVITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan. 14</td>
<td>Course objectives, reading assignments, general discussion – A Historical Perspective</td>
</tr>
<tr>
<td>Jan. 16</td>
<td>Discussion of early papers in Health Physics</td>
</tr>
<tr>
<td>Jan. 21</td>
<td>Early recommendations on radiation safety, the ICRP, NCRP</td>
</tr>
<tr>
<td>Jan. 23</td>
<td>Begin discussions of ICRP Publications 26 and 27</td>
</tr>
<tr>
<td>Jan. 28</td>
<td>No class – OUTSIDE READING ASSIGNMENT</td>
</tr>
<tr>
<td>Jan. 30</td>
<td>Interpretation of ICRP Recommendations in 10CFR20</td>
</tr>
<tr>
<td>Feb. 4</td>
<td>Discussion of ICRP Publication 60 and NCRP Report No. 116</td>
</tr>
<tr>
<td>Feb. 6</td>
<td>Regulatory Guides and Other Useful Documents</td>
</tr>
<tr>
<td><strong>Feb. 11</strong></td>
<td><strong>QUIZ NO. 1</strong> <strong>QUIZ NO. 1</strong></td>
</tr>
<tr>
<td>Feb. 13</td>
<td>Discussion of NCRP Report No. 127</td>
</tr>
<tr>
<td>Feb. 18</td>
<td>Aspects of External Exposure Control</td>
</tr>
<tr>
<td>Feb. 20</td>
<td>Approaches to External Radiation Dosimetry</td>
</tr>
<tr>
<td>Feb. 25</td>
<td>Portable Radiation Survey Instruments</td>
</tr>
<tr>
<td>Feb. 27</td>
<td>Stationary radiation survey instruments and area monitors</td>
</tr>
<tr>
<td><strong>Mar. 4</strong></td>
<td><strong>QUIZ NO.2</strong> <strong>QUIZ NO.2</strong></td>
</tr>
<tr>
<td>Mar. 6</td>
<td>No class – OUTSIDE READING ASSIGNMENT</td>
</tr>
</tbody>
</table>
Mar. 11  Spring Break – NO CLASS - Soak up that radiation!!!
Mar. 13  Spring Break – NO CLASS - Soak up that radiation!!!
Mar. 18  Aspects of Internal Exposure Control
Mar. 20  Review of Internal Dosimetry Concepts
Mar. 25  Approaches to air monitoring and contamination control
Mar. 27  Protective clothing and respiratory protection
Apr.  5  Introduction to Bioassay Programs
Apr.  7  Area and Access Control
Apr. 12  Criticality Control
Apr. 14  Non-ionizing Radiation
Apr. 19  ***********   QUIZ NO. 3   ***********
Apr. 20  Term Paper Due by 5 PM
Apr. 21  Oral Presentations by students
Apr. 26  Oral Presentations by students
Apr. 28  Oral Presentations by students
May  3  Redefined Day – attend Friday classes
May  9 (Monday)  FINAL EXAMINATION (1-3 PM) – if necessary

Anticipated Grading:

<table>
<thead>
<tr>
<th>Component</th>
<th>Weight</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Each quiz</td>
<td>20%</td>
<td>A</td>
</tr>
<tr>
<td>Term Project</td>
<td>15%</td>
<td>B</td>
</tr>
<tr>
<td>Outside assignments</td>
<td>15%</td>
<td>C</td>
</tr>
<tr>
<td>Final examination</td>
<td>10%</td>
<td>D</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>F</td>
</tr>
</tbody>
</table>
Catalog Description:

State and federal regulations concerning radioactive materials; radiation safety as applied to accelerators, nuclear reactors, and radioactive byproducts; rigorous methods of analysis applied to computation of biological radiation dose and dose rates from various sources and geometries; radiation effects on physical systems. Prerequisites: NUEN 613; Math 308.

Introduction:

In this course, we will discuss two general topics. The first topic will be the federal regulations in current use in the United States. We will begin our discussion by trying to understand the way federal regulations are promulgated in this country – which means reviewing some history. We may take a retrospective look at the “old regulations” and their basis to try to recognize the changes in radiation protection philosophy that have occurred over the years. Then, we will consider the foundation for these regulations – specifically, the recommendations on the International Commission on Radiological Protection (ICRP). Also, we will consider recommendations of the National Council on Radiation Protection and Measurements (NCRP) as these relate to the federal regulations. Following this, we will take a brief, prospective look at the newer recommendations of the ICRP and NCRP. The ICRP recommendations have been accepted and implemented in many other countries, especially in Europe. However, at this time it does not appear that the federal regulations in this country will be changed to conform to the ICRP and NCRP recommendations in the foreseeable future. However, the Department of Energy has decided to implement the ICRP Publication 60 recommendations. This difference is apparently going to be further exacerbated since the ICRP has issued another set of recommendations and it is not apparent that the US regulatory agencies will promulgate these into Federal law either.

The second topic will be a discussion of the selected aspects of a radiation protection program necessary to meet the federal requirements. This discussion will include selected subjects such as general radiation protection program, training, ALARA, personnel monitoring, external exposure control, internal dose assessment, internal exposure control, respiratory protection, evaluation and reporting of exposures, and other aspects of an effective radiation protection program. The basis for this discussion will be NCRP Report No. 127 on Operational Radiation Safety.

In addition, you will be required to read a number of scientific papers and commentaries during the course, as well as a book of your choice. For most of these, you will be asked to write a short critique of each paper you read and to turn these into the professor. I am interested in your opinions about the scientific validity of the paper, the soundness of the arguments made, etc. These assignments may be copied for everyone (without names)
and various views discussed in class. In addition, these reading assignments will be included in the material to be covered in each quiz.

The approaches to teaching will include several methods. Discussion of the regulations, etc. in the first topic will take the Socratic approach to learning. You will be expected to read selected documents and discuss these with the professor in class. The discussion will be conducted through the use of a series of questions regarding the assigned material. Thus, preparation for the class and participation in the class is very important. Again, I am not interested in you necessarily accepting what I tell you. I am really interested in your interpretation of what you are reading and how it would impact your approach to radiation safety. In addition, you may be asked to read and critically evaluate papers on selected topics relevant to the course. In some cases, these papers and the written critiques will form the basis for classroom discussions. You are expected to be prepared and to participate fully in these discussions by expressing your opinions and your views.

Later in the course, the method will be the more traditional lecture style but there will still be a need for the students to be prepared to participate in the classroom activities.

**Term Project:**

There will be a term project assigned at the beginning of the course. The project will have both a written and oral component. Specific details, deadlines, format, etc. will be supplied by the instructor. As stated above, you will be required to read a book of your choice. This book will be the basis of your term paper and the oral presentation scheduled at the end of the semester.

**Outside Assignments:**

All outside assignments and/or homework are due at the start of the class period (the due date on each assignment will be clearly indicated). Work turned in late will be accepted at the discretion of the instructor. Be neat. If the instructor can’t read it, he won’t give you any credit for the assignment. With the availability of computers and printers throughout the department, my expectation is that all assignments will be typed. The assignment should represent your own work, not a team effort.

**Tests:**

The subjects to be covered on the test will be given to you. Questions may involve concepts presented in the lectures as well as discussions similar to those given as homework. In general, these tests will be composed of discussion-type questions in which the student is expected to write in complete sentences and put these sentences together in a logical order to answer the question. If you miss a test, you must have a University-approved excuse to allow make-up of the test.
Absences:
If you are ill, stay home and get well. **BUT**, e-mail or call me to let me know why you missed class. This is very important for tests and examinations. It is also important that, if possible, you contact me prior to missing class rather than after missing class. It is doubtful that you will be so incapacitated that you could not send an e-mail or punch in my number in your cell phone.

Americans with Disabilities Act:

The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact the Department of Student Life, Services for Students with Disabilities in Room 126 of the Koldus Building, or call 845-1637.

Academic Integrity Statement:

“An Aggie does not lie, cheat, or steal or tolerate those who do.”

Please review the Honor Council Rules and Procedures. The Code forbids the following:
- Cheating: Attempting to use unauthorized materials, information, notes, study aids or other devices or materials in any academic exercise.
- Fabrication: Making up data or results; submitting fabricated documents.
- Falsification: Manipulating results such that research is not accurately represented in the research record.
- Multiple Submissions: Submitting substantial portions of the same work (including oral reports) for credit more than once without authorization from instructors.
- Plagiarism: Using another person's ideas, processes, results, or words without giving appropriate credit.
- Complicity: Intentionally or knowingly helping, or attempting to help, another to commit an act of academic dishonesty.

These can be found on the web at [http://www.tamu.edu/aggiehonors](http://www.tamu.edu/aggiehonors).
TO: Dr. John W. Poston, Sr.

Dr. Poston:

By my signature below, I affirm that I have read the syllabus you have provided and I understand your expectations and guidance you have provided for the conduct of this class. I will follow the rules you have laid out and will conduct myself in the appropriate manner, to the best of my ability, to meet your expectations.

________________________________
Signature

________________________________
Name (please print)

________________________________
Date

This form should be returned to the instructor NO LATER than the start of class on January 16, 2014. If you return it on time, this will be considered the first homework set and a grade of 100% will be recorded for you. However, the form will NOT be accepted at the end of the first class (January 14th) and it will not be accepted AFTER the start of the second class.
Syllabus NUEN 613  
Fall 2014  
Principles of Radiological Safety  
Gamal Akabani, PhD.  
Office: Zachry Engineering Center, 337  
Email: akabani@tamu.edu  
Phone: 458-1699  

Description:  

Rigorous mathematical and physical approach to various aspects of radiological safety and medical dosimetry; derivation of equations involving radiation absorption and dosimetry of external sources, including low and high x-rays, and internal emitters. Introduction to basic micro-dosimetry principles and in their use in nuclear medicine dosimetry, cellular dosimetry, microdosimetry and their application in radiobiology.  

Course Book:  

We will be following very closely the course book; however, we will be adding materials associated with new methods for dosimetry and calibration using water as a reference material. This class is reading and homework intensive. You are required to program using FORTRAN, C++, or any other programing language (such as Statistical R). 

You should collaborate and relate with your peers in order to share your knowledge and improve your communication and writing skills. This course is not intended to be a set of mechanical lectures but rather a dynamic class where you get to read and decide how a radiation dosimetry is used and implemented for a specific problem or paradigm. There is a process for learning that is built in:   
Read and ask questions, execute your homework,  
Read more and work with a team; ask questions among yourselves,  
Read and work additional problems at home on your own and in class,  

Reading Assignments: These are your READING assignments. Read please to carry out your homework.  

Chapter 1.  Ionizing radiation  
Chapter 2.  Quantities for describing the interaction of ionizing radiation with matter  
Chapter 3.  Exponential attenuation  
Chapter 4.  Charged-particle and radiation equilibria.  
Chapter 5.  Absorbed dose in radioactive media.  
Chapter 6.  Radioactive decay and basic principles  
Introduction to radio-pharmacokinetics.
Chapter 7. Gamma and X-ray interactions with matter.
Chapter 8. Charged-particle interaction with matter.
Chapter 9. X-ray production and quality
Chapter 10. Cavity Theory
Chapter 11. Dosimetry fundamentals
Chapter 12. Ionization chamber
We will be including the new calibration methods described in NIST Special Publication 250-74.
Chapter 15. Dosimetry by pulse mode detection.

Homework:
This is a graduate course and it will be homework intensive. You will receive a homework set every week with approximately ten problems for a total of approximately 10 or more homework sets.

Midterm and final test:
There will be only two take home tests, a midterm and a final test. Both tests will be based on extensive work associated with the reading materials. There will be no handouts; therefore, you are required to read your reference books. There will be a total of approximately 10 problems in each test that will require elaborate thinking, including programing. You can work together in your test but I expect that you WRITE your answers alone using your own words.

Grading policy:
Your grade will be based on your class participation, homework assignments and tests. You read you participate.

Participation: 10%
Homework: 50%
Midterm test: 20%
Final test: 20%

Grade scale: A ≥ 90; 80 ≤ B < 90; 70 ≤ C < 80; D ≤ 70.

There will be no normalization as this course is reading and homework intensive.

Reference Books:


**Americans with Disabilities Act:**

The Americans with Disabilities Act (ADA) is a federal antidiscrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact the Department of Student Life, Services for Students with Disabilities in Room 126 of the Koldus Building, or call 845-1637.

**PLEASE NOTE:**

1. **AGGIE HONOR CODE:** “An Aggie does not lie, cheat, or steal or tolerate those who do.” For additional information please visit: http://aggiehonor.tamu.edu/

2. **PROFESSIONAL BEHAVIOR:** An important attribute of your professional development is that you act and speak in a manner that will not offend others giving particular care to diversity issues.

3. **DISABILITY ACCOMMODATION:** If you believe you have a disability requiring an accommodation, please tell your instructor or contact the Department of Student Life, Services for Students with Disabilities, in Cain Hall or call 845-1637.

4. **RELIGIOUS HOLIDAYS:** If you are a member of a religious faith that has one or more holidays which require you to be absent from any class listed above, please tell your instructor at least two weeks in advance of your absence and make arrangements to make-up the class.
Objective: The objective of this class is to acquire a working understanding of the physical and stochastic nature of radiation exposure at low doses, an appreciation for the significance of these properties as they influence the response of physical and biological systems to low dose and dose rate exposures, and an understanding of the methods used for evaluating energy deposition at low doses. The approach is through the stochastic nature of energy deposition in subcellular volumes, and is independent of dosimetric approaches developed for high level exposures. We will cover the processes involved in energy deposition, the definitions of microdosimetric quantities, mathematical simulation, measurement methods and instrumentation, data analysis, and applications including radiation protection and risk estimation.

Text: lecture notes and handouts

Instructor: Dr. Stephen Guetersloh, 58B Zachry, 862-5198, e-mail guetersloh@tamu.edu
Office hours: Open

Course Outline by Major Topics and time Assigned to Each: Hours

Definitions and units
Basic quantities, $\varepsilon$, $y$, $z$
Frequency distributions, $f(y)$, $f(z)$
Averages, frequency mean, dose mean
Dose distributions, $d(y)$, $d(z)$

5

Relationship to traditional dosimetry
Relationship of $D$ to $z$
Relationship of $L$ to $y$

3

Track structure characteristics of radiation
Stochastic nature of interactions at atomic and molecular level
Directly and indirectly ionizing radiation
Ionization and excitation
Delta rays
Products of inelastic collisions

4

Energy deposited by radiation
Molecular changes

4
Clustered molecular changes
Distribution of distances between molecular changes
Effects of particle range and dE/dx
Effects of dose rate

Options for summarizing characteristics of an irradiation
Time and distance distributions
Proximity function
Distributions of multiply damaged sites
Distributions of energy in fixed size site

Characteristics of different radiations
Conventions for data presentation, yf(y)
Characteristics of x and gamma rays
Characteristics of neutrons
Characteristics of high energy heavy particles

Calculation of f(ε)
Approximation based on dE/dx and l
Errors due to straggling
Errors due to short tracks
Errors due to delta ray escape

Monte Carlo calculations
Full track simulation
Cross sections
Condensed track simulation

Measurement of f(ε)
Simulation of small sites
Proportional counter characteristics
Walled and wall-less sites
Artifacts created by walls
Detector design
Electronic requirements

Measurements of unknown radiation fields
Evaluating dose
Evaluating dose equivalent

**Approach:** There will be a limited number of homework problems which are intended to lead you through specific applications of the material that we cover. There will be two
tests through the semester, plus the final examination. These tests will present measurement and data analysis problems which will require creative application of the concepts and definitions that we have discussed. Test questions may require “back of the envelope” calculations, but we are far more interested in your approach to the problem than in the precision of the numerical solution.

Americans with Disabilities Act

The Americans with Disabilities Act (ADA) is a federal antidiscrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact the Department of Student Life, Services for Students with Disabilities in Room 126 of the Koldus Building, or call 845-1637.

Copyrights

The handouts used in this course are copyrighted. By "handouts" we mean all materials generated for this class, which include but are not limited to syllabi, lab problems, in-class materials, review sheets, and additional problem sets. Because these materials are copyrighted, you do not have the right to copy the handouts, unless the author expressly grants permission.

Scholastic Dishonesty

As commonly defined, plagiarism consists of passing off as one's own the ideas, work, writings, etc., that belong to another. In accordance with this definition, you are committing plagiarism if you copy the work of another person and turn it in as your own, even if you have the permission of that person. Plagiarism is one of the worst academic sins, for the plagiarist destroys the trust among colleagues without which research cannot be safely communicated. If you have questions regarding plagiarism, please consult the latest issue of the Texas A&M University Student Rules [http://student-rules.tamu.edu/], under the section "Scholastic Dishonesty."
**Course title and Number:** NUEN 618 - Multiphysics computations in nuclear science and engineering.

**Term:** Fall 2013

**Meeting times and location:** TR 12:45-2:00 (3 credit-hours)

---

**Course Description and Prerequisites**

This course introduces tightly coupled multiphysics simulation techniques and their application to typical problems arising in nuclear science and engineering (e.g., reactor dynamics and safety transients, conjugate heat transfer, radiative transfer, fluid structure interaction).

Most of the numerical methods currently in use in nuclear reactor safety analysis, for instance, trace back to the late 1970’s through the late 1980’s. At that time, multiphysics phenomena were computed and analyzed through a “divide and conquer”, whereby each physic component was treated using mono-disciplinary codes and coupling among the intertwined physical processes was weak and often done a priori using envelope values. With advances in computer software and hardware (e.g., the message passing interface paradigm from the mid 1990’s), computer codes have been increasingly coupled to one another, so as to model reality with a higher degree of fidelity. However, this coupling was performed in an explicit fashion, whereby some physic components was lagged in time, a mathematical approach known as operator-splitting that resulted inconsistent coupling schemes. Over the last decade, a new approach, based on a monolithic view of the whole multiphysics problem, has successfully been applied to a wide range of problems, from plasma physics to hemodynamics. These techniques, based on a derivative-free approach to Newton’s method, are now being applied to problem of interest in nuclear science and engineering.

This course focuses on advanced numerical techniques for nonlinear coupled multiphysics applications: this includes a review of operator-splitting technique and their advantages and drawbacks, a presentation of derivative-free Newton’s technique for a monolithic approach to multiphysics simulations, a description of recent trends and issues in multiphysics code development.

Multiphysics examples treated in class or as homework will include: nuclear reactor transients and accidents (such as rod ejections and loss of pump flow), radiative transfer, conjugate heat transfer, and nuclear fuel swelling and deformation. All of these applications include several physic components and are examples where an accurate treatment of the multiphysic coupling is required. The various physic component include: neutronics, thermal-hydraulics, heat conduction, mechanics of stress and deformation.

This course is intended for second-year Master students and Ph.D. students who wish to pursue a career in computational physics and/or reactor coupled neutronics/thermal-hydraulics analyses.

The course pre-requisites are MATH 609 and NUEN 606. A brief list of the knowledge and tools acquired in the two pre-requisite courses (and their pre-requisites) is given below, for informational purposes:

1. **Neutronics/thermal-hydraulics:**
   a. Neutron balance equation, delayed neutrons;
   b. Point Reactor Kinetics Equations (PRKEs), in-hour equation, some simple approximations to the PRKEs such as constant delayed source, prompt jump, etc...
   c. Heat conduction in a fuel pellet;
   d. Convective heat exchange;
   e. Conservation laws of thermal-hydraulics (mass, momentum, energy);

2. **Numerical analysis:**
   a. Laplace transforms;
   b. Solving a system of **linear** equations (i.e., how to invert a matrix using Gaussian elimination, LU decomposition, and some iterative methods such as preconditioned conjugate gradient);
c. Solving a system **nonlinear** equations using Newton’s method;
d. Time-dependent ODEs and Runge Kutta time discretizations (explicit Euler, implicit Euler, Crank-Nicholson, explicit Runge-Kutta methods);
e. Spatial discretization schemes (e.g., finite differences);
f. Eigenproblems.

**Learning Outcomes or Course Objectives**

The students will be introduced to state-of-the-art modeling of multiphysic methods development and their applications to nuclear science and engineering.

Class time will be divided between:
- understanding of the mathematical aspects of multiphysics simulation techniques,
- understanding the various physical phenomena taking place in various multiphysics applications typically found in nuclear science and engineering.

Upon completion of this course, students will be equipped with the necessary tools to continue education and pursue a career as a computational physicist, with a solid knowledge of current trends in multiphysic simulation techniques and depth in understanding coupled phenomena occurring in nuclear applications.

**Instructor Information**

Name: Dr. Jean C. Ragusa
Telephone Number: 979-862-2033
Email address: jean.ragusa@tamu.edu
Office Hours: appointment by email
Office Location: Zachry, 335-O

**Textbook and/or Resource Materials**

No textbooks are required for this class. Students are expected to take notes during lectures; some class notes may be typed and posted on the instructor’s webpage. Recent research articles will be reviewed and discussed in class to present some mathematical techniques for multiphysic simulations and their applications.

Supplementary Reactors Physics Texts:
- G. Keepin, “Physics of nuclear kinetics”, Addison Wesley, 1965

Supplementary Numerical Methods Texts:
- W. Hackbrusch, “Iterative Solution of Large Sparse Systems of Equations”, Springer-Verlag, 1994

Also note that (1) our library (http://library.tamu.edu/) has many reactor physics/numerical methods books and (2) we have access to online journals, such a Elsevier (http://www.sciencedirect.com/).
Grading Policies

Homework assignments will be assigned every week or every other week. Homework assignments will be due at the beginning of class on their due date. Late homework will be deducted 10% per day after the due date (in portion of 24 hours). The Aggie Honor Code will be strictly enforced: "An Aggie does not lie, cheat, or steal or tolerate those who do." The Code forbids the following:

- Cheating: Attempting to use unauthorized materials, information, notes, study aids or other devices or materials in any academic exercise.
- Fabrication: Making up data or results; submitting fabricated documents.
- Falsification: Manipulating results such that research is not accurately represented in the research record.
- Multiple Submissions: Submitting substantial portions of the same work (including oral reports) for credit more than once without authorization from instructors.
- Plagiarism: Using another person’s ideas, work, processes, results, writings, words, etc. without giving appropriate credit.
- Complicity: Intentionally or knowingly helping, or attempting to help, another to commit an act of academic dishonesty.

Exams: One mid-term exam may be scheduled (in early November). A take-home final project will be given in lieu of a final exam.

The grades will be determined on the usual scale:

\[
\begin{align*}
\text{A} & \geq 90 \\
80 \leq & B <90 \\
70 \leq & C <80 \\
60 \leq & D < 70 \\
F & < 60
\end{align*}
\]

Grades will be computed according to the weight distribution given below.

- Assignments: 50% (or 70% if no mid-term)
- Mid-term: 20%
- Final: 30%

Americans with Disabilities Act (ADA)

The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact Disability Services, in Cain Hall, Room B118, or call 845-1637. For additional information, visit http://disability.tamu.edu.

Academic Integrity

For additional information please visit: http://www.tamu.edu/aggiehonor

“An Aggie does not lie, cheat, or steal, or tolerate those who do.”
NUEN 623
Nuclear Engineering Heat Transfer and Fluid Flow
Fall 2014

Time: TR: 9:35 – 10:50 a.m.

Place: CHEN 111

Instructor: Yassin A. Hassan
Office: Zachry 335Q
Telephone Number:
845 -7090 Office
218-4417 Cell
Email: y-hassan@tamu.edu

Rodolfo Vaghetto
Office: #3
Telephone Number:
845-4109 Office
940-293-7706 Cell
Email: r.vaghetto@tamu.edu

Office Hours: Come in any time

Text:

The following books are highly recommended:


Any other books of heat transfer and fluid mechanics would be helpful in understanding the course material.

Credit: 3 hrs
Course Grade:

The final grade in the course will be based on performance in the following areas

- Homework: 25%
- 2 Exams: 30%
- Final Project: 10%
- Class Participation: 5%
- Final Exam: 30%

Homework will be regularly assigned and graded. Individual work is encouraged but students should discuss assigned problems with other students where such discussion enhances an understanding of the material. Class participation is highly encouraged and positive participation may improve one's final grade in the course. We have the opportunity to work closely in a small class.

Up to four (4) quizzes will be supplied in class to the students without notice. The quizzes are designed to allow students to identify the topics requiring particular attention or further study. Quizzes will be graded. The final grade may be adjusted based on the outcome of the in-class quizzes.

A written final report with references is required. The final report should include all information necessary to explain in detail the project and the results of the work over the semester.
The following is the course outline:

I. Introduction, Examples of transfer processes, governing equations

II. Fluid Flow and Momentum Transport
   A. Laminar and Turbulent Flows
      1. Viscosity and Newton’s Law
      2. Conservation of mass, momentum, and energy
      3. Mechanism of momentum transport
      4. Momentum transfer in laminar flow
      5. Momentum transfer in turbulent flow
      6. Experimental techniques and results
   B. Pressure drop calculations (Applications for nuclear reactor systems and components)
   C. Applications of conservation relations

III. Heat Transfer and Energy Transport
   A. Types of heat transfer – Qualitative description of conduction, convection and radiation
   B. Quantitative calculations
      1. Conduction
      2. Convection
      3. Radiation
   C. Nuclear Applications – Temperature distribution in nuclear fuel pins

IV. Turbulence Transport Concepts and Nuclear Applications

V. Mass Transport
   Diffusivity and mechanisms of mass transport

VI. Macroscopic Balances for Large Systems

VII. Thermodynamics
   A. State Principle
   B. First Law of thermodynamics
   C. Second law of thermodynamics
   D. Power plant component analysis
   E. Applications

VIII. Introduction to System Codes for Analysis of Nuclear Systems
Americans with Disabilities Act (ADA)

The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact Disability Services, in Cain Hall, Room B118, or call 845-1637. For additional information visit http://disability.tamu.edu

Academic Integrity

For additional information please visit: http://aggiehonor.tamu.edu
NUEN 624

Nuclear Thermal Hydraulics and Stress Analysis
(TWO-PHASE FLOW AND PHASE TRANSITION)

Spring 2015

Instructors: Yassin A. Hassan
Rodolfo Vaghetto

Time: TR: 9:35 – 10:50 a.m.

Classroom: TBD

Telephone Number:
Y. Hassan: (979) 845 -7090 Office
R. Vaghetto: (940) 293 -7706 Cell

Email: y-hassan@tamu.edu
r.vaghetto@tamu.edu

Office Hours: Come in any time

Text:

No thorough and complete text in two-phase flow has yet appeared. Good topics can be found in several books and journals. The instructor may mention appropriate reference books for each topic in class.


Recommended Books:


Credit: 3 hrs

Course Grade:

The final grade in the course will be based on performance in the following areas

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homework</td>
<td>20%</td>
</tr>
<tr>
<td>2 Exams</td>
<td>25%</td>
</tr>
<tr>
<td>Project</td>
<td>15%</td>
</tr>
<tr>
<td>Class Participation</td>
<td>5%</td>
</tr>
<tr>
<td>Term Paper</td>
<td>10%</td>
</tr>
<tr>
<td>Final Exam</td>
<td>25%</td>
</tr>
</tbody>
</table>

* Final Exam is on Friday May 2, 2014, Time: 12:30-2:30 p.m.*
Homework will be regularly assigned and graded. Individual work is encouraged but students should discuss assigned problems with other students where such discussion enhances an understanding of the material. Class participation is highly encouraged and positive participation may improve one's final grade in the course. We have the opportunity to work closely in a small class.

Each student will be asked to make an oral presentation highlighting the results of the project (oral presentation = 5%). A written report with references is required. The final report should include all information necessary to explain in detail the project and the results of the work over the semester.

Other Useful References:


*Americans with Disabilities Act (ADA) Policy Statement*
The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact Disability Services, in Cain Hall, Room B118 or call 845-1637. For additional information visit http://disability.tamu.edu

**Academic Integrity Statement**

*Aggie Honor Code: "An Aggie does not lie, cheat, or steal, or tolerate those who do."

Upon accepting admission to Texas A&M University, a student immediately assumes a commitment to uphold the Honor Code, to accept responsibility for learning and to follow the philosophy and rules of the Honor System. Students will be required to state their commitment on examinations, research papers, and other academic work. Ignorance of the rules does not exclude any member of the Texas A&M University community from the requirements or the processes of the Honor System. For additional information please visit: www.tamu.edu/aggiehonor/

On all course work, assignments, and examinations at Texas A&M University, the following Honor Pledge shall be preprinted and signed by the student:

"On my honor, as an Aggie, I have neither given nor received unauthorized aid on this academic work."

**Excused Absences**

7.1 The student is responsible for providing satisfactory evidence to the instructor to substantiate the reason for absence. Among the reasons absences are considered excused by the university are the following:

7.1.6 Injury or illness that is too severe or contagious for the student to attend class.

7.1.6.1 Injury or illness of three or more days. For injury or illness that requires a student to be absent from classes for three or more university business days (to include classes on Saturday), the student should obtain a medical confirmation note from his or her medical provider. The Student Health Center or an off-campus medical professional can provide a medical confirmation note only if medical professionals are involved in the medical care of the student. The medical confirmation note must contain the date and time of the illness and medical professional's confirmation of needed absence.

7.1.6.2 Injury or illness less than three days. Faculty members may require confirmation of student injury or illness that is serious enough for a student to be absent from class for a period less than three university business days (to include classes on Saturday). At the discretion of the faculty member and/or academic department standard, as outlined in the course syllabus, illness confirmation may be obtained by one or both of the following methods:


b. Confirmation of visit to a health care professional affirming date and time of visit.

7.1.6.3 An absence for a non acute medical service does not constitute an excused absence.

To view all Student Rules, please go to: http://student-rules.tamu.edu/

To view Rule 7 of the Student Rules please go to: http://student-rules.tamu.edu/rule7.htm
### Two-Phase Flow

**Introduction**
- Variables
- Flow patterns

**Homogeneous flow model**
- Conservation equations
- Pressure gradient
- Velocity of sound
- Two-phase friction factor, $\Delta p$

**Separated flow model**
- Pressure gradient
- Maximum flow rate, choked flow
- $\Delta p$—Martinelli & other correlations

**Critical Flow**

**Drift flux model**
- Flooding, flow reversal

**Special applications**
- Bubbly flow
- Slug flow
- Annular flow
- $\Delta p$ for special geometries

### Phase Transition

**Boiling**
- Basic processes
  - Nucleation
  - Bubble growth
  - Pool boiling
  - Convective boiling

**Subcooled boiling**
- Onset, mechanisms, correlations
- Void fraction and $\Delta p$

**Saturated boiling**
- Critical heat flux

**Condensation**
- Basic Processes
  - Nucleation, growth
  - Kinetic Theory, non-condensable
  - Film condensation
  - Drop wise condensation

### Two-phase instability

### System Codes for Industrial applications
- Codes Overview, Capabilities and Specific Applications
Introduction to RELAP5 Computer code
RELAP5 models and correlations
Use of RELAP5 for nuclear and other industrial applications
Course Description
The purpose of this course is to introduce the student to neutron transport theory. Basic computational methods for neutron transport will also be introduced and numerical calculations performed to ensure that students develop a practical facility with transport theory. Analytic solution techniques are too difficult and restrictive for this purpose. Perhaps the most versatile deterministic numerical method for solving the neutron transport equation is the $S_n$ method. Our approach in this course will be to primarily teach the $S_n$ method. Methods other than the $S_n$ method for solving the transport equation will be discussed, but only to give the student a basic awareness of them.

Learning Outcomes
Upon completion of this course, the student is expected to:

1. Understand the derivation and physical interpretation of the linearized Boltzmann equation.
2. Be able to generate elementary solutions of that equation.
3. Be able to formulate and use various forms of point kernel transport equations.
4. Understand various discretization methods and accelerated solution techniques for that equation.
5. Be able to use Fourier analysis techniques to analyze the convergence of iterative methods.
6. Be able to derive the diffusion equation from the transport equation using a Galerkin method and an asymptotic expansion.
7. To understand the concept of an asymptotic-preserving discretization.
8. To understand the adjoint transport equation and be able to use it for response and perturbation calculations
9. Have written a 1-D spherical geometry one-group transport code with DSA acceleration wrapped in a Krylov solver.

Class Time And Location
This course will meet three days per week. The course consists of three hours and twenty minutes of in-class lecture according to the following schedule:

Time: TR 3:55 P.M. - 5:10 P.M. and W 3:00pm – 3:50pm
Instructor
Jim E. Morel, Ph.D.
Professor
3133 TAMU
College Station, TX 77843-3133
Office Address: ZACH 335P
Phone: (979) 845-6072
Fax: (979) 845-6075
Email: morel@tamu.edu
Office Hours: By appointment, but walk-ins are accommodated whenever possible.

Textbooks
There is no textbook for this course. Complete lecture notes in LaTeX format, excerpts from various textbooks, and many relevant journal articles will be placed on the TAMU Vista site for access by students.
Exams
All exams will be of the take-home variety.

Computational Project
There will be one computational project relating to a 1-D spherical-geometry one-group Sn code.

Grading
Grading information follows in Tables 1 and 2. Homework represents preparation for the exams, which tend to be very conceptual. No concept will appear on an exam that has not appeared on the homework.

Table 1: Weighting of homework, exams, and projects.

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homework</td>
<td>10 percent</td>
</tr>
<tr>
<td>Exam 1</td>
<td>30 percent</td>
</tr>
<tr>
<td>Project</td>
<td>30 percent</td>
</tr>
<tr>
<td>Final Exam</td>
<td>30 percent</td>
</tr>
</tbody>
</table>

Table 2: Letter grades versus total percentage score.

<table>
<thead>
<tr>
<th>Letter Grade</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>90-100</td>
</tr>
<tr>
<td>B</td>
<td>80-89</td>
</tr>
<tr>
<td>C</td>
<td>65-74</td>
</tr>
<tr>
<td>D</td>
<td>60-64</td>
</tr>
<tr>
<td>F</td>
<td>0-59</td>
</tr>
</tbody>
</table>

Course Content
The following is representative of all topics that may be covered in the course. The actual material covered will depend upon the backgrounds and abilities of the students.

1. Fundamental Concepts of Transport Theory
   (a) Phase Space
   (b) Phase-Space Density
2. Fundamental Forms of the Integro-Differential Transport Equation

(a) The Boltzmann Equation for Neutrons
   i. Source calculations
   ii. k-eigenvalue calculations
   iii. \( \alpha \)-eigenvalue calculations
   iv. Parameter search calculations

3. Properties of the Boltzmann Scattering Operator

(a) Addition Theorem for the Spherical Harmonic Functions
(b) Eigenvalues and Eigenfunctions

4. The Integral Form of the Neutral-Particle Transport Equation

(a) The integral angular flux equation
(b) The integral scalar flux equation

5. Elementary Solutions of the Neutral-Particle Transport Equation

(a) Vacuum and Pure Absorber Solutions
(b) The Asymptotic Modes
(c) A Glimpse of Singular Eigenfunction Solutions

6. The Adjoint Transport Equation

(a) Adjoint Operators
(b) The Adjoint Transport Operator
(c) Response Calculations
(d) Perturbation Theory
7. Second-Order Self-Adjoint Forms of the Transport Equation
   (a) Even-Parity and Odd-Parity Angular Fluxes
   (b) The Even-Parity Transport Equation
   (c) The Odd-Parity Transport Equation
   (d) The Self-Adjoint Angular Flux Equation

8. Asymptotic Transport Approximations
   (a) The Neutron Diffusion Limit
   (b) The Fokker-Planck Continuous-Scattering Limit
   (c) The Fokker-Planck Continuous-Slowing-Down Limit

9. Approximation Methods
   (a) Least-squares Methods
   (b) Galerkin and Petrov-Galerkin Methods

10. Discretization of the Diffusion Equation
    (a) Finite Difference Methods
    (b) Finite-Element Methods
    (c) Mixed Hybrid Methods

11. Hybrid Transport-Diffusion Methods
    (a) The First-Scattered Distributed Source Technique
    (b) The N’th-Scattered Distributed Source Technique

12. Angular Discretization Techniques for the Integro-Differential Transport Equation
    (a) The Spherical-Harmonics or $P_n$ Method
    (b) The Discrete-Ordinates $S_N$ Method
    (c) Finite-Element Methods

13. Analytic $S_n$ Solutions

    (a) Order of Convergence
    (b) Positivity
    (c) Diffusion-Limit Behavior
15. Spatial Discretization Schemes for the $S_n$ Equations
   (a) Step Differencing
   (b) Diamond Differencing
   (c) Discontinuous Finite-Element Methods
   (d) Corner Balance and Multiple Balance Methods

16. Solution of the Slab-Geometry $S_n$ Equations
   (a) The Source Iteration Method
   (b) Fourier Analysis of the Source Iteration Method
   (c) Diffusion-Synthetic Acceleration
   (d) Fourier Analysis of the Diffusion-Synthetic Acceleration Method
   (e) Krylov Solution Techniques
   (f) Diffusion-Synthetic Acceleration Recast as a Preconditioner

17. Energy Discretization for the Transport Equation
   (a) The Classic Multigroup Method
   (b) The Multigroup/Galerkin Method
   (c) Multigroup Source Iteration

18. Time Discretization for the Transport Equation
   (a) Backward-Euler Differencing
   (b) Crank-Nicholson Differencing
   (c) BDF-2 and TBDF-2 Differencing
   (d) Discontinuous Finite-Element Methods

**On-Line Course Material and Submissions**
All of the material for this course will be maintained on the TAMU E-Campus site. This includes an electronic copy of this syllabus, the course schedule, all lecture notes, supplemental readings, and homework assignments. All will submit homework, projects, and exams to the TAMU E-Campus site in a single pdf file. This provides an archive that eliminates problems with lost submissions. The NUEN copy machines have a capability for scanning documents to a pdf file and e-mailing them to the any desired addressee. Students have access to this capability. Each submission must include the student’s name. Students grades will be posted on the TAMU E-Campus system, and students can use this system to check their grades at any time.
E-mail Communication
The instructor will use regular e-mail (as opposed to E-Campus e-mail) to communicate important messages to students. Students should ensure that their e-mail address as listed on the HOWDY site is valid and is either their primary address or forwards to their primary address.

ADA Statement
The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact the Department of Student Life, Services for Students with Disabilities in Room 126 of the Koldus Building. The phone number is 845-1637.

Copyrights
The handouts used in this course are copyrighted. By "handouts" we mean all materials generated for this class by the instructor and provided to the students. Because these materials are copyrighted, you do not have the right to distribute them unless the author expressly grants permission.

Scholastic Dishonesty
As commonly defined, plagiarism consists of passing off as one's own the ideas, work, writings, etc., that belong to another. In accordance with this definition, you are committing plagiarism if you copy the work of another person and turn it in as your own, even if you have the permission of that person. Plagiarism is one of the worst forms of academic dishonesty, for the plagiarist destroys the trust among colleagues without which research cannot be safely communicated. If you have questions regarding plagiarism, please consult the latest issue of the Texas A&M University Student Rules http://student-rules.tamu.edu/, under the section "Scholastic Dishonesty."
NUEN 627-600 – RADIATION-HYDRODYNAMICS  
Spring 2015  
Course Syllabus

COURSE DESCRIPTION
This course will study the physics and numerical characteristics of the radiation-hydrodynamics equations. These equations basically consist of the Euler equations of compressible fluid dynamics and the thermal radiation transport equation coupled via the exchange of energy and momentum. The radiation-hydrodynamics equations play a major role in many high temperature astrophysical phenomena as well as high-temperature terrestrial phenomena characterized by stellar-like temperatures. Inertial confinement fusion is an example of a terrestrial application in which radiation-hydrodynamics is of fundamental importance. From a numerical point of view, the radiation-hydrodynamics equations exhibit multiphysics/multiscale behavior in that the time and length scales associated with these equations can vary greatly from those associated with either the hydrodynamics equations themselves or the thermal radiation transport equation itself. The prerequisite for this course is MATH 602.

COURSE OBJECTIVES
The primary goal of this course is to educate the student in the basic physics and numerics of the radiation-hydrodynamics equations. After completing this course, the student will be able to:
1. Derive the non-relativistic radiation-hydrodynamics equations and their associated asymptotic limits.
2. Understand the fundamental impact of material-motion on radiation transport.
3. Understand both the laboratory and co-moving reference frames used to describe radiation transport.
4. Write a computer program to solve the 1D radiation-hydrodynamics equations using a grey diffusion approximation, and verify that program via elementary radiation-hydrodynamics solutions.

SCHEDULE OF TOPICS

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The Euler equations and the Lagrangian picture of hydrodynamics.</td>
</tr>
<tr>
<td>2</td>
<td>The equations of thermal radiation transport with a fixed transport medium.</td>
</tr>
<tr>
<td>3</td>
<td>The equilibrium-diffusion limit with a fixed transport medium.</td>
</tr>
<tr>
<td>4</td>
<td>Numerical methods for thermal radiation transport with a fixed transport medium.</td>
</tr>
<tr>
<td>5</td>
<td>The equations of thermal radiation transport with a moving transport medium</td>
</tr>
<tr>
<td>6</td>
<td>The equations of radiation-hydrodynamics with non-relativistic material motion.</td>
</tr>
<tr>
<td>7</td>
<td>The equilibrium-diffusion limit for radiation-hydrodynamics</td>
</tr>
<tr>
<td>8</td>
<td>The grey radiation diffusion approximation.</td>
</tr>
<tr>
<td>9</td>
<td>1-D Lagrangian hydrodynamics with grey radiation diffusion</td>
</tr>
</tbody>
</table>
### Class Time and Location
This course consists of three hours of in-class lecture according to the following schedule:

**Time:** Tuesday-Thursday 3:55-5:10pm  
**Place:** Emerging Technologies Building, 1035

### Instructor
Jim E. Morel, Ph.D.  
Professor  
3133 TAMU  
College Station, TX 77843-3133  
Office Address: Bizzell East, Rm 108  
Phone: (979) 845-6072  
Fax: (979) 845-6443  
Email: morel@tamu.edu  
Office Hours: By appointment, but walk-ins will be accommodated whenever possible.

### Textbooks

### Method of Evaluation
Students will be graded on homework and exams. Homework will be assigned throughout the semester (normally you will be assigned one homework set every other week). There will be two exams: a mid-term exam and a final exam. The student's final grade will be determined according to the following percentages:

- **10%** - Homework  
- **50%** - Two Exams  
- **40%** - Final Exam
The homework will represent a conceptual preview of the exams. All exams will be of the take-home type and will be designed to be conceptual rather than calculationally intensive. No concept will appear on an exam unless it has also appeared in the homework. The final exam will require use of a radiation-hydrodynamics code written by each student.

The grades will be determined on the following scale:

<table>
<thead>
<tr>
<th>Grade</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>90.00-100.00</td>
</tr>
<tr>
<td>B</td>
<td>75.00-89.99</td>
</tr>
<tr>
<td>C</td>
<td>60.00-74.99</td>
</tr>
<tr>
<td>F</td>
<td>0.00-59.99</td>
</tr>
</tbody>
</table>

**ONLINE COURSE MATERIAL**

All of the material for this course will be maintained on the University’s eCampus system. This includes an electronic copy of this syllabus, the course schedule, all lecture notes, supplemental readings, and homework assignments. The instructor will use email system and discussion board to communicate important messages to the students. Students should check their email often to keep updated on current messages. Also, the student’s grades will be posted on the eCampus system, and the students can use this system to check their grades at any time.

The eCampus system can be accessed through [http://ecampus.tamu.edu/](http://ecampus.tamu.edu/).

**ATTENDENCE**

In general, attendance at class is highly encouraged, but not required. If a student misses an examination or an examination deadline due to illness or a religious holiday, a reasonable accommodation will be made upon request. In all such cases, a student will be expected to submit a Texas A&M University Explanatory Statement for Absence from Class form available at [http://attendance.tamu.edu](http://attendance.tamu.edu).

**ADA STATEMENT**

The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact the Department of Student Life, Services for Students with Disabilities in Room 126 of the Koldus Building. The office e-mail address is disability@tamu.edu and the phone number is 845-1637.

**COPYRIGHTS**

The handouts used in this course are copyrighted. By "handouts" we mean all materials generated for this class, which include but are not limited to syllabi, lab problems, in-class materials, review sheets, and additional problem sets. Because these materials are copyrighted, you do not have the right to copy the handouts, unless the author expressly grants permission.
SCHOLASTIC DISHONESTY

As commonly defined, plagiarism consists of passing off as one's own the ideas, work, writings, etc., that belong to another. In accordance with this definition, you are committing plagiarism if you copy the work of another person and turn it in as your own, even if you have the permission of that person. Plagiarism is one of the worst academic sins, for the plagiarist destroys the trust among colleagues without which research cannot be safely communicated. If you have questions regarding plagiarism, please consult the latest issue of the Texas A&M University Student Rules [http://student-rules.tamu.edu/], under the section "Scholastic Dishonesty."
Course Description
In this course you will learn modern computational methods for analyzing nuclear reactors and for solving other transport problems. We will focus most of our attention on methods for computing the neutron distribution (in position, energy, and direction) in reactors. You will learn by doing—you will write programs that employ some of the methods that we discuss.

By the end of the course you should be able to:
- **Describe** modern reactor-analysis methods (divide-and-conquer approach, numerical approximations for diffusion and transport equations, and iterative methods);
- **Describe** modern methods for more general particle-transport problems;
- **Analyze** discretization methods and iteration methods to predict and understand their performance;
- **Discuss** the approximations that are made in these methods, including a discussion of the conditions under which these approximations are accurate or inaccurate;
- **Compare** different numerical methods for diffusion and transport equations, including a discussion of strengths and weaknesses;
- **Write** computer codes that perform numerical transport and diffusion calculations;
- **Verify** that your codes perform as intended. This includes being able to convince a knowledgeable skeptic.

Details
Prerequisites: NUEN 430 or equivalent; NUEN 606 or equivalent; NUEN 625 or permission of instructor; MATH 609 or permission of instructor
Text: no required text
Instructor: Dr. Marvin L. Adams, Zachry 335N, 845-4198, mladams@tamu.edu
Schedule: ~5:10 – ~6:00 Mondays
3:55 – ~5:10 Tuesdays
~5:10 – ~6:00 Wednesdays
TBD to answer questions and make up missed classes
Grades: 40-60% problem sets
40-60% programs
Office hours: by appointment.

General info
I encourage you to discuss assignments with each other. Learn from each other, but don't copy from each other.

Assignments are due at the start of class on the due date. Penalties for late homework, unless you make other arrangements with me in advance, are:
- until 5:00 next working day: ~20% of points earned
- from then until last class: ~33% ”
- after last class: no credit
I usually answer email within 24 hours. This is the best way to ask me quick questions or schedule an appointment.

**Course Outline: Lectures (two per week)**

<table>
<thead>
<tr>
<th>Topic</th>
<th>Estimated number of class periods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overview / Organization</td>
<td>1</td>
</tr>
<tr>
<td>Divide and Conquer</td>
<td>2</td>
</tr>
<tr>
<td>Neutron Conservation</td>
<td>1</td>
</tr>
<tr>
<td>Transport Equation</td>
<td>1</td>
</tr>
<tr>
<td>Multigroup Equations</td>
<td>1</td>
</tr>
<tr>
<td>P1 Equations</td>
<td>1</td>
</tr>
<tr>
<td>Diffusion Equations</td>
<td>1</td>
</tr>
<tr>
<td>Transport Discretization &amp; Solution</td>
<td>TBD</td>
</tr>
<tr>
<td>Diffusion Discretization &amp; Solution</td>
<td>TBD</td>
</tr>
<tr>
<td>Iteration</td>
<td>2</td>
</tr>
<tr>
<td>Leakage Corrections</td>
<td>2</td>
</tr>
<tr>
<td>Transport Corrections</td>
<td>2</td>
</tr>
<tr>
<td>Summary</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>28</td>
</tr>
</tbody>
</table>

We will also have **one class period per week** devoted to problem-solving and programming.
Notices
(I take these seriously. You should too.)

Professional Behavior
An important attribute of your professional development is that you act and speak in a manner that will not offend others, giving particular care to diversity issues.

Scholastic Dishonesty and the Aggie Honor Code
AGGIE HONOR CODE: "An Aggie does not lie, cheat, or steal or tolerate those who do." The Code forbids the following:

- Cheating: Attempting to use unauthorized materials, information, notes, study aids or other devices or materials in any academic exercise.
- Fabrication: Making up data or results; submitting fabricated documents.
- Falsification: Manipulating results such that research is not accurately represented in the research record.
- Multiple Submission: Submitting substantial portions of the same work (including oral reports) for credit more than once without authorization from instructors.
- Plagiarism: Using another person's ideas, processes, results, or words without giving appropriate credit.
- Complicity: Intentionally or knowingly helping, or attempting to help, another to commit an act of academic dishonesty.

For more information see http://www.tamu.edu/aggiehonor/definitions.php.

Copyrights
The handouts used in this course are copyrighted. By "handouts" we mean all materials generated for this class, which include but are not limited to syllabi, course notes, book drafts, in-class materials, review sheets, and problem sets. You do not have the right to copy the handouts unless the author grants permission.

Americans with Disabilities Act
The Americans with Disabilities Act (ADA) is a federal antidiscrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact the Department of Student Life, Services for Students with Disabilities in Room 126 of the Koldus Building, or call 845-1637.

Religious Holidays
If you are a member of a religious faith that has one or more holidays which require you to be absent from any class listed above, please tell your instructor at least two weeks in advance of your absence and make arrangements to make up the class.
SYLLABUS

Course title and Number: “Monte Carlo Computational Particle Transport” NUEN 630

Term: Fall 2013
Meeting times and location: Mon, Wed 9:10am to 10:00am, 119B Zachry Engineering Center
                                      Fri 9:10am to 11:10am, 119B Zachry Engineering Center

Course Description and Prerequisites

Credits: NUEN 630 (2 hrs. lecture - 2 hrs. lab) “Monte Carlo Computational Particle Transport” Credit 3.

Description: Principles of Monte Carlo method; Statistical methods in Monte Carlo; Random number generation; Sampling methods for physical processes represented by Boltzmann transport equation; Particle tracking in combinatorial geometry; ACE format cross-sections; Introduction to MCNP code; MCNP applied to radiation shielding, criticality safety, reactor physics and detector modeling problems; MCNP output analysis; MCNP statistical tests; MCNP tallying procedures; Variance reduction techniques; Introduction to develop Monte Carlo algorithms.

Prerequisites: Approval of instructor, MCNP code single user license from RSICC, ORNL, USA.

Learning Outcomes or Course Objectives

NUEN 630 is a graduate level course, also open to NUEN undergraduate seniors. Particle (neutron/photon/electron…) transport simulations based on Monte Carlo principles should be an inevitable part of graduate curriculum, both for nuclear engineering and radiological health engineering degrees because they are widely used now in research and industry. Monte Carlo transport code helps to develop realistic models for analyzing problems in reactor physics, radiation shielding, medical physics, etc. There are state-of-art computer codes available vis-à-vis MCNP/MCNPX, KENO, EGS and GEANT to meet these challenges. These codes are now made more attractive to students with the provision of graphical interfaces, but are vulnerable to abuse, when used as black boxes.

The objective of this course is to educate on the underlying principles of Monte Carlo method, its statistical behavior, random number generation, variance reduction schemes, sampling methods to simulate physical process of the linear Boltzmann transport equation, combinatorial geometry modeling, forward/adjoint capabilities, interaction cross section formats, etc. Hands-on computer lab training will be provided on the use of MCNP code through model development and analyses of international benchmark exercises. In addition, a flavor to code Monte Carlo algorithms will be taught, so as to appreciate the basic ideas of MCNP code.

Successful completion of the course would provide the students in depth knowledge on the theory and principles of Monte Carlo transport simulations. This should facilitate them to independently handle transport simulations and analyses envisaged in reactor core physics, criticality safety, radiation shielding, radiation detector modeling, medical physics, etc., which are amenable by Monte Carlo methods. Also, students would have acquired insight to develop Monte Carlo algorithms and coding.
Instructor Information

Name: Dr. Sunil S. Chirayath  
Telephone Number: (979) 862-2616  
Email address: sunilsc@tamu.edu  
Office Hours: Monday 1:30pm to 3:30pm (appointment to meet on other days)  
Office Location: Room No. 336C, Zachry Engineering Center  
Texas A&M University, College Station  
TX-77843-3473, USA

Textbook and/or Resource Materials

1. Notes: Lecture notes on "Monte Carlo Computational Particle Transport, NUEN 630"

2. Textbooks:  
   - L.L. Carter and E.D. Cashwell, *Particle transport simulation with the Monte Carlo method*, ERDA critical review series, TID-26607, 1975

3. References:  

   http://mcnp-green.lanl.gov/index.html

Grading Policies

1. **Professional Behavior:** An important attribute of your professional development is that you act and speak in a manner that will not offend others giving particular care to diversity issues.

2. **Home Assignments:** Each assignment work will be prepared with an assignment number, student name, date of submission, course number on a cover sheet along with assignment description and your workout in the subsequent pages. Your assignment work should look neat and legible with a logical presentation. Handwritten or typed pages are acceptable. Group efforts are encourages in submitting the assignments with the listing of participating course-mates on the cover sheet. However, individual contributions should be made visible in the final submitted assignments. **No score will be assigned, if instructor observes copying of other’s assignment workouts.**
All assignments are due at the start of the class on the due date. No late assignments are accepted without creditable excuse/explanation for the delay. No assignments will be accepted after the last day of classes (See course schedule provided in this syllabus).

Late Submission (1 week to explain and ask for a new due date):

If a student cannot submit the assignment workout by the due date, he/she has 1 week after the due date to explain the reasons for no-submission and ask for a new due date. At the discretion of the instructor and based on the reasons explained for the delay, a new date may be assigned without grade penalty or denied. If denied, late assignment submissions will not be accepted. If the student fails to contact the instructor within 1 week after the due date, the delayed work will not be accepted. No exceptions. Re-submission of assignments with corrections indicated by the instructor can fetch you at the most 70% of the maximum score assigned to each of the assignments. And, only one re-submission is permitted.

3. Structure of final course score:

<table>
<thead>
<tr>
<th>Course Element</th>
<th>Element Score</th>
<th>Element Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class attendance and participations</td>
<td>5%</td>
<td>40%</td>
</tr>
<tr>
<td>Home assignments</td>
<td>35%</td>
<td></td>
</tr>
<tr>
<td>Midterm written examination</td>
<td>20%</td>
<td></td>
</tr>
<tr>
<td>Project</td>
<td>20%</td>
<td>60%</td>
</tr>
<tr>
<td>Final written examination</td>
<td>20%</td>
<td></td>
</tr>
<tr>
<td><strong>Total final score</strong></td>
<td></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

4. Final course grade ranges:

<table>
<thead>
<tr>
<th>Final Course Score</th>
<th>Final Course Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>90% and above</td>
<td>A</td>
</tr>
<tr>
<td>80% to &lt; 90%</td>
<td>B</td>
</tr>
<tr>
<td>70% to &lt; 80%</td>
<td>C</td>
</tr>
<tr>
<td>60% to &lt; 70%</td>
<td>D</td>
</tr>
</tbody>
</table>

Course Topics, Calendar of Activities, Major Assignment Dates
(Dates and topics are subject to change, but will be informed in advance)

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
<th>Lecture - Date</th>
<th>Task</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/15</td>
<td><strong>1. Principles of Monte Carlo method</strong></td>
<td>1/41 – 08/26/13 (M)</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>• Course overview</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Particle transport &amp; random walk</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Random number generator</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Law of large numbers</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Central limit theorem</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Means, variances, standard deviation</td>
<td>2/41 – 08/28/13 (W)</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>• Walk to Gaussian distribution</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Confidence intervals</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Precision and accuracy</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Linear Boltzmann transport equation</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3/41 – 08/30/13 (F)</td>
<td>Computer Lab &amp; Assignment #1</td>
<td></td>
</tr>
<tr>
<td>2/15</td>
<td>2. Physical processes sampling methods</td>
<td>4/41 – 09/02/13 (M)</td>
<td></td>
</tr>
<tr>
<td>------</td>
<td>--------------------------------------</td>
<td>---------------------</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Monte Carlo transport simulation, a process of integration</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Metropolis</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Table lookup</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Rejection method</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Importance Sampling</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Path length selection</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Direction cosines</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Neutron elastic scattering</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Compton scattering</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Fission spectrum energy sampling</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Collision nuclide selection</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Next reaction selection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3/15</td>
<td>3. Particle tracking in 3D combinatorial geometry</td>
<td>7/41 – 09/09/13 (M)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• General quadratic equation</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Surface equations</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Macro bodies (RPP, RCC, ARB, )</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Geometry cell (INTERSECTION, UNION and NOT operation)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Particle tracking method</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4/15</td>
<td>4. Monte Carlo Vs. Deterministic</td>
<td>10/41 – 09/16/13 (M)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Point CXS</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Angular binning</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• 3D geometry</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Error estimate</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5. Introduction to MCNP</td>
<td>11/41 – 09/18/13 (W)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• MCNP installation</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• ACE CXS formats</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Reaction IDs</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Materials IDs</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• CXS IDs</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Input structure</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Input verification: geometry plot &amp; details from output</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Output structure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5/15</td>
<td>6. MCNP Source Descriptions (SDEF)</td>
<td>13/41 – 09/23/13 (M)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Running mode: n, p, e or coupled</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Point, Surface, Volume source</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Criticality source (KCODE)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Source distributions and biasing through SI, SP and SB cards</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Multiple &amp; dependent sources</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6/15</td>
<td></td>
<td>Computer Lab Assignment #2</td>
</tr>
<tr>
<td></td>
<td>7/15</td>
<td></td>
<td>Computer Lab Assignment #3</td>
</tr>
<tr>
<td></td>
<td>8/15</td>
<td></td>
<td>Computer Lab Assignment #4</td>
</tr>
<tr>
<td></td>
<td>9/15</td>
<td></td>
<td>Computer Lab Assignment #5</td>
</tr>
<tr>
<td>6/15</td>
<td>7. MCNP Tallies (F cards)</td>
<td>16/41 – 09/30/13 (M)</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Surface current, F1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Surface flux, F2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Cell Flux, F4</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Point Flux (deterministic tally), F5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Pulse height tallies, F8</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Special tallies, F6 &amp; F7</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Criticality source tally</td>
<td>17/41 – 10/02/13 (W)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tallying in energy bins</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Tally units</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Tally multipliers</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Foil reaction rates, Dose rates, etc.,</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Tally special treatments</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>18/41 – 10/04/13 (F)</td>
<td>Computer Lab Assignment #6</td>
<td></td>
</tr>
<tr>
<td>7/15</td>
<td>8. MCNP Statistical Tests on Tallies</td>
<td>19/41 – 10/07/13 (M)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Mean (1 test)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Variance (relative error – 3 tests)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Variance of variance (3 tests)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Slope (Pareto fit – 1 test)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Figure of merit (2 tests)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>20/41 – 10/09/13 (W)</td>
<td>Mid-term Exam Review</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10/11/13 (F) Mid-term Exam</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8/15</td>
<td>9. Variance Reduction Methods</td>
<td>21/41 – 10/14/13 (M)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Particle attributes: position coordinates (x, y, z), direction cosines (u, v, w), energy (E) and Monte Carlo specialty, weight (w)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Importance sampling</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Splitting &amp; Russian roulette</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Exponential transform</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Energy splitting</td>
<td>22/41 – 10/16/13 (W)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Trimming to problem domain</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Biasing for population control</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Source transforms</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• BBREM, bremsstrahlung option</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Run Splitting</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>23/41 – 10/18/13 (F)</td>
<td>Computer Lab Assignment #7</td>
<td></td>
</tr>
<tr>
<td>9/15</td>
<td>10. Multi-group CXS option in MCNP</td>
<td>24/41 – 10/21/13 (M)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Forward computations</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Adjoint option</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Reactor benchmarks</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Lattices and Universes</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Fuel pin level sources and tallying</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Bulk shielding benchmarks</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Radiation streaming model</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>26/41 – 10/25/13 (F)</td>
<td>Computer Lab Assignment #8</td>
<td></td>
</tr>
<tr>
<td>Date</td>
<td>Activity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------</td>
<td>----------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10/15</td>
<td>Detector response model: HPGe, NaI gamma spectrometry with Gaussian broadening feature 27/41 – 10/28/13 (M)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Neutron coincidence counting using MCNPX and MCNP-POLIMI 28/41 – 10/30/13 (W)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>29/41 – 11/01/13 (F) Computer Lab Assignment #9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11/15</td>
<td>Medical LINAC Beam Characterization 30/41 – 11/04/13 (M)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Brachy Therapy Modeling 31/41 – 11/06/13 (W)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>32/41 – 11/08/13 (F) Computer Lab Assignment #10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12/15</td>
<td>12. MCNP &amp; other codes 33/41 – 11/11/13 (M)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ORIGEN/MONTEBURNS coupler</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>MCNPX and BURN card 34/41 – 11/13/13 (W)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>35/41 – 11/15/13 (F) Computer Lab Assignment #11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13/15</td>
<td>PROJECT 36/41 – 11/18/13 (M)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PROJECT 37/41 – 11/20/13 (W)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PROJECT 38/41 – 11/22/13 (F)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14/15</td>
<td>PROJECT 39/41 – 11/25/13 (M)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PROJECT 40/41 – 11/27/13 (W)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Thanks Giving Holiday</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15/15</td>
<td>Final Exam Review 41/41 – 12/02/13 (M)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Final written examination  
Monday - December 09, 2013
Other Pertinent Course Information

Desirable Background Knowledge:

- Basics of nuclear physics
- Basics of coordinate geometry
- Knowledge in any scientific computer programming

Course Structure:

The academic elements of the course along with their purpose and content are listed below:

1. **Lecture and lecture notes:**
   Lectures and stand alone lecture notes provided will suffice to cover the theoretical portion of the course.

2. **Computer lab:**
   Hands on training on the use of MCNP code through simulations of the benchmark exercises is vital and will provide a better understanding of Monte Carlo principles and applications.

3. **Home assignments:**
   Out of class assignments will be given and graded weekly. Note the Course Policy, Assignment Submission Guidelines and Grading Policy defined later in this syllabus.

4. **One to one performance assessment:**
   Instructor will individually meet with each student to assess their performance in meeting the course requirements. In these meetings students will get an opportunity to discuss their progress with instructor, share concerns and suggestions about the course. A detailed performance report and instructor feedbacks will be made available to each student. It is mandatory to attend the performance assessment meeting.

5. **Midterm examinations:**
   In the midst of the semester, students will undergo one written examination. The examinations will be closed book, closed notes and with no calculators. The examinations will be conducted based on the course material, homework assignments and lab exercises completed till the end of first term of the semester. See the midterm examination schedule embedded in course timetable.

6. **Final written examination:**
   The mandatory final written examination (closed book, closed notes and no calculators) will be based on the entire course materials, homework assignments and lab exercises.

Copyrights: The handouts used in this course are copyrighted. By “handouts” we mean all materials generated for this class, which include but are not limited to syllabi, lab problems, in-class materials, review sheets, and additional problem sets. Because these materials are copyrighted, you do not have the right to copy the handouts, unless the author expressly grants permission.

Americans with Disabilities Act (ADA)

The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact Disability Services, in Cain Hall, Room B118, or call 845-1637. For additional information visit [http://disability.tamu.edu](http://disability.tamu.edu)

Academic Integrity

For additional information please visit: [http://www.tamu.edu/aggiehonor](http://www.tamu.edu/aggiehonor)

“An Aggie does not lie, cheat, or steal, or tolerate those who do.”
Spring 2014

NUEN 633: Radiation Measurements and Calibrations.
Instructor: Gamal Akabani Email: akabani@tamu.edu
Office: 337L Zachry Engineering Center
Phones: 458-1699 (O), 676-0695 (M)
Office Hours: by appointment via email

Catalog title and description:
Radiation metrology is the science of measurement. Radiation metrology includes all theoretical and practical aspects of radiation measurement. This course provides a careful study of radiation metrology and a study of the behavior of various radiation detectors systems, radiation dosimetry protocols, standards, and guidelines, with an emphasis in their theoretical design and calibration. The specific objectives of this course are the following:

- You should be able to understand the basic concepts on general metrology with an emphasis in radiation metrology.
- You should be able to assess the physical principles utilized in a detector system, carry out an analysis of the system’s parts and its set up, and calibration.
- You should be able to assess the limitations of a radiation detection system based on basic principles of radiation interactions with matter, physical and available radiation detection techniques, and the characteristics of various nuclear radiation detectors to design an appropriate system;
- You should be able to build and calibrate a detection system based on your own design to provide observation of radiation interaction phenomena;
- You should be able to perform required statistical analysis of results derived from a detection system and assess its statistical value;
- You will develop communication skills, particularly technical writing.
- You will enhance your research and computer skills by learning how to program FORTRAN 95, C++, the statistical package R, or any other high level programming language.

Objectives:
The main objective of this course is for you to learn the trade of radiation detection, calibrations and measurements. This is a theoretical course where you will get acquainted with radiation measuring instrumentation and to gain knowledge in this sensing field, calibration and system limitations. You will be able to assert the use of different radiation detection systems and their characteristics, benefits, limitations, and differences.

You should collaborate and relate with your peers in order to share your knowledge and improve your communication and writing skills. This course is not intended to be a set of mechanical procedures/experiments but rather a dynamic laboratory where you get to read and decide how a radiation detection system should be used.
and be implemented for a specific problem. There is a process for learning that is built in:

- Read and ask questions, execute your experiments,
- Read more and work with your team; ask more questions among yourselves,
- Read and work additional problems at home on your own and in class,
- Participate and develop a final laboratory project

**Grading policy:**

There will be homework, a midterm and final take home exams; you are encouraged to work as teams to answer all questions and tests. Class participation during lectures is considered as part of your grade. Therefore, you need to be an active participant.

<table>
<thead>
<tr>
<th></th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homework</td>
<td>30%</td>
</tr>
<tr>
<td>Midterm</td>
<td>20%</td>
</tr>
<tr>
<td>Final exam</td>
<td>20%</td>
</tr>
<tr>
<td>Final project</td>
<td>30%</td>
</tr>
</tbody>
</table>

**Final report structure:**

This is a research and writing intensive course and your final report should contain the following sections:

1. Abstract or summary
2. Objectives and hypothesis (if any) or paradigm
3. Background and significance
4. Current, materials and methods (procedures associated with the paradigm)
5. Results associated with your paradigm or example of results
6. Discussion of your paradigm in the present status
7. Conclusions
8. References

Be as creative as possible and provide the reader a clear view of what you are trying to accomplish. Do not be mechanical in your final report, as a professional you need to elaborate good outstanding reports that give a good idea of your thinking process. Make it fun to read and impress the reader with a good vocabulary, style and references. It is understood that you know how to carry out a literature search.

Your report must be in PDF format. Please use wisely your time in order to provide you with constructive feedback. I recommend that you use references in your final report in order to be professional. I use ENDNOTE embedded in MSWord to introduce my references in my documents. A good report will be considered outstanding if it contains good and pertinent references that make the reader aware of the quality of your report. The software ENDNOTE is free through the university system
Please contact me if you have any issues with ENDNOTE.

Remember that the description of your data must be such that errors and uncertainties must be described in your final report, to simply state the number of counts is insufficient. Moreover, you are carrying the analysis of experimental measurements that require to be described in terms of accuracy and/or precision, statistical precision to be concise. Thus, a good final report requires reporting data and corresponding associated uncertainties to be properly evaluated.

I am assuming that every student knows basic nuclear processes and basic principles of radiation interaction with matter, as well as basic radiation dosimetry. You should get acquainted with these concepts before or as you go along in class. Do not hesitate to ask questions or contacting Robert on these matters.

Schedule:


2. Introduction to the National Metrological Laboratories
   b. National Institute for Standards and Technology, NIST.
   c. National Physical Laboratories, NPL.
   d. The International Commission on Radiation Units and Measurements, ICRU.


4. General Sensor (detector) characteristics, calibration of general sensors, radiation sensors and transducers.

5. Calibration and uncertainty of gas-filled detectors. The NIST reference system for absorbed dose to water calibration for ionization chambers in a $^{60}$Co gamma ray beam.

6. Calibration and uncertainty of scintillation detectors.

8. Calibration and uncertainty of neutron sources based on ISO standards ISO+8529 parts 1, 2 and 3.

9. Calibration of OSL and Thermoluminescence detectors.

10. Calibration and measurement in chemical dosimetry detectors.


13. Final project group discussion (groups of two).

Reference Texts:

English for Biomedical Scientists
by Ramón Ribes, Palma Iannarelli, and Rafael F. Duarte Publisher: Springer; 1st edition (Sep 1, 2009)
ISBN: 978-3-540-77126-5
e-ISBN: 978-3-540-77127-2

Introductory Statistics with R (Statistics and Computing)
by Peter Dalgaard
Publisher: Springer; 2nd edition (August 15, 2008)
ISBN-10: 0387790535

A Beginner's Guide to R (Use R)
by Alain F. Zuur, Elena N. Ieno, and Erik H.W.G. Meesters Publisher: Springer; 1 edition (July 1, 2009)
ISBN-10: 0387938362

Introduction to Programming with Fortran: with coverage of Fortran 90, 95, 2003 and 77
by Ian Chivers and Jane Sleightholme
Publisher: Springer; 1 edition (December 31, 2008)
ISBN-10: 1846280532

Developing Statistical Software in Fortran 95 (Statistics and Computing)
by David R. Lemmon and Joseph L. Schafer
Introduction to Radiological Physics and Radiation Dosimetry
by Frank Herbert Attix
Publisher: Wiley-Interscience; 1 edition (September 1986)
ISBN-10: 0471011460

Radiation Detectors for Medical Applications (NATO Science for Peace and Security Series B: Physics and Biophysics)
by Stefaan Tavernier, Alexander Gektin, Boris Grinyov, and William W. Moses
Publisher: Springer; 1 edition (June 13, 2008)
ISBN-10: 1402050925

Practical Gamma Ray Spectrometry
by Gordon Gilmore
Publisher: Wiley; 2 edition (June 10, 2008)
Language: English
ISBN-10: 0470861967

Radiation Detection and Measurement
by Glenn F. Knoll
Publisher: Wiley; 3 edition (January 5, 2000)
ISBN-10: 0471073385

Techniques for Nuclear and Particle Physics Experiments: A How-to Approach
by William R. Leo
Publisher: Springer; 2nd edition (February 22, 2009)
ISBN-10: 3540572805

Handbook of Modern Sensors: Physics, Designs, and Applications
by Jacob Fraden
Publisher: Springer; 3rd edition (December 4, 2003)
ISBN-10: 0387007504

Handbook of X-Ray Data
by G. Zschornack
Publisher: Springer; 1 edition (March 12, 2007)
ISBN-10: 3540286187

Inorganic Scintillators for Detector Systems: Physical Principles and Crystal Engineering (Particle Acceleration and Detection)
by Paul Lecoq, Alexander Annenkov, Alexander Gektin, and Mikhail Korzhik
Publisher: Springer; 1 edition (Hardcover - April 11, 2006)
ISBN-10: 3540277668

Pixel Detectors: From Fundamentals to Applications (Particle Acceleration and Detection)
by Leonardo Rossi, Peter Fischer, Tilman Rohe, and Norbert Wermes
Publisher: Springer; 1 edition (Mar 8, 2006)
SBN-10: 3540283323

Americans with Disabilities Act
The Americans with Disabilities Act (ADA) is a federal antidiscrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact the Department of Student Life, Services for Students with Disabilities in Room 126 of the Koldus Building, or call 845-1637.

Copyrights
The handouts used in this course are copyrighted. By "handouts" we mean all materials generated for this class, which include but are not limited to syllabi, lab problems, in-class materials, review sheets, and additional problem sets. Because these materials are copyrighted, you do not have the right to copy the handouts, unless the author expressly grants permission.

PLEASE NOTE:
1. AGGIE HONOR CODE: “An Aggie does not lie, cheat, or steal or tolerate those who do.” For additional information please visit: www.tamu.edu/aggiehonor/
2. PROFESSIONAL BEHAVIOR: An important attribute of your professional development is that you act and speak in a manner that will not offend others giving particular care to diversity issues.
3. DISABILITY ACCOMMODATION: If you believe you have a disability requiring an accommodation, please tell your instructor or contact the Department of Student Life, Services for Students with Disabilities, in Cain Hall or call 845-1637.
4. RELIGIOUS HOLIDAYS: If you are a member of a religious faith that has one or more holidays which require you to be absent from any class listed above,
please tell your instructor at least two weeks in advance of your absence and make arrangements to make-up the class.

Scholastic Dishonesty and the Aggie Honor Code

AGGIE HONOR CODE: "An Aggie does not lie, cheat, or steal or tolerate those who do." The Code forbids the following:

• Cheating: Attempting to use unauthorized materials, information, notes, study aids or other devices or materials in any academic exercise.
• Fabrication: Making up data or results; submitting fabricated documents.
• Falsification: Manipulating results such that research is not accurately represented in the research record.
• Multiple Submissions: Submitting substantial portions of the same work (including oral reports) for credit more than once without authorization from instructors.
• Plagiarism: Using another person’s ideas, processes, results, or words without giving appropriate credit.
• Complicity: Intentionally or knowingly helping, or attempting to help, another to commit an act of academic dishonesty.

For additional information see http://www.tamu.edu/aggiehonor/definitions.php/
Nutrition, Nuclear Engineering, Kinesiology 646  
(NUTR/NUEN/KINE 646, Section 600)  
Fundamentals of Space Life Sciences  
Course Syllabus, Fall, 2014

Instructor: Nancy D. Turner, Ph.D.  214C Cater-Mattil, 847-8714  
n-turner@tamu.edu

Time/Location: Monday/Wednesday, 8:00 – 9:15, Rm. 109 AGLS

Textbook: All materials will be from original journal articles, 
supplemented with references to text books as appropriate.  
All reading materials will be posted on the web and 
students are required to access these materials through the 
Texas A&M web based system.  Class readings are to be 
completed prior to the listed presentation date.

Course Description: This course is designed to integrate nutrition, biochemistry, 
physiology and radiation biology to define the major 
biological problems encountered in long duration space 
flight. It will provide an overview of each of these 
problems with potential countermeasures against the 
problems. Countermeasure development will focus 
primarily on nutrition and exercise protocols to counter 
problems of bone loss, muscle wasting, and radiation-
enhanced carcinogenesis. Experts in each of these areas 
will provide students with a good understanding of the 
major biological problems facing long duration space 
flight, and their countermeasures.

Prerequisites: An undergraduate degree in Nutrition, Kinesiology or 
Health Physics or similar qualifications. Contact instructor 
for further guidance in this area.

Course Objectives: With successful completion of the course, you will have 
achieved:
1. An understanding of the major life science problems encountered during long duration 
   space flight.
2. An understanding of the primary agencies involved in long duration space flight 
   (NASA, NSBRI, ESA), and the types of research models used to assess the severity of 
   physiological changes occurring during long duration space flight.
3. An understanding of countermeasures against the critical problems of long duration 
   space flight, an appreciation of how countermeasures may influence responses in non-
   target tissues, and a perspective of countermeasure success.
Evaluation: Exams - 3 (100 points each) 300 points
Oral presentation on a problem of long duration space flight and a proposed countermeasure (your topic must be outside of your own graduate degree program) 150 points
Paper describing the topic of oral presentation 150 points
TOTAL 600 points

Grading Scale: 90-100% A 70-79 C
80-89 B 60-69 D
59% and below F

Make-up Policy: Make-up examinations will be given only for university authorized absences. It is the student's responsibility to arrange a date and time with the instructor. If possible, students should make arrangements prior to the scheduled examination time.

The oral presentation will be given during the last two weeks of regular classes. Papers will be due November 24. The papers need to be 10-12 double spaced pages (1 inch margins and 12 point font) and the information presented should be supported by results from original research articles (n > 15) and review articles (no more than 5).

Americans with Disabilities Act (ADA) Policy Statement: The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact Disability Services, in Cain Hall, Room B118, or call 845-1637. For additional information, visit http://disability.tamu.edu.

Academic Integrity Statement: All syllabi shall contain a section that states the Aggie Honor Code and refers the student to the Honor Council Rules and Procedures on the web (http://aggiehonor.tamu.edu/RulesAndProcedures/HonorSystemRules.aspx). All students should make themselves aware of correct citation techniques by reviewing the Academic Integrity Tutorials available on the library web site (http://library.tamu.edu/help/help-yourself/using-materials-services/online-tutorials/academic-integrity/index.html).

Aggie Honor Code: “An Aggie does not lie, cheat, or steal or tolerate those who do.”
LECTURE SCHEDULE

**Week 1**
9/1 Introduction to the course, content and methods of evaluation. The role of NASA and NSBRI in space life sciences. (Turner)
9/3 **Space physiology.** The space environment and how it differs from earth. Major research methods and techniques to study space-related problems and their countermeasures. (Bloomfield)

**Week 2**
9/8 Bone loss and risk of fracture and renal stones I (Bloomfield)
9/10 Bone loss and risk of fracture and renal stones II (Bloomfield)

**Week 3**
9/15 Cardiovascular deconditioning I (Woodman)
9/17 Cardiovascular deconditioning II (Woodman)

**Week 4**
9/22 Skeletal muscle adaptations to microgravity I (Fluckey)
9/24 Skeletal muscle adaptations to microgravity II (Fluckey)

**Week 5**
9/29 **Exam: Space physiology**
10/1 **Space Radiation:** Radiation and radiation production (Braby)

**Week 6**
10/6 Radiations in Space, solar cycle and regions of space (Braby)
10/8 Radiation detection and measurement (Braby)

**Week 7**
10/13 Interactions between spacecraft and radiation environment (Braby)
10/15 Consequences of shielding and review (Braby)

**Week 8**
10/20 Radiation chemistry and DNA damage and repair (Ford)
10/22 Biological effects of high and low LET radiation, synergistic effects of microgravity/ altered gravity and radiation (Ford)

**Week 9**
10/27 Biological effects of space radiation observed in astronauts, radiation protection and regulations for space flight (Ford)
10/29 Biomedical countermeasures to radiation exposure (Ford)

**Week 10**
11/3 **Exam: Space Radiation**
11/5 **Space Nutrition:** Antioxidants and other vitamin roles in space (Walzem)
<table>
<thead>
<tr>
<th>Week 11</th>
<th>Date</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>11/10</td>
<td></td>
<td>Mineral requirements, balance studies and other measures of turnover, e.g. Calcium (Scott Smith recording)</td>
</tr>
<tr>
<td>11/12</td>
<td></td>
<td>Space flight and ground based research in nutrition and review of space food, intake patterns (Turner)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Week 12</th>
<th>Date</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>11/17</td>
<td></td>
<td>Depressed food intake and its consequences (Turner)</td>
</tr>
<tr>
<td>11/19</td>
<td></td>
<td>Protein and amino acid turnover - relationship to loss of muscle mass (Wu)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Week 13</th>
<th>Date</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>11/24</td>
<td></td>
<td>Radiation-induced colon carcinogenesis – dietary mitigation (Turner)</td>
</tr>
<tr>
<td>11/26</td>
<td></td>
<td>Diet and the intestinal microbiome (Turner)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Week 14</th>
<th>Date</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>12/1</td>
<td></td>
<td><strong>EXAM: Space Nutrition</strong></td>
</tr>
<tr>
<td>12/3</td>
<td></td>
<td>Student presentations</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Week 15</th>
<th>Date</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>12/8</td>
<td></td>
<td>Student presentations-redefined Friday</td>
</tr>
<tr>
<td>12/10</td>
<td></td>
<td>Reading day, no classes (or possible presentations if class wants)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Week 16</th>
<th>Date</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>12/16</td>
<td></td>
<td><strong>Final Exam time 3:30-5:30</strong> – Used for Student presentations, class evaluation</td>
</tr>
</tbody>
</table>
NUEN 650 Nuclear Nonproliferation and Arms Control  
Fall 2014  
TR 11:10-12:25

Course Description

This course will study the political and technological issues associated with nuclear nonproliferation and arms control. Topics studied will include the history of arms control, descriptions and effects of weapons of mass destruction, introduction to the technology of nuclear weapons, details of various arms control treaties and efforts, proliferation pathways in the nuclear fuel cycle, international and domestic safeguards, proliferation resistance in the nuclear fuel cycle, nonproliferation strategies, treaty verification regimes, nuclear terrorism, verifying the elimination of weapons programs, safeguards measurement techniques for material accountancy programs, containment and surveillance, and physical protection mechanisms. Lecture material will be supplemented by homework assignments that will require analytical and computer-based calculations to reinforce material understanding.

Course Learning Objectives

The primary goal of this course is to educate the student in the political, historical, and technical issues associated with battling the proliferation of nuclear weapons. The student will gain expertise in the following topic areas:

1. History of nuclear weapons development
2. Technologies used by the proliferator
3. Known and suspected weapons programs around the world
4. Arms control treaties and treaty verification
5. Technologies and techniques for securing nuclear materials
6. Technologies for monitoring for proliferation activities and verifying the elimination of weapons programs
7. Proliferation within the commercial nuclear fuel cycle
8. Nuclear terrorism

After completing this course, the student should be able to:

1. Describe the history of nuclear weapons including a description of the weapons programs of the U.S., U.K., U.S.S.R., China, France, India, Pakistan, South Africa, Iran, Iraq, North Korea, Libya, and Israel.
2. List and describe the skills, capabilities, and materials needed by a proliferator to produce a nuclear weapon.
3. Calculate HEU and Pu production quantities for various nuclear facilities.
4. Identify proliferation risks in a nuclear fuel cycle or in a collection of facilities within a country.
5. Determine methods for safeguarding nuclear material at declared facilities and describe the technology used to measure bulk nuclear materials.
6. Describe methods for identifying covert nuclear activities and how they can be applied to treaty verification.
7. Understand the need for future developments in nonproliferation policy and technology.
8. Assess the interaction between technology and policy in the nonproliferation arena.
Instructor Information

Name: William S. Charlton, Ph.D.
Title: Associate Professor, Nuclear Engineering Department
Director, Nuclear Security Science & Policy Institute
Telephone Number: (979) 845-7092
Email address: wcharlton@tamu.edu
Office Hours: T 14:00-16:00 or by appointment
Office Location: Zachry Engineering Center Room 336E or via TTVN webmeeting

You are welcome to contact me anytime, but my office hour times are rather limited. Thus, it is suggested that you use email as the primary means of contact for the instructor. This will provide for a record of the communication and allow for scheduling of a more specific time to meet for discussing any issues you have in class. If you need to schedule an appointment with the instructor, please call my assistant (Gayle Rodgers) at 979-845-7092.

Class Time and Location

This course will be taught as a web-based course. A physical room location will not be used for the course except on special occasions. Lectures will be delivered twice per week on TR from 11:10-12:25. All lectures will be given using synchronous webconferencing via the TAMU TTVN WebMeeting system. This system will allow you to see the slides being presented, hear the lecturer, ask questions via text or voice chat, and interact with the other students. The webconferencing system works best if the students connect to it using a webcam. Students are required to have available a webcam and microphone for discussions during lecture times. If the students are unfamiliar with how to use the TTVN WebMeeting system, instruction will be provided.

To access the lecture delivery, go to http://ttvnwebmeeting.tamu.edu/, click on the link on the upper left hand side of the page for “Login to TTVN WebMeeting”, and then enter the following information:

Event ID: SPD566702
Event Password: NSSPI650

Textbook and/or Resource Materials

The principle source of information for this course is a set of electronic notes which will be provided to the student in MS PowerPoint form. The following texts are required as a supplement for these notes:


The following texts are not required; however, the student may find them to be valuable resources for additional information:


Various additional resources will be provided in electronic format to the student and will be used for the class readings.

---

1 An electronic copy of “The Los Alamos Primer” (a Los Alamos Unclassified Report) will be provided to the student; however, the hardcover text referred to here includes a series of annotations and notes by Richard Rhodes which provide excellent insight into the book’s material. These notes are not available in the electronic version.
Grading Policies

Students will be graded on homework, simulation exercises, online quizzes from NSEP modules, and a mid-term exam. The student’s final grade will be determined according to the following percentages:

- 35% - Homework
- 15% - Pre-Simulation Exercise Material
- 15% - Simulation Exercise Participation
- 25% - Mid-Term Exam
- 10% - Online Quizzes from NSEP Module

The grades will be determined on the following scale:

- A - 90.00-100.00
- B - 80.00-89.99
- C - 70.00-79.99
- D - 60.00-69.99
- F - 0.00-59.99

Homework will be assigned throughout the semester (normally you will be assigned one homework set every three week). Late homework will be deducted 10% per day after the due date.

A simulation exercise will be held at the end of the semester. Prior to the exercise the students will submit pre-simulation materials in small groups. We will meet twice during class time to conduct the exercise. The dates for these meetings are shown in the schedule at the end of this syllabus. The student will be graded on both the pre-simulation materials and their performance in the exercise.

A mid-term exam will be conducted on or about the date specified in the schedule below. This exam will be closed book and closed notes. The exam will be conducted electronically using the eCampus system.

Students will complete NSEP modules according to the schedule listed below. These modules include online quizzes. The students should complete the quizzes and have the scores for the quizzes sent to the instructor.

Other Pertinent Course Information

All of the material for this course will be maintained on the University's eCampus course management system. This includes an electronic copy of this syllabus, the course schedule, all lecture notes, supplemental readings, and homework assignments. The instructor will use the eCampus email system and discussion board to communicate important messages to the students. Students should check their email often to keep updated on current messages. Also, the student’s grades will be posted on the eCampus system, and the students can use this system to check their grades at any time. The eCampus system can be accessed through http://ecampus.tamu.edu. If you are unfamiliar with this system, instruction will be provided.

Students will also make occasional use of electronic resources available on the Nuclear Safeguards Educational Portal (http://nsspi.tamu.edu/NSEP) maintained by the Nuclear Security Science & Policy Institute at TAMU. The instructor will direct you to this resource when necessary.

Americans with Disabilities Act (ADA)

The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact Disability Services, in Cain Hall, Room B118, or call 845-1637. For additional information visit http://disability.tamu.edu
Religious Holidays

If you are a member of a religious faith that has one or more holidays which require you to be absent from any class listed above, please tell your instructor at least two weeks in advance of your absence and make arrangements to make-up the class.

University Writing Center

The University Writing Center (UWC), located in Evans Library 1.214 (second floor), offers help to writers at any stage of the writing process including brainstorming, researching, drafting, documenting, revising, and more; no writing concern is too big or too small. These sessions are highly recommended but are not required and will not directly affect your final grade. While the UWC consultants will not proofread or edit your papers, they will help you improve your own proofreading and editing skills. If you visit the UWC, take a copy of your writing assignment. To find out more about UWC services or to schedule an appointment, call 458-1455, browse the web page at http://writingcenter.tamu.edu, or stop by the center.

Academic Integrity

All students at Texas A&M University are bound by the Aggie Honor Code:

“An Aggie does not lie, cheat or steal, or tolerate those who do.”

For more information, the student is referred to the Honor Council Rules and Procedures on the web at http://www.tamu.edu/aggiehonor.

As commonly defined, plagiarism consists of passing off as one’s own the ideas, work, writings, etc., that belong to another. In accordance with this definition, you are committing plagiarism if you copy the work of another person and turn it in as your own, even if you have the permission of that person. Plagiarism is one of the worst academic sins, for the plagiarist destroys the trust among colleagues without which research cannot be safely communicated. If you have questions regarding plagiarism, please consult the latest issue of the Texas A&M University Student Rules [http://student-rules.tamu.edu/], under the section “Scholastic Dishonesty.”
<table>
<thead>
<tr>
<th>Module</th>
<th>Session</th>
<th>Date</th>
<th>Lecture</th>
<th>Readings</th>
<th>Assignments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overview</td>
<td>1</td>
<td>2-Sep</td>
<td>Introduction and Overview</td>
<td>Doyle (Chapter 1) Mozley (Chapter 1)</td>
<td></td>
</tr>
<tr>
<td>History of Nuclear Weapons Development and the Technology of Proliferation</td>
<td>2</td>
<td>4-Sep</td>
<td>Scientific Revolution Prior to WWII and the Development of Uranium Enrichment</td>
<td>Mozley (Chapters 2 and 4)</td>
<td>NSEP Basic Nuclear &amp; Atomic Physics Module</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>9-Sep</td>
<td>Foundations of the Manhattan Project and Pu Production</td>
<td>Mozley (Chapter 3)</td>
<td>NSEP Nuclear Fuel Cycle Module</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>11-Sep</td>
<td>The Manhattan Project</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>16-Sep</td>
<td>To the End of WWII</td>
<td>Mozley (Chapter 5)</td>
<td>Homework #1 Due</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>18-Sep</td>
<td>The Cold War (US and USSR)</td>
<td>Mozley (Chapter 6)</td>
<td>Watch &quot;MCNP Criticality Simulations&quot; Video</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>23-Sep</td>
<td>The Breakup of the Soviet Union</td>
<td></td>
<td>Homework #2 Due</td>
</tr>
<tr>
<td>Known and Suspected Nuclear Weapons Programs</td>
<td>8</td>
<td>25-Sep</td>
<td>India and Israel</td>
<td>Mozley (Chapter 7)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>30-Sep</td>
<td>Argentina and Brazil, South Africa</td>
<td>Doyle (Chapters 16-17)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>2-Oct</td>
<td>Pakistan and the North Korea</td>
<td>Doyle (Chapter 30)</td>
<td>Watch &quot;Material Production Calculations with ORIGEN&quot; Video</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>7-Oct</td>
<td>Iran</td>
<td></td>
<td>Homework #3 Due</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>9-Oct</td>
<td>Iraq, Libya, and Syria</td>
<td>Doyle (Chapter 18)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>14-Oct</td>
<td>Proliferation Determinants and Motivations</td>
<td></td>
<td>Homework #4 Due</td>
</tr>
<tr>
<td>International and Regional Treaties and Agreements, International Safeguards</td>
<td>14</td>
<td>16-Oct</td>
<td>Treaties and Agreements</td>
<td>Doyle (Chapter 2)</td>
<td>Watch International Relations Primer</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>21-Oct</td>
<td>Nuclear Safeguards and the Security of Nuclear Material</td>
<td>Doyle (Chapter 3)</td>
<td>NSEP Basic Radiation Detection Module</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>23-Oct</td>
<td>Nuclear Safeguards Instrumentation</td>
<td>Doyle (Chapter 4)</td>
<td>NSEP Containment and Surveillance Module</td>
</tr>
<tr>
<td></td>
<td>17</td>
<td>28-Oct</td>
<td>Containment and Surveillance and Physical Protection</td>
<td>Doyle (Chapters 5 and 6)</td>
<td>NSEP Physical Protection Systems Module</td>
</tr>
<tr>
<td>Module</td>
<td>Session</td>
<td>Date</td>
<td>Lecture</td>
<td>Readings</td>
<td>Assignments</td>
</tr>
<tr>
<td>-------------------------------------------------</td>
<td>---------</td>
<td>---------</td>
<td>-----------------------------------------------------------</td>
<td>--------------------------------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td>18 Proliferation Resistance for Commercial Fuel Cycles</td>
<td>30-Oct</td>
<td>Doyle (Chapters 7-9)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19 Mid-Term Exam</td>
<td>4-Nov</td>
<td>Mid-Term Exam</td>
<td>Doyle (Chapter 9)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Detecting Undeclared Nuclear Activities and Verifying the Elimination of Nuclear Weapons Programs</td>
<td>6-Nov</td>
<td>IAEA Additional Protocol (INFCIRC/540)</td>
<td>Doyle (Chapters 10-11)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>11-Nov</td>
<td>Open Source Analysis and Commercial Satellite Imagery</td>
<td>Doyle (Chapter 9)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>13-Nov</td>
<td>Environmental Sampling and Test Detection</td>
<td>Doyle (Chapter 13)</td>
<td>Presimulation Exercise Material Due</td>
<td></td>
</tr>
<tr>
<td>22 Simulation Exercise: Part 1</td>
<td>18-Nov</td>
<td>Doyle (Chapters 14-15)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preventing Nuclear Terrorism and Illicit Nuclear Trade</td>
<td>20-Nov</td>
<td>Export Controls</td>
<td>Doyle (Chapters 28-30)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>25-Nov</td>
<td>Illicit Trafficking and Field Detection of Nuclear Materials</td>
<td>Doyle (Chapters 21 and 22) Mozley (Chapter 8)</td>
<td>NSEP Threats to Nuclear Security Module</td>
<td></td>
</tr>
<tr>
<td>26 Thanksgiving Holiday</td>
<td>27-Nov</td>
<td>Thanksgiving Holiday</td>
<td>Doyle (Chapter 8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>27 Nuclear Terrorism</td>
<td>2-Dec</td>
<td>Doyle (Chapters 23-26)</td>
<td></td>
<td>Homework #5 Due</td>
<td></td>
</tr>
<tr>
<td>28 Nuclear Forensics and Post-Nuclear Event Attribution</td>
<td>4-Dec</td>
<td>Doyle (Chapters 27)</td>
<td></td>
<td>Presimulation Exercise Material Due</td>
<td></td>
</tr>
<tr>
<td>29 Deterrence Value of Safeguards and Security</td>
<td>9-Dec</td>
<td>Doyle (Chapters 27)</td>
<td></td>
<td>Homework #6 Due</td>
<td></td>
</tr>
<tr>
<td>Final Exam</td>
<td>12-Dec</td>
<td>Simulation Exercise: Part 2 (15:00-17:00)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
NUEN 651 – Nuclear Fuel Cycles and Nuclear Material Safeguards
Spring 2014
Course Syllabus

COURSE DESCRIPTION
A description of the civilian and military nuclear fuel cycles is given including the physics of the fundamental components of the fuel cycle (including enrichment, fuel fabrication, reactors, and reprocessing). The student learns methods for analysis of these cycles. Topics include the nuclear fuel resources, mining, and metallurgy; enrichment and conversion; reactor fuel design and fabrication; in-core fuel management; reprocessing and recycling; fuel cycle economics and analysis; heavy water and tritium production; and high level waste management. The course also details the fundamentals of nuclear material safeguards. This includes material protection, control, and accounting practices and the IAEA system of safeguards. The course also covers statistics applied to safeguards; the additional protocol; strengthened and integrated safeguards; environmental sampling; remote monitoring; application of NDA and DA to safeguards; and application of measurement techniques to reactors, fuel fabrication facilities, reprocessing plants, enrichment plants, and critical assemblies.

COURSE OBJECTIVES
The primary goal of this course is to educate the student in the fundamentals of nuclear fuel cycles and nuclear material safeguards and how to design and analyze these. After completing this course, the student will be able to:

1. Describe all of the steps in military and civilian nuclear fuel cycles.
2. Perform engineering calculations to assess major elements of a fuel cycle.
3. Describe the fundamentals of how nuclear material safeguards are implemented to secure nuclear material from theft and diversion.
5. Assess the effectiveness of safeguards systems.
6. Design a safeguards system for implementation in a fuel cycle facility.
7. Use quantitative and qualitative assessment techniques to provide estimates of data reliability.

CLASS TIME AND LOCATION
This course will meet three days per week. The course consists of three hours of in-class lecture according to the following schedule:

   Time:  MWF 11:30 am - 12:20 pm
   Place:  ZACH 119B
INSTRUCTOR

Two instructors will be available for this class:

Sunil S. Chirayath, Ph.D.
Visiting Assistant Professor, Nuclear Engineering Department
TEES Research Scientist, Nuclear Security Science and Policy Institute
Texas A&M University
College Station, TX 77843-3473
Office: ZACH 336C
Office Hours: TR 9:00-10:00, or by appointment
Phone: 979-862-2616
Fax: 979-845-7497
Email: sunilsc@tamu.edu

You are welcome to stop by at any time we are available, but office hour times are rather limited. Thus, it is suggested that you use email as the primary means of contact for professors in this class. This will provide for a record of the communication and allow for scheduling of a more specific time to meet and discuss any issues you have in class.

TEXTBOOKS

Lecture Notes
The primary reference for this course is a set of lecture notes which will be provided in electronic format to the students via the university’s WebCT system. The students should print these notes and bring them to class for each lecture session. The lecture notes provided to the students will include blank spaces which will need to be filled in by the students during the lecture.

Required Text
The following textbook is required for this class:

This text is available for purchase online at http://www.ans.org/store/i_350024. Readings for the lectures will be assigned from this text as well as selected problem sets.

Electronic Documents
Several electronic resources will also be used for course readings. The majority of these can be found on the open web and will be provided via download from WebCT. The following electronic documents will be provided to the student:


**METHOD OF EVALUATION**

The student’s grade will be determined based on the following percentages:

- 30% - Homework
- 30% - Fuel Cycle Project
- 20% - Mid-Term Exam
- 20% - Final Exam

The grades will be determined on the following scale:

- **A** - 90.00-100.00
- **B** - 80.00-89.99
- **C** - 70.00-79.99
- **D** - 60.00-69.99
- **F** - 0.00-59.99

**Homework**

Homework assignments will consist of short problem sets (generally 4-6 problems each assignment). These assignments are intended to exercise the student’s understanding of both
lecture and reading material. Homework will be assigned approximately every other week and will be due according to the schedule at the end of this syllabus.

Each Homework submitted should (1) give the assignment number, (2) use only the front side of each page, (3) provide a brief problem statement, (4) be neat and legible and present work logically to allow the reader to follow the solution progression, (5) provide units for solutions where applicable, and (6) be stapled together.

Project
Each student will work on a small group project designing a proliferation pathways or safeguards approach to nuclear fuel cycle in a hypothetical country. The project work will be assigned approximately midway through the semester. The project work will be divided between two groups with a group working on proliferation pathways and another working on the safeguards approach. The State Evaluation Report describing country’s political situation and fuel cycle activities will be provided.

The project results will be reported via a written project report that will be due at the end of the semester. The report should be less than 20 pages in length but may include appendices to show more detailed calculations if needed.

Mid-Term Examination
A written mid-term examination will be conducted according to the schedule below. This exam will be an in-class, closed-book, closed-notes exam and will cover all matter up to the date of the exam.

Final Examination
A final examination for the class will be scheduled according to the approved University Final Examination Schedule. This exam will be comprehensive and cover all information discussed in lectures, readings, and homework. A review sheet will be provided to the student to aid in studying for this exam.

LATENESS POLICY
Late homeworks may be submitted late but will be deducted 10% per day after the due date.

ONLINE COURSE MATERIAL
An electronic copy of this syllabus, the course schedule, all lecture notes, data tables, supplemental readings, and homework assignments will be available to the student through the University’s WebCT system.

The instructor will use the WebCT email system and discussion boards to communicate important messages to the students. Students should check their email often to keep updated on current messages. Also, the student’s grades will be posted on the WebCT system, and the students can use this system to check their grades at any time.
The WebCT system can be accessed through elearning.tamu.edu. If you are unfamiliar with this system, please ask the instructor for help or consult the Information Technology Services staff by emailing them at its@tamu.edu.

ADA STATEMENT
The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact the Department of Student Life, Services for Students with Disabilities in Room B118 of Cain Hall. The phone number is 845-1637.

COPYRIGHTS
The handouts used in this course are copyrighted. By "handouts" we mean all materials generated for this class, which include but are not limited to syllabi, lab problems, in-class materials, review sheets, and additional problem sets. Because these materials are copyrighted, you do not have the right to copy the handouts, unless the author expressly grants permission.

SCHOLASTIC DISHONESTY
As commonly defined, plagiarism consists of passing off as one's own the ideas, work, writings, etc., that belong to another. In accordance with this definition, you are committing plagiarism if you copy the work of another person and turn it in as your own, even if you have the permission of that person. Plagiarism is one of the worst academic sins, for the plagiarist destroys the trust among colleagues without which research cannot be safely communicated. If you have questions regarding plagiarism, please consult the latest issue of the Texas A&M University Student Rules [http://student-rules.tamu.edu/], under the section “Scholastic Dishonesty.”

RELIGIOUS HOLIDAYS
If you are a member of a religious faith that has one or more holidays which require you to be absent from any class listed above, please tell your instructor at least two weeks in advance of your absence and make arrangements to make-up the class.
<table>
<thead>
<tr>
<th>Module</th>
<th>Session</th>
<th>Subject</th>
<th>Due</th>
<th>Readings</th>
<th>Instructor</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>1</td>
<td>Introduction to Fuel Cycles and Safeguards</td>
<td></td>
<td>T'soulfanidis</td>
<td>Chirayath</td>
<td>13-Jan-14</td>
</tr>
<tr>
<td>Overview of IAEA Safeguards</td>
<td>2</td>
<td>The International Safeguards System</td>
<td></td>
<td>IAEA/NVS/3/CD pp. 1-36</td>
<td>Chirayath</td>
<td>15-Jan-14</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Nuclear Material Accountancy</td>
<td></td>
<td>IAEA/NVS/3/CD pp. 37-41</td>
<td>Chirayath</td>
<td>17-Jan-14</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Martin Luther King, Jr. Day, Holiday</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Front-End Safeguards Measures</td>
<td>4</td>
<td>Nuclear Material Measurement Techniques and Equipment</td>
<td></td>
<td>IAEA/NVS/3/CD pp. 48-52</td>
<td>Chirayath</td>
<td>22-Jan-14</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>Inspection and Reports</td>
<td></td>
<td></td>
<td>Chirayath</td>
<td>24-Jan-14</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Statistical Concepts and Techniques for Material Verification</td>
<td></td>
<td></td>
<td>Chirayath</td>
<td>27-Jan-14</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>Homework Questions &amp; Answer Writing</td>
<td></td>
<td></td>
<td>Chirayath</td>
<td>29-Jan-14</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>Mining/Milling and Uranium Conversion</td>
<td></td>
<td>T'soulfanidis</td>
<td>Chirayath</td>
<td>31-Jan-14</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>Uranium Enrichment: Gaseous Diffusion and Centrifuge</td>
<td></td>
<td>T'soulfanidis</td>
<td>Chirayath</td>
<td>3-Feb-14</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>Uranium Enrichment: Laser and Electromagnetic Separation</td>
<td></td>
<td>T'soulfanidis</td>
<td>Chirayath</td>
<td>3-Feb-14</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>Fuel Fabrication</td>
<td></td>
<td></td>
<td>Chirayath</td>
<td>7-Feb-14</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>Semester Project Description</td>
<td></td>
<td></td>
<td>Chirayath</td>
<td>10-Feb-14</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>Containment, Surveillance, and Monitoring</td>
<td></td>
<td>IAEA/NVS/3/CD pp. 54-58</td>
<td>Chirayath</td>
<td>12-Feb-14</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>Environmental Sampling</td>
<td></td>
<td>IAEA/NVS/3/CD pp. 59-61</td>
<td>Chirayath</td>
<td>14-Feb-14</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>Bulk Measurement Methods (Weight, Volume, and Flow)</td>
<td></td>
<td></td>
<td>Chirayath</td>
<td>17-Feb-14</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>Nondestructive Assay Methods for Uranium Enrichment Safeguards</td>
<td></td>
<td></td>
<td>Chirayath</td>
<td>19-Feb-14</td>
</tr>
<tr>
<td></td>
<td>17</td>
<td>Case Study: Safeguards Approach for Small Enrichment Plant</td>
<td></td>
<td>Homework 3</td>
<td>Chirayath</td>
<td>21-Feb-14</td>
</tr>
<tr>
<td></td>
<td>18</td>
<td>Mid-term Exam Review</td>
<td></td>
<td></td>
<td></td>
<td>24-Feb-14</td>
</tr>
<tr>
<td>Transmuter Safeguards</td>
<td>19</td>
<td>Fuel Irradiation (LWR, CANDU, and FBR)</td>
<td></td>
<td>T'soulfanidis</td>
<td>Chirayath</td>
<td>26-Feb-14</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>Mid-Term Exam</td>
<td></td>
<td>Exam</td>
<td></td>
<td>28-Feb-14</td>
</tr>
<tr>
<td></td>
<td>21</td>
<td>In-core Fuel Management (LWR and FBR blanket)</td>
<td></td>
<td>T'soulfanidis</td>
<td>Chirayath</td>
<td>3-Mar-14</td>
</tr>
<tr>
<td></td>
<td>22</td>
<td>Irradiated Fuel Measurements</td>
<td></td>
<td>IAEA/NVS/1 pp. 54-64</td>
<td>Chirayath</td>
<td>5-Mar-14</td>
</tr>
<tr>
<td></td>
<td>23</td>
<td>Case Study: Safeguards Approach for a CANDU Reactor</td>
<td></td>
<td>STI/DOC/010/392 pp. 1-56</td>
<td>Chirayath</td>
<td>7-Mar-14</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Spring Break</td>
<td></td>
<td></td>
<td>None</td>
<td>10-Mar-14</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Spring Break</td>
<td></td>
<td></td>
<td>None</td>
<td>12-Mar-14</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Spring Break</td>
<td></td>
<td></td>
<td>None</td>
<td>14-Mar-14</td>
</tr>
<tr>
<td></td>
<td>24</td>
<td>Risk Informed Safeguards and Proliferation Resistance</td>
<td></td>
<td>Homework 4</td>
<td>Ainger et al. pp. 1-49</td>
<td>Chirayath</td>
</tr>
<tr>
<td></td>
<td>Topic</td>
<td>Lecturer</td>
<td>Date</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>-----------------------------------------------------------------------</td>
<td>--------------</td>
<td>------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>LWR and FBR Spent Fuel Storage</td>
<td>Tsoulfanidis</td>
<td>19-Mar-14</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>Solvent Extraction of Metals</td>
<td>Tsoulfanidis</td>
<td>21-Mar-14</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>Spent Fuel Reprocessing (PUREX)</td>
<td>Chirayath</td>
<td>24-Mar-14</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>Spent Fuel Reprocessing (PUREX and FBR aspects)</td>
<td>Chirayath</td>
<td>26-Mar-14</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>Spent Fuel Reprocessing (UREX, Pyroprocessing and other)</td>
<td>Homework 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>MOX Fuel Fabrication and Irradiation</td>
<td>Tsoulfanidis</td>
<td>31-Mar-14</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>D$_2$O, ³H Production, Waste Treatment and Management</td>
<td>Tsoulfanidis</td>
<td>2-Apr-14</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>Nondestructive Assay using Neutron Detectors in NFC Facilities</td>
<td>Chirayath</td>
<td>1-Apr-14</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>33</td>
<td>Chemical Assay Methods (Separation Methods)</td>
<td>IAEA/NVS/3/CD p. 69-84</td>
<td>1-Apr-14</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>34</td>
<td>Chemical Assay Methods (Mass Spectrometry)</td>
<td>Chirayath</td>
<td>8-Apr-14</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>Chemical Assay Methods (Calorimetry and Alpha Counting)</td>
<td>Chirayath</td>
<td>11-Apr-14</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>Case Study: Safeguards approach for large reprocessing plant</td>
<td>Chirayath</td>
<td>14-Apr-14</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>37</td>
<td>Case Study: Analysis of the Indian Fuel Cycle</td>
<td>Chirayath</td>
<td>16-Apr-14</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>38</td>
<td>Material Flow sheet Assessments (LWR Once-Through Cycle) &amp; FBR Recycle</td>
<td>Chirayath</td>
<td>21-Apr-14</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>39</td>
<td>Student Project Presentation</td>
<td>Chirayath</td>
<td>23-Apr-14</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>Student Project Presentation</td>
<td>Chirayath</td>
<td>25-Apr-14</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>41</td>
<td>Exam Review (Tuesday re-defined day, attend Friday Class)</td>
<td>Chirayath</td>
<td>29-Apr-14</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Final Exam (3pm-5pm)</td>
<td>Final Exam</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Other possible dates are 5th or 7th May for final exams
Course Description

This is a project-based course which studies the analysis of events, threats, and data relevant to nuclear security and nuclear forensics. Students will each be assigned a project at the beginning of the semester which requires an analysis of multiple datasets for a hypothetical case of interest to U.S. national security. This involves synthesis of data and analysis methods learned in the student's other classes as well as developing the ability to learn new techniques when needed. In addition to developing their skills in performing forensics analysis and interpretation, the students are taught critical analysis techniques and study how to use “Red Team” exercises to move a project forward.

The course focuses on detailed technical analysis using diverse datasets and country/organization profiles. These datasets may include:

- mass and gamma-ray spectroscopy from air, biota, soil, water, and swipe samples;
- destructive analysis (including mass spectroscopy) of samples from solid nuclear material;
- alpha and gamma spectroscopy of swipes samples;
- overhead imagery;
- press reports, watchdog group reports, and historical details;
- company reports;
- export control information;
- human intelligence data;
- seismic data;
- nondestructive radiation measurements of solid samples; and
- safeguards accounting data.

The students develop their analysis over the semester by learning how these analyses are performed at U.S. national laboratories and other similar organizations. The students will present their results on several occasions throughout the semester and the audience will serve as the “Red Team” for the analysis. Quantitative and qualitative analysis is developed, but the focus in this course is critical analysis of quantitative data.

Various techniques are studied on how to effectively manage a nuclear security project and to help critique data sources. The following techniques will be discussed and used where applicable: critical success factors, competitor profiling, SWOT analysis, and gap analysis. Also included are presentations on recognizing the interaction between the collection and analysis phases, methods to analyze creatively, how to employ inductive and deductive reasoning in analysis, how to recognize gaps and blind-spots and ways to determine when to cease analysis.

Prerequisites

Students entering this course should have previously completed NUEN 650 Nuclear Nonproliferation and Arms Control and NUEN 601 Nuclear Reactor Theory (or equivalent).
Instructor Information

Name: William S. Charlton, Ph.D.
Title: Associate Professor, Nuclear Engineering Department
Director, Nuclear Security Science and Policy Institute
Telephone Number: (979) 845-7092
Email address: wcharlton@tamu.edu
Office Hours: M 13:00-15:00 PM or by appointment
Office Location: Zachry Engineering Center Room 336E

Course Learning Objectives

The primary goal of this course is to educate the student in how to perform critical technical analysis of data sets of interest to the areas of nuclear nonproliferation, nuclear forensics, nuclear safeguards and nuclear security. After completing this course, the student should be able to:

1. Design and organize a detailed project plan for a research or analysis project.
2. Analyze diverse datasets using technical skills and facilities available in the scientific community.
3. Use quantitative and qualitative assessment techniques to provide estimates of data reliability.
4. Perform forward and inverse analyses and understand the limitation of these analyses in terms of uncertainties and uniqueness of solutions.
5. Synthesize results from analyses of multiple datasets to draw conclusions including eliminating incorrect hypotheses and supporting likely hypotheses.
6. Assess the risks associated with low-probability, high-consequence events.
7. Make decisions when data supplied has various degrees of uncertainty.
8. Critique a project to identify gaps in datasets and data needs.
9. Present the results of a nuclear security or nuclear forensics project both orally and via writing.
10. Present a critical analysis of someone else’s technical work both orally and via writing.
11. Actively participate in Red Team exercises to aid in the development of technical conclusions from data.
12. Perform a self-assessment to understand the limit of one's knowledge

Class Time and Location

This course will be taught as a web-based course. A physical room location will not be used for the course except on special occasions. Lectures will be delivered three times per week on MWR from 4:10-5:25. All lectures will be given using synchronous webconferencing via the TAMU TTVN WebMeeting system. This system will allow you to see the slides being presented, hear the lecturer, ask questions via text or voice chat, and interact with the other students. The webconferencing system works best if the students connect to it using a webcam. If the students are unfamiliar with how to use the TTVN WebMeeting system, instruction will be provided.

To access the lecture delivery, go to https://webmeeting.tamu.edu/main/event/ and enter the following information:

Event ID: LGK732418
Event Password: NSSPI656

Textbook and/or Resource Materials

The principle source of information for this course is a set of electronic notes which will be provided to the student in MS PowerPoint form. No textbook is required for the class. The student will however be expected to use the TAMU library and internet resources throughout the course.
Grading Policies

The student's grade will be determined based on their performance on the class project and on homework assignments. Class projects will be graded based on two "Red Team" presentations and participation, one final project presentation, and a final project report. The student's grade will be determined based on the following percentages:

- 30% - Homework
- 15% - Red Team Exercise #1
- 15% - Red Team Exercise #2
- 20% - Final Presentation
- 20% - Project Report

The grades will be determined on the following scale:

- A - 90.00-100.00
- B - 80.00-89.99
- C - 70.00-79.99
- D - 60.00-69.99
- F - 0.00-59.99

Late homework will be deducted 10% per day after the due date.

Class Projects

Each student will be assigned a class project. Class projects will be conducted individually or in small teams. Initial information will be distributed to each project team describing the case or event in question and asked by a hypothetical competent authority to provide analysis to help characterize the event. The students analyze the data given and then periodically (no more than once per week) may ask for additional data to help them better understand the event. If this information is available, the instructor will provide it (up to one additional report per week). Thus, additional information will be distributed to the students on a selective release basis (i.e., all information will not be available at the beginning of the project but will evolve as the project is studied). The projects are intended to require a diverse set of data to generate a complete analysis. In some cases, the student will not have the skills needed to analyze the data provided or understand the measurement instrument to be used. In those cases, “just in time” lecture material will be provided to allow them to move forward with each project.

Examples of possible projects are as follows:

1. a suspected radiological weapon is seized in a port in Marseille, France
2. an unknown radiological material is discovered by U.S. Marines in a cave in Afghanistan
3. a possible theft of material from a facility in Russia and possibly in transit across Eastern Europe
4. a suspected weapons test in the mountains of Argentina
5. a possible diversion of material reported by Japanese commercial nuclear facilities

Red Team Exercises. The student will be required to participate in two Red Team exercises as shown on the course schedule below. These exercises are intended to help develop the student’s project and to develop the student's skills at critically analyzing the other student’s projects. The student’s grade for the Red Team exercises will be assessed based 50% on the presentation of their project and 50% on their analysis of the other student’s projects.

Project Presentations and Report. Each student will present the final results of their project in an oral presentation at the end of the semester as well as via a written report. The presentation will be less than thirty minutes in length (including time for questions from the audience). This report will be due the last day of class. The project reports should be less than 20 pages in length (not including references).
Other Pertinent Course Information

All of the material for this course will be maintained on the University's Elearning system. This includes an electronic copy of this syllabus, the course schedule, all lecture notes, supplemental readings, and homework assignments. The instructor will use the Elearning email system and discussion board to communicate important messages to the students. Students should check their email often to keep updated on current messages. Also, the student's grades will be posted on the Elearning system, and the students can use this system to check their grades at any time. The Elearning system can be accessed through http://elearning.tamu.edu. If you are unfamiliar with this system, instruction will be provided.

Students will also make occasional use of electronic resources available on the Nuclear Safeguards Educational Portal (http://nsspi.tamu.edu/NSEP) maintained by the Nuclear Security Science and Policy Institute at TAMU. The instructor will direct you to this resource when necessary.

Americans with Disabilities Act (ADA)

The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact Disability Services, in Cain Hall, Room B118, or call 845-1637. For additional information visit http://disability.tamu.edu

Academic Integrity

All students at Texas A&M University are bound by the Aggie Honor Code:

"An Aggie does not lie, cheat or steal, or tolerate those who do."

For more information, the student is referred to the Honor Council Rules and Procedures on the web at http://www.tamu.edu/aggiehonor.

As commonly defined, plagiarism consists of passing off as one's own the ideas, work, writings, etc., that belong to another. In accordance with this definition, you are committing plagiarism if you copy the work of another person and turn it in as your own, even if you have the permission of that person. Plagiarism is one of the worst academic sins, for the plagiarist destroys the trust among colleagues without which research cannot be safely communicated. If you have questions regarding plagiarism, please consult the latest issue of the Texas A&M University Student Rules [http://student-rules.tamu.edu/], under the section “Scholastic Dishonesty.”
<table>
<thead>
<tr>
<th>Module</th>
<th>Session</th>
<th>Date</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overview</td>
<td>1</td>
<td>26-Aug</td>
<td>Introduction and Class Projects</td>
</tr>
<tr>
<td>Critical Analysis Tools</td>
<td>2</td>
<td>28-Aug</td>
<td>Structure and Attributes of a Research Project</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>29-Aug</td>
<td>Literature Review</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>2-Sep</td>
<td>Critical Thinking</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>4-Sep</td>
<td>Critical Analysis</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>5-Sep</td>
<td>JIT Information for Projects</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>9-Sep</td>
<td>Inductive/Deductive Reasoning and Inverse Analysis</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>11-Sep</td>
<td>Critical Success Factors and Gap Analysis</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>12-Sep</td>
<td>JIT Information for Projects</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>16-Sep</td>
<td>SWOT Analysis, Gantt Charts, PERT Charts, and Critical Path Analysis</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>18-Sep</td>
<td>Decision Tree Analysis</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>19-Sep</td>
<td>JIT Information for Projects</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>23-Sep</td>
<td>Estimating Confidence in Quantitative and Qualitative Data</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>25-Sep</td>
<td>Estimating Confidence in Results</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>26-Sep</td>
<td>JIT Information for Projects</td>
</tr>
<tr>
<td>Red Team Exercise #1</td>
<td>16</td>
<td>30-Sep</td>
<td>The Role of the Red Team</td>
</tr>
<tr>
<td></td>
<td>17</td>
<td>2-Oct</td>
<td>Red Team Exercise #1 (20 minute presentations)</td>
</tr>
<tr>
<td></td>
<td>18</td>
<td>3-Oct</td>
<td>Red Team Exercise #1 (20 minute presentations)</td>
</tr>
<tr>
<td>Macroscopic Assessments</td>
<td>19</td>
<td>7-Oct</td>
<td>Country/Organization Profiles</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>9-Oct</td>
<td>Open Source Reports</td>
</tr>
<tr>
<td></td>
<td>21</td>
<td>10-Oct</td>
<td>JIT Information for Projects</td>
</tr>
<tr>
<td></td>
<td>22</td>
<td>14-Oct</td>
<td>Overhead Imagery Analysis (Part 1)</td>
</tr>
<tr>
<td></td>
<td>23</td>
<td>16-Oct</td>
<td>Overhead Imagery Analysis (Part 2)</td>
</tr>
<tr>
<td></td>
<td>24</td>
<td>17-Oct</td>
<td>JIT Information for Projects</td>
</tr>
<tr>
<td></td>
<td>25</td>
<td>21-Oct</td>
<td>Analyzing Technological Capabilities of Countries and Organizations</td>
</tr>
<tr>
<td>Test Detection</td>
<td>26</td>
<td>23-Oct</td>
<td>Seismic Test Detection</td>
</tr>
<tr>
<td></td>
<td>27</td>
<td>24-Oct</td>
<td>JIT Information for Projects</td>
</tr>
<tr>
<td></td>
<td>28</td>
<td>28-Oct</td>
<td>Radionuclide Sampling for Test Detection</td>
</tr>
<tr>
<td></td>
<td>29</td>
<td>30-Oct</td>
<td>Infrasound, Ultrasound, and EMP Test Detection</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>31-Oct</td>
<td>JIT Information for Projects</td>
</tr>
<tr>
<td>Red Team Exercise #2</td>
<td>31</td>
<td>4-Nov</td>
<td>Red Team Exercise #2 (20 minute presentations)</td>
</tr>
<tr>
<td></td>
<td>32</td>
<td>6-Nov</td>
<td>Red Team Exercise #2 (20 minute presentations)</td>
</tr>
<tr>
<td></td>
<td>33</td>
<td>7-Nov</td>
<td>JIT Information for Projects</td>
</tr>
<tr>
<td>Critical Analysis Examples</td>
<td>34</td>
<td>11-Nov</td>
<td>Example: Nuclear Archaeology</td>
</tr>
<tr>
<td></td>
<td>35</td>
<td>13-Nov</td>
<td>Example: Proliferation Resistance</td>
</tr>
<tr>
<td></td>
<td>36</td>
<td>14-Nov</td>
<td>JIT Information for Projects</td>
</tr>
<tr>
<td></td>
<td>37</td>
<td>18-Nov</td>
<td>Example: Physical Protection</td>
</tr>
<tr>
<td></td>
<td>38</td>
<td>20-Nov</td>
<td>Example: Nuclear Forensics</td>
</tr>
<tr>
<td></td>
<td>39</td>
<td>21-Nov</td>
<td>Thanksgiving Holiday</td>
</tr>
<tr>
<td>Final Project Presentations</td>
<td>40</td>
<td>25-Nov</td>
<td>Data Fusion</td>
</tr>
<tr>
<td>and Summary</td>
<td>41</td>
<td>27-Nov</td>
<td>When to Cease Analysis</td>
</tr>
<tr>
<td></td>
<td>42</td>
<td>28-Nov</td>
<td>JIT Information for Projects</td>
</tr>
<tr>
<td></td>
<td>43</td>
<td>3-Dec</td>
<td>Conclusions</td>
</tr>
<tr>
<td></td>
<td>44</td>
<td>9-Dec</td>
<td>Final Project Presentations 3:30-5:30 PM (30 minutes each)</td>
</tr>
</tbody>
</table>
NUEN 661 - Nuclear Fuel Performance

Instructor: Sean M. McDeavitt
Office: ZACH 340AC
Email: mcdeavitt@tamu.edu

Course Description: This course will review the basic phenomena that govern nuclear fuel performance. This includes structural changes and rate controlling phenomena for oxide and metal fuels as well as cladding and other structural materials.

Prerequisites: Graduate Standing

Reference Texts: FRAPCON Manuals (available online @ http://www.pnl.gov/frapcon3/)
. . . and others

Course Web Page: eLearning (http://elearning.tamu.edu/)
(Lectures, HW information, selected readings and grades posted here)

Schedule: Lecture TR 11:10 AM to 12:25 PM in ZACH 105C
Office Hours: open door policy and by appointment

References: Online Periodic Table, http://www.webelements.com/
Online Table of the Nuclides, http://atom.kaeri.re.kr/
Course Policies:

Grading: The course grade will be based upon class participation and homework (20%), one topical paper (25% each), one student-led lecture (25%), and the final design project (30%).

- Participation/Homework 25%
- Topical Paper 25%
- Student Lecture 25%
- Fuel Design Project 25%

Grading is expected to be on a straight 90/80/70/60 scale.

Participation: This is a small discussion-based class, so attendance is very important. Excessive unexcused absence may result in a 5% penalty in the course score. Attendance at the Student Lectures is mandatory (excuses will be considered).

Homework: Homework will be assigned in-class with a nominal 1-week turnaround time. The assignments will comprise four writing assignment centered on providing a one page technical description of selected fuel performance phenomena.

Topical Paper/Lecture: Each student will prepare a paper (25% of grade) on a subject of their choosing relevant to the course content and deliver a 75 minute oral lecture (25% of grade) covering the same material. The intent is to provide the student an opportunity to write in a manner that mimics a conference submission and to properly prepare and present an oral scientific lecture. The papers will be provided to the entire class in a symposium-style pdf for review and to assist in the evaluation of the oral presentation. Both the paper and the oral presentation will be judged on scientific and technical merit, as well as on the writing and speaking quality. A list of previous topics is attached. The student lectures will be presented in-class during the last 4 weeks of the semester; attendance at these lectures represents 5% of the course grade (see participation).

- Topic selection: February 13, 2014
- Paper Due Date: March 27, 2014
- Lecture Dates: April 1 to 24, 2014

Final Project: A term design project will be defined by the class in the first 2 weeks of the course. The project will comprise a detailed creation of a specific fuel concept for a specific application. It is expected that the final result could be submitted to the ANS graduate student design competition.

Scholastic Dishonesty and the Aggie Honor Code: "An Aggie does not lie, cheat, or steal or tolerate those who do." The Code forbids the following:

- Cheating: Attempting to use unauthorized materials, information, notes, study aids or other devices or materials in any academic exercise.
- Fabrication: Making up data or results; submitting fabricated documents.
• **Falsification**: Manipulating results such that research is not accurately represented in the research record.

• **Multiple Submissions**: Submitting substantial portions of the same work (including oral reports) for credit more than once without authorization from instructors.

• **Plagiarism**: Using another person’s ideas, work, processes, results, writings, words, etc. without giving appropriate credit.

• **Complicity**: Intentionally or knowingly helping, or attempting to help, another to commit an act of academic dishonesty.

If you have questions regarding scholastic dishonesty and the Aggie Honor Code, please visit [http://www.tamu.edu/aggiehonor](http://www.tamu.edu/aggiehonor) for the Honor Council Rules and Procedures, and [http://student-rules.tamu.edu](http://student-rules.tamu.edu) for the Texas A&M University Student Rules.

Violation of the Aggie Honor Code may result in a 0 for the assignment or exam, failure of the course, and reports Aggie Honor System Office.

**Professional Behavior**: An important attribute of your professional development is that you act and speak in a manner that will not offend others giving particular care to diversity issues.

**Americans with Disabilities Act (ADA)**: The Americans with Disabilities Act (ADA) is a federal antidiscrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please tell your instructor or contact the Department of Student Life, Services for Students with Disabilities, in Cain Hall, or call 845-1637.

**Religious Holidays**: If you are a member of a religious faith that has one or more holidays which require you to be absent from any class listed above, please tell your instructor at least two weeks in advance of your absence and make arrangements to make-up the class.

**Copyrights**: The handouts used in this course are copyrighted. "Handouts," refers to all materials generated for this class, which include but are not limited to syllabi, lecture notes, problems, in-class materials, review sheets, and additional problem sets. Because these materials are copyrighted, you do not have the right to copy the handouts, unless the author expressly grants permission.
<table>
<thead>
<tr>
<th>1. Overview of Nuclear Fuels - 1</th>
<th>2. Overview of Nuclear Fuels - 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. Overview of Nuclear Fuels - 3</td>
<td>4. Overview of Nuclear Fuels - 4</td>
</tr>
<tr>
<td>5. LWR Cladding Performance - 1</td>
<td>6. LWR Cladding Performance - 2</td>
</tr>
<tr>
<td>7. LWR Cladding Performance - 3</td>
<td>8. LWR Dry Fuel Storage</td>
</tr>
<tr>
<td>11. TRISO Fuel Overview - 1</td>
<td>12. TRISO Fuel Overview - 2</td>
</tr>
</tbody>
</table>

**SPRING BREAK**

| 17. Thermal Conductivity        | 18. FCCI/FCMI - 1               |
| 21. Student Lecture             | 22. Student Lecture            |
| 25. Student Lecture             | 26. Student Lecture            |
| 27. Student Lecture             | 28. Student Lecture            |

**FINAL EXAM (3:00 PM on May 2)**
Course title and Number: NUEN 662 – Nuclear Materials under Extreme Conditions
Term (e.g., Fall 200X): Fall 2014
Meeting times and location:

**Course Description and Prerequisites**

This course will review fundamentals of materials degradation under reactor environments. The course will provide a linkage from radiation induced microstructure changes to materials thermal properties, mechanical properties, corrosion resistance, swelling, creep, and overall integrities. Materials issues of nuclear fuel, cladding, out-core structural components and waste storage managements will be covered.

**Prerequisites:** Senior Undergraduate students or Graduate Standing or Consent of the Instructor

**Learning Outcomes or Course Objectives**

**Instructor Information**

Name: Lin Shao  
Telephone Number: 845-4107  
Email address: lshao@tamu.edu  
Office Hours: Open door policy  
Office Location: ZACH 335R

**Textbook and/or Resource Materials**

**Reference Texts:**  
“Nuclear Materials under Extreme Conditions”, Lin Shao, lecture notes.  

**Course Web Page:** WebCT  
(Lectures, HW information, selected readings and grades posted here)

**Grading Policies**

**Grading:** The course grade will be based upon homework assignments and three exams.

- Homework 30%
- Exam I 20%
- Exam II 20%
- Final Exam 30%

Grading is expected to be on a straight 90/80/70/60 scale.

**Homework:** Homework will be assigned in-class with a 1-week turnaround time.

Guidelines for homework preparation:
- Show all work, not just the final answer.
- Present your work neatly (extremely “messy” work will not be graded)
Final Exam: The final exam may consist of true/false questions, multiple choice questions, short answer problems, and problem solving calculations.

Course Topics, Calendar of Activities, Major Assignment Dates

Reactor Materials Properties and Requirements
Displacements and Damage Cascade Formation
Atomic Diffusion and Thermal Dynamics of Diffusion
Defect Clustering, Void Formation and Swelling
Solid State Transformation: Grain migration and growth
Solid State Transformation: Dislocation interaction and recrystallization
Solid State Transformation: Precipitation
High Temperature Alloys
Stress Analysis
Macroscopic Aspects of Fractures and Fracture Mechanics
Materials Issues in Fuel Materials
Radiation Hardening
Fracture and Creep
High Temperature Irradiation Embrittlement
Materials Decay and Phase Segregation
Materials Issues in Fuel Materials
Materials Issues in Cladding Materials
Materials Issues in Moderator, Reflector, Blanket, and Coolant Materials
Materials Issues in Control, Shielding and Safety System Materials
Materials Issues in Piping System and Pressure Vessel
Materials Issues in Next Generation Reactors
Frontiers of Materials Synthesis

Other Pertinent Course Information

None

Americans with Disabilities Act (ADA)

The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact Disability Services, in Cain Hall, Room B118, or call 845-1637. For additional information visit http://disability.tamu.edu

Academic Integrity

For additional information please visit: http://www.tamu.edu/aggiehonor

“An Aggie does not lie, cheat, or steal, or tolerate those who do.”
Course title and Number: NUEN 663 – Fundamentals of Ion Solid Interactions
Term (e.g., Fall 200X): Fall 2012
Meeting times and location: TR 12:45pm to 2pm ETB1035

Course Description and Prerequisites
This course will review fundamentals of neutron and ion interactions with solid state materials, and subsequent damage cascade formation, defect clustering, and structural changes. The course will focus on details of electronic stopping and nuclear stopping mechanisms based on quantum mechanics, and practice series of modeling approaches to simulate damage creations. The students expect to develop basic modeling capabilities to carry out simulations for their relevant research topics.

Prerequisites: Graduate Standing or Consent of the Instructor

Learning Outcomes or Course Objectives

Instructor Information

Name: Lin Shao
Telephone Number: 845-4107
Email address: lshao@tamu.edu
Office Hours: Open door policy
Office Location: ZACH 335R

Textbook and/or Resource Materials

Reference Texts:

Course Web Page: WebCT
(Lectures, HW information, selected readings and grades posted here)

Grading Policies

Grading: The course grade will be based upon homework assignments and three exams.

Homework 30%
Exam I 20%
Exam II 20%
Final Exam 30%

Grading is expected to be on a straight 90/80/70/60 scale.
Homework: Homework will be assigned in-class with a 1-week turnaround time.

Guidelines for homework preparation:
• Show all work, not just the final answer.
• Present your work neatly (extremely "messy" work will not be graded)
• Staple all pages together (2% penalty)

Final Exam: The final exam may consist of true/false questions, multiple choice questions, short answer problems, and problem solving calculations.

Course Topics, Calendar of Activities, Major Assignment Dates

• Overview of radiation materials science in nuclear reactors and microelectronics
• Neutron, electron and gamma ray interactions with solids
• Classical ion scattering theory
• Quantum mechanics treatment of ion scattering
• Linhard dielectric theory
• Nuclear energy loss of ions
• Electronic energy loss of ions
• Defect and impurity diffusion in solids
• Ostwald ripening and defect clustering
• Monte Carlo simulation of ion bombardment
• Boltzmann transport equation simulation
• Thermal spike and damage cascade formation
• Molecular dynamics simulation
• Boltzmann transport equation
• Kinetic Monte Carlo simulation
• Continuum method based rate theory calculation
• Sputtering
• Channeling
• Ion beam analysis techniques
• Ion doping
• Characterization of irradiated samples
• Accelerator development

Other Pertinent Course Information

None

Americans with Disabilities Act (ADA)

The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact Disability Services, in Cain Hall, Room B118, or call 845-1637. For additional information visit http://disability.tamu.edu

Academic Integrity

For additional information please visit: http://www.tamu.edu/aggiehonor

“An Aggie does not lie, cheat, or steal, or tolerate those who do.”
Prerequisites
Graduate classification or approval of the instructor.

Objective
This course will provide an understanding of the molecular, cellular, and tissue responses of organisms exposed to ionizing radiation. Conditions that can modify these responses will be discussed. Emphasis will be placed on the most current areas of research and the molecular techniques being exploited to investigate current research questions.

Required Text

Suggested Texts

Assignments and Grades
Homework & participation 10%
Literature review 30%
Tests 50%
Presentation 10%

Grades are awarded on 10 point scale.
# Tentative Class Calendar

<table>
<thead>
<tr>
<th>DATE</th>
<th>TOPIC</th>
<th>ASSIGNMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 1</td>
<td>Introduction</td>
<td>PubMed</td>
</tr>
<tr>
<td>Jan. 21</td>
<td>No Class</td>
<td></td>
</tr>
<tr>
<td>Week 2</td>
<td>Chromatin and radiation damage</td>
<td></td>
</tr>
<tr>
<td>Week 3</td>
<td>DNA repair</td>
<td>Abstract (1/30)</td>
</tr>
<tr>
<td>Week 4</td>
<td>Cell-cycle checkpoints</td>
<td></td>
</tr>
<tr>
<td>Week 5</td>
<td>Review</td>
<td>Test 1 (2/15)</td>
</tr>
<tr>
<td>Week 6</td>
<td>Apoptosis</td>
<td></td>
</tr>
<tr>
<td>Week 7</td>
<td>Chromosome aberrations</td>
<td></td>
</tr>
<tr>
<td>Week 8</td>
<td>Non-targeted effects</td>
<td>Test 2 (3/8)</td>
</tr>
<tr>
<td>March 11-15</td>
<td>SPRING BREAK</td>
<td></td>
</tr>
<tr>
<td>Week 9</td>
<td>Tissue specific effects</td>
<td></td>
</tr>
<tr>
<td>Week 10</td>
<td>Fetal Exposures</td>
<td>Draft (3/27)</td>
</tr>
<tr>
<td>March 29</td>
<td>No Class</td>
<td></td>
</tr>
<tr>
<td>Week 11</td>
<td>Radiotherapy, 4R’s</td>
<td></td>
</tr>
<tr>
<td>Week 12</td>
<td>Modifiers of radiation response</td>
<td></td>
</tr>
<tr>
<td>Week 14</td>
<td>Radiation Carcinogenesis</td>
<td>Review (4/26)</td>
</tr>
<tr>
<td>Week 15</td>
<td>Presentations</td>
<td></td>
</tr>
<tr>
<td>April 29</td>
<td>Last Day of Class</td>
<td></td>
</tr>
</tbody>
</table>
Assignments

**Literature Review**
Select a topic based on a survey of reviews published in the years 2010 and 2011. Write a review of the current literature from the date of the last review to the present using the style and format of *Radiation Research*.

**Tests**
Tests will consist primarily of short discussion with an occasional essay question.

**Presentation**
Pick a recent interesting radiobiology journal article from an appropriate journal. “Recent” means published within the last six months (preferably in the last 3 months). Appropriate journals include but are not limited to the following:
- *Radiation Research*
- *Health Physics*
- *International Journal of Radiation Biology*
- *Cancer Research*
- *Cell*
- *Mutation Research*
- *Nature*
- *Science*

Present some background information and the data from the article. The presentation should be approximately 20 minutes. Answer any audience questions.
Americans with Disabilities Act
The Americans with Disabilities Act (ADA) is a federal antidiscrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact the Department of Student Life, Services for Students with Disabilities in Room 126 of the Koldus Building, or call 845-1637.

Copyrights
The handouts used in this course are copyrighted. By "handouts" we mean all materials generated for this class, which include but are not limited to syllabi, lab problems, in-class materials, review sheets, and additional problem sets. Because these materials are copyrighted, you do not have the right to copy the handouts, unless the author expressly grants permission.

Scholastic Dishonesty
As commonly defined, plagiarism consists of passing off as one's own the ideas, work, writings, etc., that belong to another. In accordance with this definition, you are committing plagiarism if you copy the work of another person and turn it in as your own, even if you have the permission of that person. Plagiarism is one of the worst academic sins, for the plagiarist destroys the trust among colleagues without which research cannot be safely communicated. If you have questions regarding plagiarism, please consult the latest issue of the Texas A&M University Student Rules [http://student-rules.tamu.edu/], under the section "Scholastic Dishonesty."

PLEASE NOTE:
1. AGGIE HONOR CODE: "An Aggie does not lie, cheat, or steal or tolerate those who do." For additional information please visit: www.tamu.edu/aggiehonor/
2. PROFESSIONAL BEHAVIOR: An important attribute of your professional development is that you act and speak in a manner that will not offend others giving particular care to diversity issues.
3. DISABILITY ACCOMMODATION: If you believe you have a disability requiring an accommodation, please tell your instructor or contact the Department of Student Life, Services for Students with Disabilities, in Cain Hall or call 845-1637.
4. RELIGIOUS HOLIDAYS: If you are a member of a religious faith that has one or more holidays which require you to be absent from any class listed above, please tell your instructor at least two weeks in advance of your absence and make arrangements to make-up the class.

Scholastic Dishonesty and the Aggie Honor Code

AGGIE HONOR CODE: "An Aggie does not lie, cheat, or steal or tolerate those who do." The Code forbids the following:
- Cheating: Attempting to use unauthorized materials, information, notes, study aids or other devices or materials in any academic exercise.
- Fabrication: Making up data or results; submitting fabricated documents.
- Falsification: Manipulating results such that research is not accurately represented in the research record.
- Multiple Submissions: Submitting substantial portions of the same work (including oral reports) for credit more than once without authorization from instructors.
- Plagiarism: Using another person's ideas, processes, results, or words without giving appropriate credit.
- Complicity: Intentionally or knowingly helping, or attempting to help, another to commit an act of academic dishonesty.

For additional information see http://www.tamu.edu/aggiehonor/definitions.php.
Instructor: Dr. John Ford  
Office: 58A Zachry  
Lab: Nuclear Science Center  
Email: ford@ne.tamu.edu  
Phone: 845-6271  
Phone: 862-3660  
Office hours: 9:00 - 10:00 MWF or by appointment.

Prerequisites  
Graduate classification or the approval of the instructor.

Objective  
This course examines the experimental models and mathematical simulations for the investigation of radiation-induced cancer. Students will become familiar with the current scientific literature concerning the intersection of risk analysis and interpretation of disparate data from varied biological systems.

Required Text  

Suggested Texts  
<table>
<thead>
<tr>
<th>DATE</th>
<th>TOPIC</th>
<th>Lecture Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 1</td>
<td>Introduction</td>
<td>3</td>
</tr>
<tr>
<td>Week 2&amp;3</td>
<td>Current Ideas in Radiation Carcinogenesis</td>
<td>6</td>
</tr>
<tr>
<td>Week 4</td>
<td>Cancer Biology</td>
<td>3</td>
</tr>
<tr>
<td>Week 5</td>
<td>Simple Conceptual Cancer Models</td>
<td>3</td>
</tr>
<tr>
<td>Week 6&amp;7</td>
<td>Animal Model Systems</td>
<td>6</td>
</tr>
<tr>
<td>Week 8</td>
<td>Risk Projection Animals to Humans</td>
<td>3</td>
</tr>
<tr>
<td>Week 9</td>
<td><em>In vitro</em> Radiation Transformation Models</td>
<td>3</td>
</tr>
<tr>
<td>Week 10</td>
<td>Non-targeted Radiation Effects and Risk</td>
<td>3</td>
</tr>
<tr>
<td>Week 11</td>
<td>Models of Specific Tissues</td>
<td>3</td>
</tr>
<tr>
<td>Week 12&amp;13</td>
<td>Genetic Susceptibility to Radiation</td>
<td>6</td>
</tr>
<tr>
<td>Week 14</td>
<td>Multi-scale computer models</td>
<td>3</td>
</tr>
<tr>
<td>Week 15</td>
<td>General Review and Discussion</td>
<td>3</td>
</tr>
</tbody>
</table>
Assignments

Paper Review/Synopsis

A reference or two will be provided and the student will be expected to write between 350-500 words addressing a specific topic or in response to a particular query. The assignment will be made at the end of class on Wednesdays and will be due the following week at the beginning of class. The required format is: one-inch margins, left justified text with proper indentation, 12 point New Times Roman Font with 1.5x spacing between the lines of text. The students name should appear in the header with the date. The paper or papers should be properly referenced according the Instructions to Authors for *Radiation Research* (these can be found on the journal’s website). In addition the final version should be emailed to me in .pdf format. A printed copy should be turned in on the date it is due with the signatures of two proofreaders who will vouch for the grammar, spelling and content of the short synopsis.

Tests

Tests will most likely take the form of exams composed of long discussion of one or two topics with pertinent references.

Grades

Grades will be on the normal 10 pt scale.

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homework</td>
<td>50%</td>
</tr>
<tr>
<td>Tests</td>
<td>40%</td>
</tr>
<tr>
<td>Project</td>
<td>10%</td>
</tr>
</tbody>
</table>
**Americans with Disabilities Act**
The Americans with Disabilities Act (ADA) is a federal antidiscrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact the Department of Student Life, Services for Students with Disabilities in Room 126 of the Koldus Building, or call 845-1637.

**Copyrights**
The handouts used in this course are copyrighted. By "handouts" we mean all materials generated for this class, which include but are not limited to syllabi, lab problems, in-class materials, review sheets, and additional problem sets. Because these materials are copyrighted, you do not have the right to copy the handouts, unless the author expressly grants permission.

**Scholastic Dishonesty**
As commonly defined, plagiarism consists of passing off as one's own the ideas, work, writings, etc., that belong to another. In accordance with this definition, you are committing plagiarism if you copy the work of another person and turn it in as your own, even if you have the permission of that person. Plagiarism is one of the worst academic sins, for the plagiarist destroys the trust among colleagues without which research cannot be safely communicated. If you have questions regarding plagiarism, please consult the latest issue of the Texas A&M University Student Rules [http://student-rules.tamu.edu/], under the section "Scholastic Dishonesty."

PLEASE NOTE:
1. **AGGIE HONOR CODE:** “An Aggie does not lie, cheat, or steal or tolerate those who do.” For additional information please visit: [www.tamu.edu/aggiehonor/](http://www.tamu.edu/aggiehonor/)
2. **PROFESSIONAL BEHAVIOR:** An important attribute of your professional development is that you act and speak in a manner that will not offend others giving particular care to diversity issues.
3. **DISABILITY ACCOMMODATION:** If you believe you have a disability requiring an accommodation, please tell your instructor or contact the Department of Student Life, Services for Students with Disabilities, in Cain Hall or call 845-1637.
4. **RELIGIOUS HOLIDAYS:** If you are a member of a religious faith that has one or more holidays which require you to be absent from any class listed above, please tell your instructor at least two weeks in advance of your absence and make arrangements to make-up the class.

Scholastic Dishonesty and the Aggie Honor Code

AGGIE HONOR CODE: "An Aggie does not lie, cheat, or steal or tolerate those who do." The Code forbids the following:
- **Cheating:** Attempting to use unauthorized materials, information, notes, study aids or other devices or materials in any academic exercise.
- **Fabrication:** Making up data or results; submitting fabricated documents.
- **Falsification:** Manipulating results such that research is not accurately represented in the research record.
- **Multiple Submissions:** Submitting substantial portions of the same work (including oral reports) for credit more than once without authorization from instructors.
- **Plagiarism:** Using another person's ideas, processes, results, or words without giving appropriate credit.
- **Complicity:** Intentionally or knowingly helping, or attempting to help, another to commit an act of academic dishonesty.

For additional information see [http://www.tamu.edu/aggiehonor/definitions.php](http://www.tamu.edu/aggiehonor/definitions.php).
Objectives
The class will cover the current and proposed techniques for assessing the absorbed dose due to internally deposited radionuclides. This includes the techniques recommended by international and national bodies as well as those used in nuclear medicine. Students will become familiar with some of the currently available software used for internal dose assessment. Selected references from the recent scientific literature will be discussed.

Useful Texts


Assignments and Percent of Final Grade (tentative)

- Homework: 40%
- Oral Exams: 40%
- Project: 20%
Tentative Class Schedule

<table>
<thead>
<tr>
<th>DATE</th>
<th>TOPIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan. 14</td>
<td>Introduction</td>
</tr>
<tr>
<td>Jan. 16 – 18</td>
<td>ICRP 2</td>
</tr>
<tr>
<td><strong>Jan. 21</strong></td>
<td><strong>NO CLASS</strong></td>
</tr>
<tr>
<td>Jan. 23 – 25</td>
<td>ICRP 2, 6, 10 &amp; 10A</td>
</tr>
<tr>
<td>Jan. 28 – 30</td>
<td>ICRP 23- Reference Man</td>
</tr>
<tr>
<td>Feb. 4 – 8</td>
<td>ICRP 26 &amp; 30</td>
</tr>
<tr>
<td>Feb. 11 – 15</td>
<td>ICRP 30- Gastrointestinal Model</td>
</tr>
<tr>
<td>Feb. 18 – 22</td>
<td>ICRP 30- Bone Model</td>
</tr>
<tr>
<td>Feb. 25 – Mar. 1</td>
<td>ICRP 30- Respiratory Model</td>
</tr>
<tr>
<td>Mar. 4 – 8</td>
<td>Exam 1 <em>(Oral Exam)</em></td>
</tr>
<tr>
<td><strong>Mar. 11 – 15</strong></td>
<td><strong>SPRING BREAK - NO CLASS</strong></td>
</tr>
<tr>
<td>Mar. 18 – 22</td>
<td>NUREG 8.9 /8.34</td>
</tr>
<tr>
<td>Mar. 25 – 27</td>
<td>MIRD</td>
</tr>
<tr>
<td><strong>Mar. 29</strong></td>
<td><strong>NO CLASS</strong></td>
</tr>
<tr>
<td>Apr. 1 – 5</td>
<td>MIRD</td>
</tr>
<tr>
<td>Apr. 8 – 12</td>
<td>Fetal Exposures NUREG 8.36</td>
</tr>
<tr>
<td>Apr. 15 – 19</td>
<td>Exam 2 <em>(Oral Exam)</em></td>
</tr>
<tr>
<td>Apr. 22 – 26</td>
<td>EPA &amp; ICRP recommendations</td>
</tr>
<tr>
<td>April 29</td>
<td>Last day of class- Projects Due</td>
</tr>
</tbody>
</table>
**Americans with Disabilities Act**
The Americans with Disabilities Act (ADA) is a federal antidiscrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact the Department of Student Life, Services for Students with Disabilities in Room 126 of the Koldus Building, or call 845-1637.

**Copyrights**
The handouts used in this course are copyrighted. By "handouts" we mean all materials generated for this class, which include but are not limited to syllabi, lab problems, in-class materials, review sheets, and additional problem sets. Because these materials are copyrighted, you do not have the right to copy the handouts, unless the author expressly grants permission.

**Scholastic Dishonesty**
As commonly defined, plagiarism consists of passing off as one's own the ideas, work, writings, etc., that belong to another. In accordance with this definition, you are committing plagiarism if you copy the work of another person and turn it in as your own, even if you have the permission of that person. Plagiarism is one of the worst academic sins, for the plagiarist destroys the trust among colleagues without which research cannot be safely communicated. If you have questions regarding plagiarism, please consult the latest issue of the Texas A&M University Student Rules [http://student-rules.tamu.edu/], under the section "Scholastic Dishonesty."

**PLEASE NOTE:**
1. **AGGIE HONOR CODE:** “An Aggie does not lie, cheat, or steal or tolerate those who do.” For additional information please visit: [www.tamu.edu/aggiehonor/](http://www.tamu.edu/aggiehonor/)
2. **PROFESSIONAL BEHAVIOR:** An important attribute of your professional development is that you act and speak in a manner that will not offend others giving particular care to diversity issues.
3. **DISABILITY ACCOMMODATION:** If you believe you have a disability requiring an accommodation, please tell your instructor or contact the Department of Student Life, Services for Students with Disabilities, in Cain Hall or call 845-1637.
4. **RELIGIOUS HOLIDAYS:** If you are a member of a religious faith that has one or more holidays which require you to be absent from any class listed above, please tell your instructor at least two weeks in advance of your absence and make arrangements to make-up the class.

Scholastic Dishonesty and the Aggie Honor Code

AGGIE HONOR CODE: "An Aggie does not lie, cheat, or steal or tolerate those who do." The Code forbids the following:
- Cheating: Attempting to use unauthorized materials, information, notes, study aids or other devices or materials in any academic exercise.
- Fabrication: Making up data or results; submitting fabricated documents.
- Falsification: Manipulating results such that research is not accurately represented in the research record.
- Multiple Submissions: Submitting substantial portions of the same work (including oral reports) for credit more than once without authorization from instructors.
- Plagiarism: Using another person's ideas, processes, results, or words without giving appropriate credit.
- Complicity: Intentionally or knowingly helping, or attempting to help, another to commit an act of academic dishonesty.

For additional information see [http://www.tamu.edu/aggiehonor/definitions.php](http://www.tamu.edu/aggiehonor/definitions.php).
**NUEN-676 Syllabus**

**Radiation Dosimetry Laboratory**

**Spring 2012**

T 12:45-1:35, 1:35-4:35; R 12:45-1:35, 1:35-3:00

Or whatever we arrange in class

**Course Objectives:**
To provide the student with the opportunity to learn the principles of radiation interactions with matter, radiation dosimetry techniques, and the characteristics of various radiation detectors.

To provide laboratory observation of radiation detection phenomena and “hands-on” experience in the use of radiation dosimetry instrumentation.

To encourage development of communication skills including technical writing and oral presentation.

**Format:**
One 50-minute lecture and two 3-hour labs per week; three formal laboratory reports and a formal report of a design project; one oral presentation.

**Prerequisites:** graduate classification, enrollment in NUEN 633, or instructor approval

**Textbook:** Frank Attix, Introduction to Radiological Physics and Radiation Dosimetry, John Wiley & Sons, 1986

**References:**
Knoll, Radiation Detection and Measurement, 3\textsuperscript{rd} Ed., John Wiley & Sons, 2000


**Instructor:** Dr. W. D. Reece, 58-O Zachry, NSC 845-7551

Office hours: Good question (some time before or after class) email me:

w-reece@tamu.edu

**Teaching Assistants:** Just me
Class Structure

There will be a great deal of class participation in this course. I hope to help solidify the topics covered in 611 and 633 (and other courses) by question and answer during lectures and labs. The labs are very much “hands on” and much more challenging than 611. Get a lab notebook and use it or you’ll never keep it all straight.

Schedule

Topics

1. Review of Statistics
2. Review of basic nuclear physics
3. X-ray production
4. Ion chambers
5. Selected statistics topics
6. TLDs
7. Neutron dosimetry
8. Other dosimetry techniques
9. TG-43 measurements
10. Linac dose calibrations

Final Exam: TBA

Final Design Project Write-up: TBA

Formal reports will be required covering the experiments done in the laboratories. Material to be covered in the reports will be discussed in class.

Course Grading:

<table>
<thead>
<tr>
<th>Component</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Midterm</td>
<td>15%</td>
</tr>
<tr>
<td>Final</td>
<td>15%</td>
</tr>
<tr>
<td>Homework/class participation</td>
<td>10%</td>
</tr>
<tr>
<td>Formal Lab Reports</td>
<td>40%</td>
</tr>
<tr>
<td>Final Design Report</td>
<td>10%</td>
</tr>
<tr>
<td>Oral Presentations</td>
<td>10%</td>
</tr>
</tbody>
</table>

Attendance is mandatory for all lectures and laboratories. Unexcused absences exceeding three lectures or two laboratories will result in automatic failure of the course.

Working together in lab and, to some extent, on lab write-ups is encouraged and can be an efficient way to learn. Working together on homework or exams is an excellent way to find out what it’s like to leave school.
**Americans with Disabilities Act**
The Americans with Disabilities Act (ADA) is a federal antidiscrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact the Department of Student Life, Services for Students with Disabilities in Room 126 of the Koldus Building, or call 845-1637.

**Copyrights**
The handouts used in this course are copyrighted. By "handouts" we mean all materials generated for this class, which include but are not limited to syllabi, lab problems, in-class materials, review sheets, and additional problem sets. Because these materials are copyrighted, you do not have the right to copy the handouts, unless the author expressly grants permission.

**PLEASE NOTE:**
1. **AGGIE HONOR CODE:** “An Aggie does not lie, cheat, or steal or tolerate those who do.” For additional information please visit: [www.tamu.edu/aggiehonor](http://www.tamu.edu/aggiehonor/)
2. **PROFESSIONAL BEHAVIOR:** An important attribute of your professional development is that you act and speak in a manner that will not offend others giving particular care to diversity issues.
3. **DISABILITY ACCOMMODATION:** If you believe you have a disability requiring an accommodation, please tell your instructor or contact the Department of Student Life, Services for Students with Disabilities, in Cain Hall or call 845-1637.
4. **RELIGIOUS HOLIDAYS:** If you are a member of a religious faith that has one or more holidays which require you to be absent from any class listed above, please tell your instructor at least two weeks in advance of your absence and make arrangements to make-up the class.

Scholastic Dishonesty and the Aggie Honor Code

**AGGIE HONOR CODE:** "An Aggie does not lie, cheat, or steal or tolerate those who do." The Code forbids the following:
- Cheating: Attempting to use unauthorized materials, information, notes, study aids or other devices or materials in any academic exercise.
- Fabrication: Making up data or results; submitting fabricated documents.
- Falsification: Manipulating results such that research is not accurately represented in the research record.
- Multiple Submissions: Submitting substantial portions of the same work (including oral reports) for credit more than once without authorization from instructors.
- Plagiarism: Using another person's ideas, processes, results, or words without giving appropriate credit.
- Complicity: Intentionally or knowingly helping, or attempting to help, another to commit an act of academic dishonesty.

For additional information see [http://www.tamu.edu/aggiehonor/definitions.php](http://www.tamu.edu/aggiehonor/definitions.php).
GRADING/COURSE POLICIES

• Formal lab reports are to be no longer than twenty pages MAXIMUM, INCLUDING tables and figures. Appendices should include only raw data and other supporting materials. All documents should be typed in twelve-point Times New Roman font, double-spaced, and with a minimum of one-inch margins. **Digression from these standards will be penalized.**

• All work should be submitted with the highest professional standards in mind, laser or ink jet printed on clean white paper, and a Microsoft Word .doc file should be sent by email. Students should retain copies of their work.

• Spelling, grammar, punctuation, neatness, and adherence to format all “count” and lack of attention to these details will adversely affect grades (at least 50% of the total grade).

• References: web sites, web pages etc. may not be cited as references unless you can prove that the cited work has been peer reviewed.

• Grade disputes will be handled in the instructor’s office on a case-by-case basis.

• Attendance is mandatory for all lectures and laboratories. Unexcused absences exceeding three lectures or two laboratories will result in automatic failure of the course.

• Any act of cheating or plagiarism will result in a grade of F in the course and a referral to the department head for further action.
NUEN 678, Waste Management in the Nuclear Industry

Instructor: Sean M. McDeavitt
ZACHRY 340A (TRF)
Nuclear Science Center (MW)
email: mcdeavitt@tamu.edu

Course Description: This course will familiarize students with the management of radioactive, hazardous and mixed waste generated by all segments of the nuclear fuel cycle and users of radioisotopes. This includes treatment, storage and disposal technologies and their related political and socioeconomic issues.

Prerequisites: Graduate classification or consent of instructor.

Reference Texts:

Multiple other sources will be used.

Course Web Page: New eCampus site (Lectures, selected readings and grades posted here) http://ecampus.tamu.edu

Schedule: Lecture TR 12:45 – 2:00, ZACH 105B
Office Hours: Tuesdays@4:00 PM and Fridays@11:00 AM

Grading: The course grade will be based upon participation and homework, a final exam, a topical paper, and a topical lecture:

- Participation and HW (See Below) 25%
- Topical Paper (ANS Summary Format) 30%
- Topical Lecture 40%

Grading is expected to be on a straight 90/80/70/60 scale.

Participation: The class will be engaged in 4 interactive projects (called Forums) that may include debates, competitive proposals, and diagnostic reviews with individual assignments. The instructor will assign a topic for each forum related to recent lectures. Students will be required to gather information and participate according to the instructions provided. Preparation of presentation materials, if relevant, (1 or two overheads) is strongly encouraged. The participation “grade” will be based on participation in the events (20%) and attendance of the student-prepared Topical Lectures (5%).

Topical Paper/Lecture: Each student will prepare a paper (30% of grade) on a subject of their choosing relevant to the course content and deliver a 75 minute lecture (40% of grade) on the same material. The intent is to provide the student an opportunity to write in a manner that mimics a conference submission and to properly prepare and present a scientific lecture. The papers will be provided to the entire class in a
symposium-style pdf collection for review and to assist in the evaluation of the oral presentation. Both the paper and the oral presentation will be judged on scientific and technical merit, as well as on the writing and speaking quality. A list of previous topics is attached. The student lectures will be presented in-class during the last 4 weeks of the semester; attendance at these lectures represents 5% of the course grade (see participation).

Topic selection: Sept. 30, 2014
Paper Due Date: Oct. 28, 2014
Lecture Dates: Nov. 4 to Dec. 4, 2014

Scholastic Dishonesty and the Aggie Honor Code: "An Aggie does not lie, cheat, or steal or tolerate those who do." The Code forbids the following:

- **Cheating:** Attempting to use unauthorized materials, information, notes, study aids or other devices or materials in any academic exercise.
- **Fabrication:** Making up data or results; submitting fabricated documents.
- **Falsification:** Manipulating results such that research is not accurately represented in the research record.
- **Multiple Submissions:** Submitting substantial portions of the same work (including oral reports) for credit more than once without authorization from instructors.
- **Plagiarism:** Using another person’s ideas, work, processes, results, writings, words, etc. without giving appropriate credit.
- **Complicity:** Intentionally or knowingly helping, or attempting to help, another to commit an act of academic dishonesty.

If you have questions regarding scholastic dishonesty and the Aggie Honor Code, please visit [http://www.tamu.edu/aggiehonor](http://www.tamu.edu/aggiehonor) for the Honor Council Rules and Procedures, and [http://student-rules.tamu.edu](http://student-rules.tamu.edu) for the Texas A&M University Student Rules.

Violation of the Aggie Honor Code may result in a 0 for the assignment or exam, failure of the course, and reports Aggie Honor System Office.

Professional Behavior: An important attribute of your professional development is that you act and speak in a manner that will not offend others giving particular care to diversity issues.

Americans with Disabilities Act (ADA): The Americans with Disabilities Act (ADA) is a federal antidiscrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please tell your instructor or contact the Department of Student Life, Services for Students with Disabilities, in Cain Hall, or call 845-1637.

Religious Holidays: If you are a member of a religious faith that has one or more holidays which require you to be absent from any class listed above, please tell your instructor at least two weeks in advance of your absence and make arrangements to make-up the class.

Copyrights: The handouts used in this course are copyrighted. "Handouts," refers to all materials generated for this class, which include but are not limited to syllabi, problems, in-class materials, review sheets, and additional problem sets. Because these materials are copyrighted, you do not have the right to copy the handouts, unless the author expressly grants permission.
Additional Notes - Term Paper/Lecture:

Previous Student Project Topics

- Transportation of Radioactive Waste
- The Geology of Yucca Mountain
- Legal Issues Regarding Yucca Mountain
- High Level Waste Testing and Evaluation
- Spent Nuclear Fuel Pool Management
- Fission Product Storage Forms for Cesium and Strontium
- Borosilicate Glass for High Level Nuclear Waste Disposal
- Phosphate Glass for High Level Nuclear Waste Disposal
- Synroc for High Level Nuclear Waste Disposal
- Zeolite Waste Forms for High Level Nuclear Waste Disposal
- Metal Waste Forms for High Level Nuclear Waste Disposal
- The TRUEX Process
- European Reprocessing
- Radwaste Management in Canada
- Advanced Fuels & Pyroprocessing
- Plutonium Disposition Issues
- TRU Burning Reactors
- Radioactive Iodine Therapy for Humans and Cats
- Decommissioning Waste from Nuclear Facilities
- The Hanford Waste Tanks
- Cleanup of Defense-Related Nuclear Waste
- Issues from the Use of DU Weapons
- What do the Anti-Nukes Say about Radwaste
- Sources/Disposal of Medical Radwaste
- Navy Reactors – Radwaste Management
- Chernobyl - Waste Management Issues
- Radiolysis in Radwaste Tanks
- Emergency hazmat during transport in the US
- Transportation of SNF in Europe
- ISFSI and Dry Storage
- MARSSIM: Multi-Agency Radiation Site Survey and Investigation Manual
- Spent Fuel Pool – consolidation, shipping, & other SFP projects

Additional Notes:

- The lecture content should go beyond class notes from the instructor.
- This is a teaching exercise, not just a presentation. Spend time with details, work out examples, and make sure the “students” come away with new knowledge and capability.
- The 50 min time slot should allow time for questions.
- Attendance is required . . . 1% lost from course grade for each unexcused absence (up to 5%).

(Reasonable excuses will be evaluated before an absence. Only serious and documented excuses will be accepted if class is missed without making arrangements beforehand.)
Potential Class Topics

Low Level Waste
TRU Waste/Mixed Waste
Transportation
Tank Wastes
High Level Waste
Yucca Mountain and Beyond.
Spent Nuclear Fuel
Fuel Cycle Operations
High Level Waste Processing
High Level Waste Forms
Course title and number: Special Topics in Internal Dose Assessment - NUEN 685
Term: Fall 2014
Meeting times and location: 10:20-11:10 p.m. W ZACH 008 Lecture

Course Description and Prerequisites
Current and proposed techniques for assessing the absorbed dose due to internally deposited radionuclides; techniques recommended for international and national bodies, as well as those used in nuclear medicine. Prerequisites: NUEN 612 and NUEN 613.

Learning Outcomes
In completing this course the student should develop experimental expertise in the use of nuclear reactors and nuclear radiation as well as analytical capabilities in modeling reactor-based experiments. The student will acquire practical experience in the safe operation of nuclear reactors using a research reactor and this experience will be applicable to larger power reactors, experimental reactors, space reactors, and other nuclear systems. The student will learn (both theoretically and practically) the fundamental measurements performed to test the physics of nuclear systems.

After completion of this course, the student should be able to:
1. Calculate the dose estimate to a particular organ using ICRP or MIRD techniques
2. Calculate the dose estimate to the whole body using ICRP or MIRD techniques
3. Describe the assumptions used by different techniques
4. To use tabulated data to estimate doses for a variety of scenarios.
5. To demonstrate ability during an oral examination
6. To describe the regulations that pertain to a particular exposure scenario

Instructor Information
Name: John Ford
Telephone number: 845-6271
Email address: ford@ne.tamu.edu
Office hours: 10:30-12:30 pm M or by appointment
Office location: 58A ZACH
Textbook and/or Resource Material
While there are no required texts for this course, a number of references should be consulted during this course:


Grading Policies
The student’s final grade will be determined based on the following percentages:

- **Homework**: 50%
- **Oral Examinations**: 40%
- **Project**: 10%

**Standard 10 pt. Scale**: 90+ A, 80-89 B, 70-79 C; 60-69 D, less than 60 F.

Homework
Homework assignments will generally be due the week following the assignment.

Oral Exam
Students will be given an oral exam over the covered material. They will be expected to demonstrate a complete understanding of the topics covered. A review sheet will be provided to aid in preparation.

Lateness Policy
Late homework will be deducted 10% per day after the due date. No homework will be accepted after the graded assignments have been returned to the students (one week following the original due date).

Final Examination
A final examination for the class will be scheduled according to the approved University Final Examination Schedule. The exam will be optional. If selected, the student’s grade will first be determined using the above distribution; this grade will then constitute 80% of the final grade, and the final exam will constitute the remaining 20%. The oral exam will be comprehensive, covering all information discussed in lectures, reading and homework assignments. A review sheet will be provided to the student to aid in studying for this exam.

Per the Final Exam Schedule, the exam will be held:

   Tuesday December 16, 2014, 8:00 a.m. – 10:00 p.m.  ZACH 008

Attendance and Make-up Policies
*Attendance at your assigned laboratory section is required*. If you are unable to attend at your assigned time please inform the instructor in advance, if possible, to schedule an alternate time.

If you have a University excused absence (see student rules, [http://student-rules.tamu.edu/rule07](http://student-rules.tamu.edu/rule07)), we will make arrangements to make up the work or provide additional time to turn in an assignment.

Enacted by the Texas Legislature and effective 9/1/03, Texas House Bill 256 amends Chapter 51: Education Code, Section 51.911, and reads (in part):
"An institution of higher education shall excuse a student from attending classes or other required activities, including examinations, for the observance of a religious holy day, including travel for that purpose. A student whose absence is excused under this subsection may not be penalized for that absence and shall be allowed to take an examination or complete an assignment from which the student is excused within a reasonable amount of time after the absence."

Course Topics, Calendar of Activities, Major Assignment Dates

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
<th>Required Reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction</td>
<td>Handouts</td>
</tr>
<tr>
<td>2</td>
<td>ICRP 2, 6 &amp; 10</td>
<td>Handouts</td>
</tr>
<tr>
<td>3</td>
<td>Reference Man</td>
<td>Handouts</td>
</tr>
<tr>
<td>4</td>
<td>ICRP 26 &amp; 30</td>
<td>Handouts, Homework due 9/22</td>
</tr>
<tr>
<td>5</td>
<td>Reference Models</td>
<td>Handouts, Homework due 9/29</td>
</tr>
<tr>
<td>6</td>
<td>Review for exam</td>
<td>Handouts, Oral Exam #1 10/8</td>
</tr>
<tr>
<td>7</td>
<td>NUREG 8.9 &amp; 8.34</td>
<td>Handouts, Homework due 10/13</td>
</tr>
<tr>
<td>8</td>
<td>MIRD</td>
<td>Handouts, Homework due 10/20</td>
</tr>
<tr>
<td>9</td>
<td>Fetal Exposures</td>
<td>Handouts, Homework due 10/27</td>
</tr>
<tr>
<td>10</td>
<td>Review for exam</td>
<td>Handouts, Oral Exam #2 11/5</td>
</tr>
<tr>
<td>11</td>
<td>EPA Reg. Guide 13</td>
<td>Handouts,</td>
</tr>
<tr>
<td>12</td>
<td>Recent recommendations.</td>
<td>Handouts,</td>
</tr>
<tr>
<td>13</td>
<td>Hot topics</td>
<td>None</td>
</tr>
<tr>
<td>14</td>
<td>Discussion</td>
<td>None, Project due 12/3</td>
</tr>
</tbody>
</table>
Americans with Disabilities Act (ADA)
The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact Disability Services, in Cain Hall, Room B118, or call 845-1637. For additional information visit http://disability.tamu.edu

Academic Integrity
For additional information please visit: http://aggiehonor.tamu.edu

“An Aggie does not lie, cheat, or steal, or tolerate those who do.”

As commonly defined, plagiarism consists of passing off as one’s own the ideas, work, writings, etc., that belong to another. In accordance with this definition, you are committing plagiarism if you copy the work of another person and turn it in as your own, even if you have the permission of that person. Plagiarism is one of the worst academic sins, for the plagiarist destroys the trust among colleagues without which research cannot be safely communicated. If you have questions regarding plagiarism, please consult http://library.tamu.edu/help/help-yourself/using-materials-services/online-tutorials/academic-integrity.
Description:

This course will present qualitative and quantitative concepts of radiation physics pertaining to medical applications in diagnostic radiology by providing an introduction to the theory and laboratory practice of different radiological imaging modalities. The course will present the basic theory of signal analysis, image acquisition and formation, and image processing as it relates to planar X-ray imaging, computed tomography (CT), single photon emission tomography (SPECT), positron emission tomography (PET), and magnetic resonance imaging (MRI).

Reading Assignments:

Basic Concepts
  1. Introduction to Medical Imaging
  2. Computers in Medical Imaging.
  3. Digital Imaging and Communications in Medicine (DICOM).

Diagnostic Radiological Imaging
  5. Screen Film Radiography.
  7. Fluoroscopy.
  8. Image Quality.
 11. Radiation Protection in Radiological Imaging.

Nuclear Medicine Imaging
  12. Radionuclide Production and Radiopharmaceuticals.
  14. Introduction to Computed Emission Tomography
  15. Basic Physics of Radioisotope Imaging.
  18. Positron Emission Tomography (PET) and PET-CT Systems.

Laboratories:
  1. Basic Diagnostic Radiology Laboratory.
  2. Computed Tomography Laboratory
  3. PET/CT Imaging Laboratory.
Final Exam:
The final exam will be a presentation on a project/topic agreed upon between the professor and the student.

Project:
The project should in an area of contemporary medical diagnostic imaging excluding MRI. It should contemplate the current status of a modality for a specific organ/disease and its implications in clinical practice. The project can be associated to a preclinical or clinical study. Please consider in your project the complete diagnostic cycle by incorporating the disease/organ or diagnostic paradigm into your write-ups.

Quizzes:
There will be three quizzes given at random during the course of the semester. They will be based upon the laboratory reports and reading assignments. Before each lab there will be a quiz that will be indicative of your reading assignments. Please read as much as possible before the commencement of each lab.

Course Books:

Reference Books:

**Americans with Disabilities Act:**

The Americans with Disabilities Act (ADA) is a federal antidiscrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation,
please contact the Department of Student Life, Services for Students with Disabilities in Room 126 of the Koldus Building, or call 845-1637.

PLEASE NOTE:

1. AGGIE HONOR CODE: “An Aggie does not lie, cheat, or steal or tolerate those who do.” For additional information please visit: http://aggiehonor.tamu.edu/

2. PROFESSIONAL BEHAVIOR: An important attribute of your professional development is that you act and speak in a manner that will not offend others giving particular care to diversity issues.

3. DISABILITY ACCOMMODATION: If you believe you have a disability requiring an accommodation, please tell your instructor or contact the Department of Student Life, Services for Students with Disabilities, in Cain Hall or call 845-1637.

4. RELIGIOUS HOLIDAYS: If you are a member of a religious faith that has one or more holidays which require you to be absent from any class listed above, please tell your instructor at least two weeks in advance of your absence and make arrangements to make-up the class.
NUEN 689 – Introduction to Radionuclide Production and Separation Methods
Fall 2013

COURSE DESCRIPTION AND PREREQUISITES
Radioisotope production has many practical uses in both research and industry, especially in medical applications. In the last few years, demand for medical radioisotopes has grown at an annual rate between 5 and 15%. This high demand, coupled with limited current production capabilities, ensures that reactor-based and cyclotron-based radioisotope production will become an increasingly important sector of the nuclear industry. It is therefore imperative that the next generation of nuclear professionals learn the intricacies of this complex subject by integrating the fields of nuclear engineering, nuclear physics, material sciences, chemistry, computer sciences, health physics, and regulatory science. This course provides detailed theoretical and practical information covering all aspects of radionuclide production via both particle accelerators and nuclear reactors, including target design, bombardment, target recovery, separation and purification, and further preparation for medical use. Laboratory experiments will be performed at the Nuclear Science Center and the Cyclotron Institute to provide hands-on experience with radioisotope production. Additionally, students are required to complete a project designed to address important concepts of radioisotope production.

Prerequisites: Graduate or Senior level classification

LEARNING OUTCOMES OR COURSE OBJECTIVES
The objectives of this course are to provide the student with a detailed understanding of all aspects of radionuclide production by both particle accelerator and nuclear reactor.

Upon completion of this course the student will be able to:
1. Understand all aspects of nuclear reactor based radioisotope production
2. Understand all aspects of particle accelerator based radioisotope production
3. Utilize computer codes and analytical methods to design a target and optimize target characteristics
4. Understand thermal considerations and target cooling and integrity
5. Estimate and experimentally verify production yields
6. Understand chemical separation and target purification procedures
7. Determine an appropriate labeling method and end-use for a specific radioisotope
8. Assess shielding requirements and other health physics considerations
9. Understand GMP requirements and regulations
10. Design procedures and technical specifications for the start-to-finish production of a specific radioisotope
INSTRUCTOR INFORMATION
Gamal Akabani, Ph.D.
Office: 328A ZACH
Phone: (979) 458-1699
Email: akabani@tamu.edu
Office Hours: By appointment

T. Michael Martin, M.S.
Office: 58Q ZACH
Email: tmichaelmartin@tamu.edu
Office Hours: By appointment

TEXTBOOK AND/OR RESOURCE MATERIALS
The instructor’s notes and lectures will provide the principle source of information for the course. No textbooks are required for this class. Lectures will provide an overview of concepts that will be implemented in labs. Notes will be provided as references to the usage of various applicable computer codes and databases.

GRADING POLICIES
Grading will be based on completion of several projects and one final project. Each project will be of equal weight consisting of 70% of the final grade. The final project due at the end of the semester will be 30% of the final grade.

ONLINE COURSE MATERIAL
All of the material for this course will be maintained on Texas A&M University’s WebCT Vista system. This includes an electronic copy of this syllabus, the course schedule, all lecture notes, laboratory procedures, lab worksheets, supplemental readings, and assignments. The instructor will use the WebCT Vista email system and discussion board to communicate important messages to the students. Students should check their email often to keep updated on current messages. Also, the student’s grades will be posted on the WebCT Vista system, and the students can use this system to check their grades at any time. The WebCT system can be accessed through elearning.tamu.edu. If you are unfamiliar with this system, instruction will be provided.

AMERICANS WITH DISABILITIES ACT (ADA)
The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact Disability Services, in Cain Hall, Room B118, or call 845-1637. For additional information visit http://disability.tamu.edu

ACADEMIC INTEGRITY
“An Aggie does not lie, cheat, or steal, or tolerate those who do.” If you would like additional information please visit: http://www.tamu.edu/aggiehonor
SYLLABUS

Section 1: Introduction and Overview

1.A. History of production, trends, future needs, supply and demand.
1.B. Basic overview of reactor based and cyclotron-based production.
1.C Overview of production facilities and logistics

Section 2: Cyclotron-Based Production

2.A. Cyclotron facility overview
2.A.i Facility design
2.A.ii Laboratory design
2.A.iii Equipment and personnel
2.A.iv Examples of cyclotron facilities

2.A. Accelerator overview
2.A.i. Cyclotrons, components and characteristics of each, why cyclotrons are used for large scale production, ancillary equipment (ion sources, vacuum pumps, cryogenics, etc.)
2.A.ii. Cyclotron physics: cyclotron motion, relativistic effects and isochronous cyclotrons, bending factors (K), focusing magnets, collimation
2.A.iii. Beam characteristics: MeV vs. MeV/nuc, beam energy distribution, electrical and particle current. Measurements of beam energy and current (TOF, monitor reactions, Faraday cups, plastic scintillators, simulation etc.)

2.B. Particle interactions
2.B.i. Cross sections/excitation functions, JANIS database, TALYS for other reactions. Competing reactions [(p,n) vs. (d,2n), etc.] and potential impurities. Other open reaction channels. Overview of other tools (FLUKA, GEANT, IBA)
2.B.ii. Target thickness and energy degradation/stopping power, SRIM, LISE++, NIST PSTAR/ASTAR, range/lateral/energy straggling and consequences. Stacked foils. More in-depth assessment of monitor reactions

2.C. Targetry
2.C.i Cyclotron-based radionuclides
2.C.ii. Target form: solid/liquid/gaseous targets. Target fabrication and availability of materials (available purity, price). Limitations on target thicknesses and tolerances from a manufacturing standpoint
2.C.iii. Heat management: passive cooling, active cooling (rear water, front helium), target geometry (tilting of target to increase area, ridges in target holder to increase cooling surface area on rear, etc.)

Section 3: Nuclear Reactor-Based Production

3.A. Reactor overview
3.A.i Thermal versus fast reactors
3.A.ii Research reactors vs. commercial production reactors
3.B. Reactor targets
   3.B.i. Reactor-based radionuclides
   3.B.ii Target locations: in-core, down tubes, beam ports
   3.B.iii Solid vs. liquid, manufacturing and preparation for activation
   3.B.iv Heating and pressure effects, radiolysis
   3.B.v Activation equations, flux vs. specific activity

Section 4: Post-production Processing
4.A. Separation of product and impurities
   4.A.i Chemical separation methods
   4.A.ii Non-chemical separation methods
   4.A.ii Specific activity
   4.A.iii Isotopic assay
   4.A.iii Quantification of impurities

Section 5: Regulatory Sciences
5.A Hot cells, hoods, other radiation safety considerations

5.B. Good Manufacturing Practices (GMP)
   5.B.i The science behind GMP
   5.B.ii The code of federal regulations (CFR)
       a. 10 CFR Part 20, 40, 50, 61
       b. 21 CFR Part 212

5.C Radiation Protection
   5.C.i Introduction
   5.C.ii Radiological Standards
   5.C.iii Conduct of radiological work
   5.C.iv Radiological and Radioactive Waste Management

Grading Policies

<table>
<thead>
<tr>
<th>Assignments</th>
<th>Number</th>
<th>Percent Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5</td>
<td>50%</td>
</tr>
<tr>
<td>Mid Term Test</td>
<td>1</td>
<td>20%</td>
</tr>
<tr>
<td>Final Project and Presentation</td>
<td>1</td>
<td>30%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Percentile</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>90-100</td>
<td>A</td>
</tr>
<tr>
<td>80-89</td>
<td>B</td>
</tr>
<tr>
<td>70-79</td>
<td>C</td>
</tr>
<tr>
<td>60-69</td>
<td>D</td>
</tr>
</tbody>
</table>
NUEN 689: Nuclear Emergency Response and Dose Assessment
Tuesday/Thursday 14:20 – 15:10, ETB 1020

COURSE DESCRIPTION
This course will provide students information on the United States Nuclear Emergency response program. The overall objective of this class is to provide the students the knowledge on how to assess radiation dose to the public and emergency responders following an event. Topics will include US response teams, the National Response Framework, US guidelines, radioecology, dose assessment techniques and useful software packages. The course will culminate with a Capstone exercise simulating a radiological release with the class being graded on how well they can evaluate doses and how they would advise decision makers.

COURSE OBJECTIVES
Following the conclusion of this class, students will have a clear understanding of how the United States government would respond to disaster that included a radioactive release. Students will also be able to understand and evaluate radioactive release, deposition and airborne data to provide radiation dose estimates for the public and first responders. Students will understand how these values relate to current US guidelines. Students will also know how to use a variety of software packages used by the US emergency response teams.

PREREQUISITES
NUEN 309 or equivalent.

INSTRUCTORS
Professor
Craig Marianno, Ph.D.
Office: 335M Zachry
Phone: (979) 845-6093
Email: marianno@tamu.edu
Office Hours: Thursdays 10:30 – 11:30 (Open door)

CLASS TIME AND LOCATION
Lecture: 14:20 – 15:10, ETB 1020

TEXTBOOKS
There is 1 required text for the course:
The instructor’s notes will be the principle source of information for the course. These notes will be supplied to the students in MS PowerPoint format.

**GRADING POLICIES**

The student’s grade will be based on the following criteria:

- 25% - Participation.
- 25% - Homework
- 25% - Midterm (2/25/2014)
- 25% - Final (5/7/2014, 13:00 – 15:00)

**Homework Policy:** All assignments are due at the beginning of class. An assignment may be turned in by 9 AM the next day, but at a cost of 25% of the grade. Draft lab reports will be given to the instructor in final form (i.e. outlines will be unacceptable).

**DO NOT ASK THE INSTRUCTOR TO PRINT UP YOUR ASSIGNMENTS FOR YOU!!!**

The grades will be determined on the following scale:

- A - 90.00-100.00
- B - 80.00-89.99
- C - 70.00-79.99
- D - 60.00-69.99
- F - 0.00-59.99

**COURSE TOPICS/SCHEDULE**

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>14-Jan</td>
<td>Regulations</td>
</tr>
<tr>
<td>21-Jan</td>
<td>ICS</td>
</tr>
<tr>
<td>28-Jan</td>
<td>Response Teams</td>
</tr>
<tr>
<td>4-Feb</td>
<td>Dose</td>
</tr>
<tr>
<td>11-Feb</td>
<td>Radioecology</td>
</tr>
<tr>
<td>18-Feb</td>
<td>Atmospheric Dispersion</td>
</tr>
<tr>
<td>25-Feb</td>
<td>Midterm</td>
</tr>
<tr>
<td>4-Mar</td>
<td>Rascal</td>
</tr>
<tr>
<td>11-Mar</td>
<td>HotSpot</td>
</tr>
<tr>
<td>18-Mar</td>
<td>Monitoring and Sampling</td>
</tr>
<tr>
<td>25-Mar</td>
<td>Rad Responder/Exercise</td>
</tr>
<tr>
<td>1-Apr</td>
<td>RESRAD and FRMAC Manuals</td>
</tr>
<tr>
<td>8-Apr</td>
<td>Dose Assessment Manual</td>
</tr>
<tr>
<td>15-Apr</td>
<td>Turbo FRMAC</td>
</tr>
<tr>
<td>22-Apr</td>
<td>Wrap-up</td>
</tr>
</tbody>
</table>

**ONLINE COURSE MATERIAL**
All of the material for this course will be maintained on Texas A&M University’s eCampus. This includes an electronic copy of this syllabus, the course schedule, all lecture notes, supplemental readings, and assignments. Students should check their email often to keep updated on current messages. The eCampus system can be accessed through http://ecampus.tamu.edu/. If you are unfamiliar with this system, instruction will be provided.

AMERICANS WITH DISABILITIES ACT (ADA)

The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact Disability Services, in Cain Hall, Room B118, or call 845-1637. For additional information visit http://disability.tamu.edu.

COPYRIGHTS

The handouts used in this course are copyrighted. By "handouts" we mean all materials generated for this class, which include but are not limited to syllabi, lab problems, in-class materials, review sheets, and additional problem sets. Because these materials are copyrighted, you do not have the right to copy the handouts, unless the author expressly grants permission.

SCHOLASTIC DISHONESTY

"An Aggie does not lie, cheat, or steal, or tolerate those who do." If you would like additional information please visit: http://www.tamu.edu/aggiehonor
Texas A&M University
Department of Nuclear Engineering
NUEN 689 – Severe Accident Analysis of Nuclear Facilities
Spring 2014

Course Syllabus

Instructor: Prof. K. Vierow vierow@tamu.edu
Zachry 335S tel. 458-0600
http://engineering.tamu.edu/nuclear/people/vierow-karen

Grader: TBA Email: TBA
Office: TBA

Schedule:
Lecture ENPH201, MWF, 10:20-11:10am
Instructor’s Office Hours: Mon.-Thurs., 11:20am-12:20noon
and by appointment in afternoons
Grader’s Office Hours TBA

Prerequisites: Graduate student in College of Engineering or consent of the instructor.

Course Objectives: This course will be offered as a 3-credit graduate-level course. Severe accident phenomena will be introduced starting with initial fuel heat up and following hypothetical event progression out to the source term. Published experimental programs will be discussed to provide an understanding of the complexity of severe accidents, the safety issues and the phenomena themselves. To aid in synthesis of the course material, lectures will be included to cover the TMI-2, Chernobyl and Fukushima Dai-ichi event sequences. Finally, severe accident codes will be described with respect to the modeling philosophy, techniques, assumptions and limitations. A class project requiring the students to develop their own analysis methodologies/techniques for open-ended problems will be assigned. This thinking exercise is intended to equip students with the analytical capabilities and creativity needed to promote new reactor designs and address unforeseen safety issues.

Course Description: Perspective of severe accidents in the context of nuclear safety; severe accident phenomena; event progression; assessment of TMI-2, Chernobyl and Fukushima Dai-ichi accidents and severe accident experimental data; severe accident analysis tools and underlying methodologies; severe accident considerations for future reactors and future regulatory demands; instruction on model development.

Learning Objectives: 1. Basic comprehension of severe accident phenomena and their implications
2. Familiarity with severe accident analysis tools, their capabilities and limitations
3. Ability to choose and/or develop appropriate modeling methods and tools
4. Intellectual flexibility and creativity to find solutions to new problems

<table>
<thead>
<tr>
<th>Grading:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Homework</td>
<td>30%</td>
</tr>
<tr>
<td>Exam I</td>
<td>20%</td>
</tr>
<tr>
<td>Project</td>
<td>30%</td>
</tr>
<tr>
<td>Final Exam</td>
<td>20%</td>
</tr>
</tbody>
</table>

It is anticipated that the course grades will be assigned as:

- A: 90% or above
- B: 80%-89%
- C: 70%-79%
- D: 60%-69%
- F: as warranted

Text: None. Reading assignments will be provided during the course.

Attendance: Since class discussion is a major course ingredient, regular attendance is mandatory. Attendance records will be taken into consideration in any borderline grade decisions. Refer to the later sections defining excused absences and about in-class quizzes.

Homework: Homework will be due in class 7 days after assignment. A penalty of 5% per day will be deducted for each day late. Homework will not be accepted more than one week late unless prior arrangement is made with the instructor.

Computer output is acceptable for programs, numeric output, and graphical results. Homework may be completed using MATHCAD or other software.

Class Projects: The objective of the class projects is to provide the student with experience on severe accident analysis techniques. Each student will select a project to be approved by the course instructor. A survey of literature available on the topic and a critical assessment of the available information will be conducted and summarized in a technical report. An original analysis will be the main deliverable of this report.

The projects will be done on an individual basis although sharing of references and ideas is welcome.

Grading of the project reports will be based on the following:

- Literature search: 20%
- Critical assessment of available information: 10%
- Technical Approach and Original Analysis: 60%
- Format and Clarity: 10%

Oral Presentation: An oral presentation of the project will be given in class. Presentation length will be determined by the number of students and time available. As an estimate, plan on 20 minutes.
**Midterm Exam:** Exams may consist of true/false questions, multiple choice questions, short answer problems and work out problems.

It is very important that exams are taken at the scheduled time. If a legitimate conflict arises, please contact the instructor ahead of time to work out an alternative exam time. Note that having an exam in other classes in close time proximity is not considered an acceptable conflict. Please attempt to avoid scheduling plant trips and interviews during exam times.

Scheduling an alternate exam is equivalent to accepting that the exam may be different than the exam taken by the rest of the class.

**Final Exam:** The final exam will be an oral exam given during final examination days. The oral final exam will be comprehensive and with closed books, closed notes and no calculators or other aids. The final exam will be approximately 30 min. per student.

**Quizzes:** The instructor reserves the right to give quizzes if class performance or attendance is lagging. Any quizzes given will count as homework points towards the course grade.

**References:**


Technical journals such as *Nuclear Engineering and Design* and *Nuclear Technology*


NRC ADAMS data collections.
Start at www.nrc.gov
Select “ADAMS Public Documents” in the right column
Select “Begin Web-based ADAMS Search”
Use the “content search” or the “advanced search” tab
Search for your topic
  e.g. “AP1000 Design Control Document”
If you know the accession number, under Content Search,
  select Accession Number for the Property and type
  the accession number as the Value.

**Honesty Policy:**
It is very important to display academic integrity in class
assignments and exams. While it is appropriate and encouraged to
work together on homework assignments and literature review
projects, each person must turn in homework assignments and a
project report that show original work to receive credit. Exams
must be taken without the assistance of others.

Academic dishonesty on an exam or class assignment will result in
actions as described in the honor code policies. Academic
dishonesty is defined on the Aggie Honor Code website.

**Aggie Honor Code**
“An Aggie does not lie, cheat, or steal or tolerate those who do.”
Ref.: http://student-rules.tamu.edu/aggiecode

For additional information, please visit:
http://aggiehonor.tamu.edu/

**Americans with Disabilities Act (ADA) Policy Statement**
The Americans with Disabilities Act (ADA) is a federal anti-
discrimination statute that provides comprehensive civil rights
protection for persons with disabilities. Among other things, this
legislation requires that all students with disabilities be guaranteed
a learning environment that provides for reasonable
accommodation of their disabilities. If you believe you have a
disability requiring an accommodation, please contact Disability
Services, in Cain Hall, Room B118, or call 845-1637. For
additional information visit http://disability.tamu.edu.

**Excused Absences:**
University Rule Regarding Excused Absences

7.1 The student is responsible for providing satisfactory
evidence to the instructor to substantiate the reason for
absence. Among the reasons absences are considered
excused by the university are the following:

7.1.6 Injury or illness that is too severe or contagious for the
student to attend class.

7.1.6.1 Injury or illness of three or more days. For injury or illness
that requires a student to be absent from classes for three or
more university business days (to include classes on
Saturday), the student should obtain a medical confirmation
note from his or her medical provider. The Student Health
Center or an off-campus medical professional can provide a
medical confirmation note only if medical professionals are
involved in the medical care of the student. The medical confirmation note must contain the date and time of the illness and medical professional's confirmation of needed absence.

7.1.6.2 Injury or illness less than three days. Faculty members may require confirmation of student injury or illness that is serious enough for a student to be absent from class for a period less than three university business days (to include classes on Saturday). At the discretion of the faculty member and/or academic department standard, as outlined in the course syllabus, illness confirmation may be obtained by one or both of the following methods:


b. Confirmation of visit to a health care professional affirming date and time of visit.

7.1.6.3 An absence for a non acute medical service does not constitute an excused absence.

To view all Student Rules, please go to: http://student-rules.tamu.edu/

Religious Holidays: Any student with a religious holiday(s) that has an obligation resulting in class absence is requested to inform the course instructor at least a week ahead of time to arrange for class makeup.
<table>
<thead>
<tr>
<th>Date</th>
<th>Topic</th>
<th>HW Set</th>
<th>Due Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>01/13/14</td>
<td>Current severe accident issues</td>
<td></td>
<td></td>
</tr>
<tr>
<td>01/15/14</td>
<td>DBA vs. severe accident, safety goals and requirements</td>
<td>Set 1</td>
<td>01/22/14</td>
</tr>
<tr>
<td>01/17/14</td>
<td>Regulatory requirements for severe accident prevention and analysis; IPE’s, NUREG-1150</td>
<td></td>
<td></td>
</tr>
<tr>
<td>01/20/14</td>
<td><strong>MLK Day</strong> – class does not meet</td>
<td></td>
<td></td>
</tr>
<tr>
<td>01/22/14</td>
<td>Perspective of severe accidents in the context of nuclear safety; historical perspective, WASH-1400</td>
<td>Set 2</td>
<td>01/29/14</td>
</tr>
<tr>
<td>01/24/14</td>
<td>Severe accident phenomena – initiating events</td>
<td></td>
<td></td>
</tr>
<tr>
<td>01/27/14</td>
<td>Severe accident phenomena – core degradation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>01/29/14</td>
<td>Severe accident phenomena – core degradation</td>
<td>Set 3</td>
<td>02/05/14</td>
</tr>
<tr>
<td>01/31/14</td>
<td>Severe accident phenomena – core degradation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>02/03/14</td>
<td>Severe accident phenomena – late phase events</td>
<td></td>
<td></td>
</tr>
<tr>
<td>02/05/14</td>
<td>Severe accident phenomena – late phase events</td>
<td>Set 4</td>
<td>02/12/14</td>
</tr>
<tr>
<td>02/07/14</td>
<td>Severe accident phenomena – late phase events</td>
<td></td>
<td></td>
</tr>
<tr>
<td>02/10/14</td>
<td>Severe accident phenomena – steam explosions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>02/12/14</td>
<td>Severe accident modeling: common assumptions and simplifications, code overviews</td>
<td>Set 5</td>
<td>02/19/14</td>
</tr>
<tr>
<td>02/14/14</td>
<td>Severe accident analysis codes – MELCOR Modeling philosophy, techniques</td>
<td></td>
<td></td>
</tr>
<tr>
<td>02/17/14</td>
<td>Severe accident analysis codes – MELCOR Assumptions, limitations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>02/19/14</td>
<td>Severe accident analysis codes – Comparison among leading US Codes</td>
<td>Set 6</td>
<td>02/26/14</td>
</tr>
<tr>
<td>02/21/14</td>
<td>TMI-2 accident progression</td>
<td></td>
<td></td>
</tr>
<tr>
<td>02/24/14</td>
<td>TMI-2 accident response: implications for current and new reactors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>02/26/14</td>
<td>Chernobyl accident progression</td>
<td></td>
<td></td>
</tr>
<tr>
<td>02/28/14</td>
<td>Model development techniques</td>
<td></td>
<td></td>
</tr>
<tr>
<td>03/03/14</td>
<td><strong>Midterm exam (covers Lectures 1-16)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>03/05/14</td>
<td>Modeling of severe accident progression – in-vessel</td>
<td>Set 7</td>
<td>03/19/14</td>
</tr>
<tr>
<td>03/07/14</td>
<td>Comanche Peak tour preparation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>03/10/14</td>
<td><strong>SPRING BREAK (March 10-14)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>03/17/14</td>
<td>Insights from experiments – in-vessel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>03/19/14</td>
<td>Code assessment against experimental data – in-vessel</td>
<td>Set 8</td>
<td>03/26/14</td>
</tr>
<tr>
<td>03/21/14</td>
<td>Modeling of severe accident progression – in containment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>03/24/14</td>
<td>Insights from experiments – in containment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>03/26/14</td>
<td>Code assessment against experimental data – in containment</td>
<td>Set 9</td>
<td>04/02/14</td>
</tr>
<tr>
<td>03/28/14</td>
<td>Modeling of severe accident progression – beyond containment – the MACCS Code</td>
<td></td>
<td></td>
</tr>
<tr>
<td>03/31/14</td>
<td>Modeling of severe accident progression – beyond containment (the SOARCA project)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>04/02/14</td>
<td>Insights from experiments – beyond containment</td>
<td>Set 10</td>
<td>04/09/14</td>
</tr>
<tr>
<td>04/04/14</td>
<td>Code assessment against experimental data – beyond containment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>04/07/14</td>
<td>Case studies: uncertainties in material properties hydrogen studies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>04/09/14</td>
<td>Risk-informed Decision Making in Severe Accident</td>
<td>Set 11</td>
<td>04/16/14</td>
</tr>
<tr>
<td>Date</td>
<td>Event</td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------</td>
<td>--------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>04/11/14</td>
<td>Fukushima Dai-ichi Accident – I</td>
<td></td>
<td></td>
</tr>
<tr>
<td>04/14/14</td>
<td>Fukushima Dai-ichi Accident - II</td>
<td></td>
<td></td>
</tr>
<tr>
<td>04/16/14</td>
<td>Fukushima Dai-ichi Accident investigations, RCIC project</td>
<td></td>
<td></td>
</tr>
<tr>
<td>04/18/14</td>
<td><strong>Reading Day</strong> – class does not meet</td>
<td></td>
<td></td>
</tr>
<tr>
<td>04/21/14</td>
<td>Estimating Societal Risks of Severe Accidents</td>
<td></td>
<td></td>
</tr>
<tr>
<td>04/23/14</td>
<td>Severe accident goals for future reactors and future regulatory demands</td>
<td>Project reports due</td>
<td></td>
</tr>
<tr>
<td>04/25/14</td>
<td>Project presentations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>04/28/14</td>
<td>Project presentations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>04/29/14</td>
<td>Project presentations</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Redefined Day. Students attend Friday classes.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>05/06/14</td>
<td>Final Exam, 8-10am</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
NUEN 689 - Introduction to GEANT4 Monte Carlo Transport
Fall 2014
Class Time: Tuesdays and Thursdays, 5:30 PM to 6:45 PM

Gamal Akabani, PhD. Jonathan Madsen, MS.
akabani@tamu.edu  madsen_jr@tamu.edu

COURSE DESCRIPTION AND PREREQUISITES
The CERN-based GEANT4 Monte Carlo Toolkit is an open-source object-oriented C++ toolkit for the simulation of the passage of particles through matter developed by a worldwide collaboration of member. Its diverse areas of application are high-energy, nuclear and accelerator physics, in addition to medical and space sciences. This course will provide an introduction to application development using GEANT4 Monte Carlo Toolkit and an introduction to the C++ language, which is required for application development. GEANT4 does not provide a standard for input files describing the desired simulation such as MCNP; instead, the design of the GEANT4 toolkit provides an API for developing particle-physics applications that are tailored to the simulation of interest. In essence, GEANT4 provides the LEGO® pieces and the application developer is responsible for choosing which LEGO® pieces are needed and assembling them. The added complexity of developing a GEANT4 program is countered by immense flexibility in the area of application, physics models, dynamic parameters, visualization, and data collection among many other things. Monte Carlo principles will be addressed as needed.

Prerequisites: Graduate level classification with some background in particle physics. Previous programming experience in any language.

LEARNING OUTCOMES OR COURSE OBJECTIVES
The objectives of this course are to give the student an understanding of how to develop particle physics simulations using GEANT4.

Upon completion of this course the student will be able to:
1. Develop in C++ programming language
2. Customize I/O and data collection in C++ for GEANT4
3. Understand the object-oriented polymorphism of GEANT4
4. Create complex geometrical structures
5. Create complex particle generators and distributions
6. Customize physics lists for a simulation
7. Understand how to implement statistical analysis in Monte Carlo
8. Create unique C++ classes for additional GEANT4 functionality
9. Create a complete GEANT4 application

INSTRUCTOR INFORMATION
Gamal Akabani, Ph.D.
Office: 328A ZACH
Phone: (979) 458-1699
Email: akabani@tamu.edu

167
TEXTBOOK AND/OR RESOURCE MATERIALS
The instructor’s notes and lectures will provide the principle source of information for the course. Online Documentation: http://geant4.web.cern.ch/geant4/support/userdocuments.shtml. No textbooks are required for this class. Lectures will provide an overview of concepts that will be implemented in labs. Notes will be provided as references to the usage for various classes provided by the core of the GEANT4 toolkit. Supplemental C++ programs for generation of GEANT4 user class templates will be provided.

GRADING POLICIES
Grading will be based on completion of labs and a final project. There will be a total of 10 labs each of equal weight consisting of 70% of the final grade. The final project due at the end of the semester will be 30% of the final grade.

SCHEDULE

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Intro to C++</td>
</tr>
<tr>
<td>2</td>
<td>Intro to C++</td>
</tr>
<tr>
<td>3</td>
<td>Intro to C++</td>
</tr>
<tr>
<td>4</td>
<td>Intro to GEANT4 and CMake</td>
</tr>
<tr>
<td>5</td>
<td>Geometry Construction</td>
</tr>
<tr>
<td>6</td>
<td>Primary Generator Action</td>
</tr>
<tr>
<td>7</td>
<td>User Action Classes*</td>
</tr>
<tr>
<td>8</td>
<td>Scoring, Visualization</td>
</tr>
<tr>
<td>9</td>
<td>User Action Classes**</td>
</tr>
<tr>
<td>10</td>
<td>Adding new classes</td>
</tr>
<tr>
<td>11</td>
<td>Physics Lists</td>
</tr>
<tr>
<td>12</td>
<td>Statistical Analysis</td>
</tr>
<tr>
<td>13</td>
<td>Parameterized Geometries</td>
</tr>
<tr>
<td>14</td>
<td>Advanced concepts</td>
</tr>
<tr>
<td>15</td>
<td>Advanced concepts</td>
</tr>
<tr>
<td>16</td>
<td>Advanced concepts</td>
</tr>
<tr>
<td>*</td>
<td>Run, Event, Stepping</td>
</tr>
<tr>
<td>**</td>
<td>Tracking, Stacking, + others</td>
</tr>
</tbody>
</table>

ONLINE COURSE MATERIAL
All of the material for this course will be maintained on Texas A&M University’s WebCT Vista system. This includes an electronic copy of this syllabus, the course schedule, all lecture notes, laboratory procedures, lab worksheets, supplemental readings, and assignments. The instructor will use the WebCT Vista email system and discussion board to communicate important messages to the students. Students should check their email often to keep updated on current messages. Also, the student’s grades will be posted on the WebCT Vista system, and the students can use this system to check their grades at any time. The WebCT system can be accessed through elearning.tamu.edu. If you are unfamiliar with this system, instruction will be provided.

AMERICANS WITH DISABILITIES ACT (ADA)
The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact Disability Services, in Cain Hall, Room B118, or call 845-1637. For additional information visit http://disability.tamu.edu

ACADEMIC INTEGRITY

“An Aggie does not lie, cheat, or steal, or tolerate those who do.” Enough said. If you would like additional information please visit: http://www.tamu.edu/aggiehonor
NUEN 489, NUEN 689. Probability and Risk Assessment

Fall Semester, 2014

Time: 12:40 – 14:40 Friday

Location: CE 134

Instructor: Ernie Kee
(979) 479-2312; erniekee@tamu.edu

Catalog Description: At least two categories of “operational risk” have evolved in the last few years: health and safety of the public (nuclear safety) and production. We will investigate these sources of risk, centering discussion around an actual plant system, using plant data and design information in models in the course.

Textbooks and/or Other Required Materials: Source materials for most subjects are course notes written by the instructor, distributed to the class, and covering topics that are not treated or incomplete in the text and reference.


Course Objectives: Develop in the students the abilities to (1) analyze radioactivity hazards, (2) critically appraise and interpret measurements, (3) understand origins of intrinsic variability and (4) assign fundamental uncertainties for risk analyses based upon the physical and chemical properties of environmental radioactive species.

Topics Covered:
Probabilistic Risk Assessment
Generation Risk Assessment
Nuclear Power Plant Equipment Availability and Reliability
Basic Software Used in NPP PRAs
Data Sources and Data Characteristics
Fault Tree Development
Event Tree Development
Conceptual Topics on Risk Assessment Model Development

Homework: 2 small projects on practical (small) applications of risk analysis
3 homework questions subjective in nature

Grading: Homework 20%; Homework may be resubmitted for additional partial credit
2 Quizzes 80% open notes, open book
Entries are tentative or planned as of current date.

<table>
<thead>
<tr>
<th>Date</th>
<th>Lecture Notes and Lectures</th>
<th>Assign</th>
<th>Due</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sept. 5</td>
<td>Lect. Notes 1: Introduction, background of PRA/GRA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sept. 12</td>
<td>Lect. Notes 2: Method of analysis, tools</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sept. 19</td>
<td>Lect. Notes 3: Example problem, FMEA, Data, Project 1</td>
<td>Proj 1</td>
<td></td>
</tr>
<tr>
<td>Sept. 26</td>
<td>Lect. Notes 4: Reliability, availability, frequency</td>
<td>Hwk. 1</td>
<td></td>
</tr>
<tr>
<td>Oct. 3</td>
<td><strong>Quiz 2</strong> Complete Lect. Notes 4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oct. 10</td>
<td>Lect. Notes 5: ESD development, concept, sources</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oct. 24</td>
<td>Lect. Notes 7: Use of risk in asset management</td>
<td>Hwk. 2</td>
<td>Proj 1</td>
</tr>
<tr>
<td>Oct. 31</td>
<td>Lect. Notes 8: Total cost of maintenance</td>
<td></td>
<td>Hwk. 1</td>
</tr>
<tr>
<td>Nov. 7</td>
<td>Lect. Notes 9: Data and data characteristics, modeling</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nov. 14</td>
<td><strong>Quiz 2</strong> Complete Lect. Notes 9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nov. 21</td>
<td>Lect. Notes 10: Data updating processes</td>
<td></td>
<td>Proj 2</td>
</tr>
<tr>
<td>Nov. 28</td>
<td>Lect. Notes 11: Risk communication, perception</td>
<td></td>
<td>Hwk 2</td>
</tr>
<tr>
<td>Dec. 5</td>
<td>Lect. Notes 12: Review</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Americans with Disabilities Act

The Americans with Disabilities Act (ADA) is a federal antidiscrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact the Department of Student Life, Services for Students with Disabilities in Room 126 of the Koldus Building, or call 845-1637.

Copyrights

The handouts used in this course are copyrighted. By "handouts" we mean all materials generated for this class, which include but are not limited to syllabi, lab problems, in-class materials, review sheets, and additional problem sets. Because these materials are copyrighted, you do not have the right to copy the handouts, unless the author expressly grants permission.

Scholastic Dishonesty

As commonly defined, plagiarism consists of passing off as one's own the ideas, work, writings, etc., that belong to another. In accordance with this definition, you are committing plagiarism if you copy the work of another person and turn it in as your own, even if you have the permission of that person. Plagiarism is one of the worst academic sins, for the plagiarist destroys the trust among colleagues without which research cannot be safely communicated. If you have questions regarding plagiarism, please consult the latest issue of the Texas A&M University Student Rules [http://student-rules.tamu.edu/], under the section "Scholastic Dishonesty."
Course general description
Over the past two decades, the average total yearly production of electrical energy from the nuclear reactors in the United States has steadily increased to the point that they are operating at approximately 90% of maximum production (installed capacity.) Three decades ago, average production from many of the same plants was less then 70% of installed capacity. Some would argue that risk analyses, particularly insights from probabilistic risk assessment analyses, has played a significant part in the production gains. The perception of risk in the minds of both the operators and the regulatory bodies has been influenced by these studies. At least two categories of what could be referred to as “operational risk” have evolved in the last few years. One category addresses risk to the health and safety of the public, or nuclear safety risk. A second category would be production risk. We will investigate practical approaches to address these sources of risk, centering discussion around an actual plant system, using plant maintenance data, and design information to progressively update the system model through the course.

Objectives:
- Introduce the meaning of risk, its mathematical formulations and how it is used in management and design of engineered processes.
- Introduce the construction and quantification of fault and event trees.
- Introduce principles of risk communication, risk perception, and applications.

Topics to be introduced in the course are:
- Quantitative and qualitative risk: definitions and measures.
- Probabilistic risk assessment, fault and event trees
- Production risk assessment in design and operation.
- Risk based regulations, risk informed decision making.
- Risk management, application and misapplication.

Course outcomes:
- Construct event sequence diagrams for simple systems.
- Construct fault trees and event trees for a simplified system.
- Develop a failure modes and effects analyses.
- Know where to find data and develop a database for basic equipment.
- Understand failure definitions for risk and reliability analyses.
- Understand availability and frequency models.
Course title and Number: NUEN 689: Special Topics in Uncertainty Quantification in Nuclear Science and Engineering  
Term: Fall 2014  
Meeting times and location: TR 2:20-3:35pm, ETB 1035

Course Description and Prerequisites
Simulation-based prediction is common in many fields of engineering, and nuclear engineering is no exception. This course asks, and begins to answer, the question of how can we have confidence in the predictions of computer codes when the inputs to those codes are inherently uncertain. We will demonstrate how to build confidence in computer models, find the important uncertain parameters, and make a qualified prediction.

Prerequisites are an understanding of numerical methods and an ability to write numerical software in Matlab, Python, Fortran, C++, etc.

Course Outcomes and Objectives
At the end of this course you will understand what it takes to make simulation-based predictions with quantified uncertainties. Specifically, the student will

1. Compare simulation results with experiments.
2. Calibrate simulation parameters to match experimental results.
3. Discuss the problem of defining a “domain” of validation.
4. Learn what code-to-code comparison can and can’t do.
5. Perform a sensitivity analysis on a numerical code.
6. Propagate uncertainties in the input parameters to the final simulation result via stochastic sampling, polynomial chaos, and reliability methods.
7. Use “intrusive” methods to propagate the uncertainties in a prediction.
8. Evaluate the effect of epistemic uncertainties on a simulation.
9. Use Bayesian inference to reduce input uncertainties.

Instructor Information
Name: Ryan G. McClarren, PhD.  
Telephone Number: (979) 862-1779  
Email address: rgm@tamu.edu  
Office Hours: W 4-5pm or by serendipity  
Office Location: ZACH 335W

Textbook and/or Resource Materials
The class notes and various handouts will serve in place of a textbook. Additional supplementary material can be found in the following resources:

Calin and Louis, *Bayesian Methods for Data Analysis*, Chapman and Hall/CRC.
Santer, Williams, and Notz, *Design and Analysis of Computer Experiments*, Springer.
**Grading Policies**

The course grade will be computed based on the following weights:
- Homework: 30%
- Project: 30%
- Starred Problems: 30%
- Class Participation: 10%

**Course Topics, Calendar of Activities, Major Assignment Dates**

**Topics**
1. Verification/Review of numerical approximations (3 lectures)
2. Validation Data (2 lectures)
3. Uncertainty Quantification
   a. Prob/Stats preliminaries (1 lecture)
   b. Perturbation / first-order sensitivity
   c. Sampling methods (2 lectures)
   d. Reliability methods (1 lecture)
   e. Polynomial Chaos/Collocation methods (2 lectures)
4. Surrogate-based Methods
   a. Linear regression (1.5 lectures)
   b. Bayesian statistics (1 lectures)
   c. Markov Chain Monte Carlo sampling (1 lecture)
   d. Gaussian Process Regression (1.5 lectures)
   e. MARS (1.5 lectures)
   f. Applications of surrogates (1.5 lectures)
5. Calibration and Prediction
   a. Calibration methods (2 lectures)
   b. Predictive models (2 lectures)

**Other Pertinent Course Information**

**Americans with Disabilities Act (ADA)**

The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact Disability Services, in Cain Hall, Room B118, or call 845-1637. For additional information visit [http://disability.tamu.edu](http://disability.tamu.edu)

**Academic Integrity**

*For additional information please visit: [http://www.tamu.edu/aggiehonor](http://www.tamu.edu/aggiehonor)*

“An Aggie does not lie, cheat, or steal, or tolerate those who do.”