Program Proposal for an Undergraduate Nuclear Engineering Minor

1. **Name of the proposed minor.**

   Undergraduate Nuclear Engineering Minor

2. **Name of the department(s) involved.**

   Mechanical Engineering Department/Industrial and Manufacturing Systems Engineering

3. **Name of contact person(s).**

   Dr. Gregory Maxwell, Mechanical Engineering Department

   Dr. Carolyn Heising, Industrial and Manufacturing Systems Engineering

4. **General description of the minor.**

   The Undergraduate Minor in Nuclear Engineering is comprised of 15 credits of which 9 credits are taken from a group of 3 required courses and the remaining 6 credits are selected from a list of supporting or optional courses. Some of the courses that comprise this minor are offered at Iowa State University while others are offered through four of the Big 12 Nuclear Consortium Schools that have formal Nuclear Engineering Departments or Programs. These four schools offering an assortment of nuclear engineering courses via web-based distance education are Texas A&M University (TAMU), University of Missouri Columbia (UMC), Kansas State University (KSU) and the University of Austin (UTA).

   The course requirements for the Undergraduate Nuclear Engineering Minor are as follows.

   Required courses (9 credits)
   - Nuc E 401 [presently ME 431-ISU] Nuclear Radiation Theory and Engineering. (3 cr, F Prereq Phys 222)
   - Nuc E 402 [ME 361E-UTA] Nuclear Reactor Engineering (3 cr, S Prereq Nuc E 401)
   - Nuc E 405 [NE 690-KSU] Radiation Protection and Shielding. (3 cr, S Prereq Nuc E 401)

   Supporting courses (2 needed for 6 credits)
   - Nuc E 410 [NUEN 301-TAMU] Nuclear Reactor Theory (3 cr, F Prereq Nuc E 405)
   - Nuc E 411 [NUEN 304-TAMU] Nuclear Reactor Analysis (3 cr, S Prereq Nuc E 410)
   - M E 433 (ISU) Alternative Energy Conversion (3 cr, F)

The above four courses included in the minor that are offered at three of the four above universities (UTA, KSU and TAMU) have been given the Iowa State University designation of "Nuc E", and they have been approved as experimental courses by the Engineering College Curriculum Committee. These four courses are Nuc E 402, Nuc E 405, Nuc E 301 and Nuc E 304.

The three courses that are on the required list were selected based on ensuring that students who participate in this minor acquire a body of knowledge in the fundamentals of nuclear engineering. This body of knowledge is valuable to any student who pursues a career in nuclear power, and in addition it allows students to then proceed to taking the more advanced courses from the supporting course list. Of special importance, the required courses selected ensures that all graduates of the nuclear engineering minor obtain a minimum body of knowledge in nuclear engineering that would allow them to apply their specialized field of engineering knowledge to nuclear-related applications such as nuclear plant and site construction, nuclear power plant operations and engineering, nuclear safety and radioactivity. The required courses also ensure that all graduates are provided with a strong foundation in the safety aspects of both nuclear radioactivity and power plant engineering and operations along with background knowledge of nuclear medicine, homeland security (detectors) and advanced reactor materials.

The supporting courses that are listed in this program provide an opportunity for students to build upon the knowledge gained in the required courses by taking either more advanced courses or more specialized courses dealing with specific areas of Nuclear Engineering.

5. Need for the proposed minor.

Because of problems related to pollution and global warming, which are occurring as a result of the widespread usage of fossil fuels, there is resurgence in society's interest for utilizing nuclear power to meet the country's energy needs. As a result of this expansion of nuclear power, many entities associated with either nuclear power plant construction, operations, and regulations are in the process of making plans to significantly increase the number of engineers they hire. In many cases, these hiring organizations would prefer that the engineers have a background in nuclear engineering, either in the form of a nuclear engineering degree or at least in the form of course work related to the nuclear engineering field. Therefore, this Nuclear Engineering Minor at Iowa State University would allow engineering students to acquire a formal background in nuclear engineering topics that would not only benefit students, but also fulfill a societal need for future hiring of engineers.

6. Objectives of the proposed minor including the student learning outcomes and how the learning outcomes will be assessed.

Nuclear Engineering Minor objectives:

Provide a mechanism where students can enroll in a formal program that enables them to acquire a basic and fundamental knowledge of nuclear power engineering

thus enabling them to pursue employment in any one of a number of fields associated with the construction, operation or regulation of nuclear power generation.

Student Learning Outcomes:

The Student Learning Outcomes are embedded in the six courses that have been selected to be part of the Nuclear Engineering Minor. However, they all have a common theme of contributing to either a basic knowledge of the nuclear sciences or a working knowledge of the nuclear engineering field, including nuclear power generation.

Assessments:

A faculty committee for course assessment was established as part of the Big 12 Nuclear Engineering Consortium with ISU's representative being Dr. Pate from the Mechanical Engineering Department. The committee was charged with establishing conventions for assessment of nuclear engineering courses that will be offered by distance education within the Big 12 Nuclear Engineering Consortium. The participants in the Big 12 have agreed to follow the committee's recommendation and for those courses offered on campus at ISU, the recommendations will also be adhered to. A copy of the agreement is attached to this proposal as an appendix.

7. Relationship of the minor to other programs at Iowa State University.

The proposed Nuclear Engineering Minor does not overlap with any other programs at Iowa State University. It will be administered by the Mechanical Engineering Department for a multitude of reasons including 1) several of the courses that make up the minor are presently taught in the ME Department as technical electives for mechanical engineers, 2) there is a historical connection in that after ISU's Nuclear Engineering Department was dissolved in the 1990s many of the professors joined the ME Department because of the close technical connection between mechanical and nuclear engineering, 3) many of the nuclear engineering programs around the country are formally joined with mechanical engineering departments, 4) most of the hires in the nuclear industry, either in terms of construction, operations, or regulations are from the mechanical engineering discipline.

8. Relationship of the minor to the strategic plans of the university, of the college, and of department or program.

The strategic plans of the university, the college and the department all, either directly or indirectly, address the goal of having Iowa State University education address societal problems while providing benefit to the state of Iowa. One of the most pressing problems of society is the widespread usage of fossil fuels, either because of global warming concerns or projected future fuel shortages, especially in the case of oil and natural gas. The solution to these problems is having society adopt on a wide scale the usage of alternative energies, and nuclear power is one of the most promising, based on its past track record as a solution along with economic

considerations. Proof of this interest in using nuclear power as an alternative to fossil fuels is the fact that numerous licenses for constructing new nuclear reactor plants have been issued by the U.S. Nuclear Regulatory Commission (NRC) in the past year. In addition, employers are making plans to significantly expand their hiring of engineers with nuclear backgrounds in the next few years to meet the needs of this resurgence in nuclear power. Many of these companies are located in the Midwest including Iowa, and historically these companies have had strong ties to Iowa State University, either in the form of a strong alumni base or in hiring our graduates on a continuous basis.

9. Comparison of the proposed minor with similar programs at other universities, including the Regent's universities.

The only other state-supported engineering program in Iowa is the one at the University of Iowa, however, it does not offer either a major or minor in nuclear engineering or related field. A search of courses at U of I, which might have nuclear engineering content, indicated that there are no applicable or related courses either presently offered or in the U of I Curriculum Catalog. In addition, neither of the two private universities in Iowa which also offer engineering degrees, namely Dordt College and Loras College, have any nuclear engineering related courses.

10. Program requirements and procedures, including:

a. prerequisites for prospective students;

Enrolled at Iowa State University as a student in the College of Engineering

b. application and selection process;

Complete and submit the official ISU "Request for Minor" form. The selection process is based on approval by the department administering the minor, which is Mechanical Engineering.

c. language requirements;

None

d. courses and seminars presently available for credit toward the program;

- Nuc E 401 [presently ME 431-ISU] Nuclear Radiation Theory and Engineering. (3 cr, F Prereq Phys 222)
- Nuc E 402 [ME 361E-UTA] Nuclear Reactor Engineering (3 cr, S Prereq Nuc E 401)
- Nuc E 405 [NE 690-KSU] Radiation Protection and Shielding. (3 cr, S Prereq Nuc E 401)
- Nuc E 410 [NUEN 301-TAMU] Nuclear Reactor Theory (3 cr, F Prereq Nuc E 405)
- Nuc E 411 [NUEN 304-TAMU] Nuclear Reactor Analysis (3 cr, S Prereq Nuc E 410)
- M E 433 (ISU) Alternative Energy Conversion (3 cr, F)

e. proposed new courses or modifications of existing courses;

The Nuclear Engineering Minor does not require that new courses be developed or that existing courses be modified.

f. advising of students;

Advising of students will be combination of their respective advisors within their major department along with, in the case of the minor, either the Mechanical Engineering Advising Center or the minor administration team, namely Drs. Maxwell and Heising.

g. implications for related areas within the university;

None

11. General description of the resources currently available and future resource needs, in terms of:

a. faculty members;

The two faculty members, Drs. Gregory Maxwell and Carolyn Heising, who are coordinating the Nuclear Engineering Minor have significant experience in the area of nuclear engineering.

Dr. Gregory Maxwell, ME Department:

Dr. Maxwell has an M.S. in Nuclear Engineering from Purdue University, and he has worked in the nuclear field on the Gaseous Centrifuge Project at the Separation Systems Division in Oak Ridge, Tennessee and with the Blowdown Heat Transfer Group (Light Water Reactor Safety) at Oak Ridge National Labs. He also has participated in "This Atomic World", which is a Secondary Education Science Enrichment Program through Oak Ridge Associated Universities (ORAU). At ISU, he is currently teaching ME 431 (Nuclear Radiation Theory and Engineering).

Dr. Carolyn Heising: IMSE

Dr. Heising has an M.S. in Nuclear Engineering from Stanford. Following completion of her Ph.D. in Mechanical Engineering at Stanford, she served as a postdoctoral research associate and then as an associate professor of Nuclear Engineering at MIT. Currently she is on faculty improvement leave to General Atomics Company, San Diego, working on the modular helium reactor which is a part of the Global Nuclear Energy Partnership (GNEP) program. Her research includes nuclear reactor safety, probabilistic risk assessment and quality control for nuclear power plants and other industry. She is an active member of the American Nuclear Society (ANS) and has served as chairman of the National Planning Committee, two-term member of the Board of Directors, and chairman and member of Professional Women in the ANS.

b. computers, laboratories, and other facilities;

As presently required by existing ISU courses that comprise the minor and in the case of off campus courses by what one would normally expect in a typical engineering course.

c. library facilities (journals, documents, etc.) in the proposed area;

As presently required by existing ISU courses that comprise the minor and in the case of off campus courses by what one would normally expect in a typical engineering course.

d. supplies, field work, student recruitment, etc.

As presently required by existing ISU courses that comprise the minor and in the case of off campus courses by what one would normally expect in a typical engineering course.

12. Describe the needs for new resources and/or reallocated resources. Attach to the program proposal memos from the department chair(s), the college dean(s), and other appropriate persons, agreeing to the allocation of new resources and/or the reallocation of resources.

No new resources are required because the courses that make up the Nuclear Engineering Minor are either already in the Iowa State University Catalog or in the case of off campus courses with ISU's Nuclear Engineering designator, "Nuc E", they have already been approved as experimental courses by the Engineering College Curriculum Committee (ECCC). The off-campus courses are offered as web-based courses and students will be responsible for any fees required by the delivery institution (either Texas A&M, University of Texas, Kansas State, or University of Missouri) that are above and beyond what ISU agrees to in formal memorandums between ISU and the Big 12 Nuclear Engineering consortium.

13. Attach to the program proposal, letters of support, recommendations, and statements when appropriate, from programs and departments at ISU which are associated with the proposed program or have an interest in the proposed program.

Not applicable since the Nuclear Engineering Minor will be administered by the Mechanical Engineering Department.

14. If the new program is interdisciplinary, a governance document should be created and submitted to the Associate Provost for Academic Programs. Indicate here that it has been completed.

Not applicable.

Appendix to Program Proposal for Nuclear Engineering Minor

Big 12 Nuclear Engineering Consortium

"Distance Learning Course Assessment Guidelines"

Big 12 Nuclear Engineering Consortium

Distance Learning Course Assessment Guidelines

Faculty Committee for Course Assessment
William L. Dunn, Kansas State University
Michael Pate, Iowa State University
Brian Robertson, University of Nebraska

Charge

A Faculty Committee for Course Assessment was formed on 14 September at the Big 12 Engineering Summit and charged with establishing conventions for assessment of Nuclear Engineering courses that will be offered by distance education within the Consortium. The list of courses initially offered is provided in Appendix 1.

Discussion

Effective course assessment requires that course objectives must be identified and some method of rating success or failure at reaching those objectives be implemented. It is felt that a single approach should be used by all instructors so that overall assessment of the program can be facilitated. Hence, the committee feels that a course syllabus should be prepared in a common format for each course offered to the Consortium and that course objectives should be identified within this syllabus. A draft syllabus template is provided in Appendix 2.

The courses offered to the Consortium will likely not be deemed as core courses within a specific engineering program at the receiving schools and hence will likely not require assessment of ABET outcomes. Nevertheless, ABET-like assessment of course objectives is desirable.

It is also felt that quantitative direct assessment is to be preferred over subjective indirect assessment, even though this will likely place some burden on the instructor. The program being offered within the consortium will only succeed if the receiving schools deem that the quality of the courses and the value of the Nuclear Engineering program are sufficiently high. Thus, the committee feels that direct measures should be implemented.

In order not to place too large a burden on the distance course instructors, it seems advisable to limit the number of course objectives that require assessment. One way to achieve this would be to list all specific course objectives first, and then identify two or three general course objectives that encompass some or all of the specific objectives. The assessment would then be of the two or three general course objectives. Of course, the instructor may choose to assess all specific objectives and base the assessment of general objectives on the specific objective assessments.

The committee feels that each teaching institution should be able to use the assessment scale that it prefers, but that the basis of assessment should be identified. For instance one instructor may wish to assess a general objective on the basis of numerical score on an exam problem. The general objective and the exam problem basis should be identified. The assessment scale could vary among institutions (e.g., between 0 and 100 at one institution and between 1 and 5 at another institution). In each case, however, what constitutes a minimum or target rating (which indicates an acceptable level of competency for that general objective) should be identified so

that performance can be judged. If assessment is below the target, then steps to address the problem should be identified. A draft sample assessment form is provided in Appendix 3.

In addition to direct course assessment by the course instructor, each receiving school may wish to determine and track how its students are performing in relation to the general pool of Consortium students. As a means to expedite such assessment, the committee feels that some means should be implemented whereby the course grades of all students (without names) are made available to each school that has students enrolled in that course in any given term. The school can then compare the grades of the local students to the grades from all the students. The scores of all students (without names) from a given course will be provided only to those schools that have students enrolled in that course during the current term.

Recommendations

The committee makes the following recommendations.

1. A common syllabus format similar to that shown in Appendix 2 be adopted for all distance courses offered by the Consortium
2. The syllabus for each course list several specific course objectives but no more than three general course objectives.
3. Each general course objective be directly assessed each time the course is taught. The assessment of a general objective may be based on directly assessing the general objective or by using the results of direct assessment of specific objectives. A suggested format for the Assessment of General Course Objectives is provided in Appendix 3.
4. The course assessment be posted on a Consortium site available to all participant schools.
5. If a course is assessed to be below the target rating, the assessment should include steps to be taken to remedy the situation.
6. The grades of all students in a course should be provided to each receiving school for each course and term.

Appendix 1. Listing of Current Course Offerings

The initial course offerings as part of the Big 12 Nuclear Engineering Consortium comprise nine courses offered by the four nuclear programs, two each from Kansas State University (KSU), University of Missouri – Columbia (UMC), University of Texas – Austin (UTA) and three from Texas A&M University (TAMU). The courses are summarized below.

School	Course No.	Course Title	Credits	Prerequisite
UTA	ME 136N	Introduction to Nuclear and Radiation Engineering Concepts	1	None
TAMU	NUEN 101	Principles of Nuclear Engineering	1	None
UMC	NE 2201	Utilization of Nuclear Technologies in Society	3	None
KSU	NE 495	Elements of Nuclear Engineering	3	ME 136N or NUEN 101 or NE 2201
KSU	NE 690	Radiation Protection and Shielding	3	NE 495
UMC	NE 4315	Energy Systems and Resources	3	NE 495
UTA	ME 361E	Nuclear Reactor Engineering	3	NE 495
TAMU	NUEN 301	Nuclear Reactor Theory	3	NE 690
TAMU	NUEN 304	Nuclear Reactor Analysis	3	NUEN 301

Other courses can be added as demand develops.

Appendix 2. Draft Syllabus Template

Source Institution Course Call Number

(&/or Course Call Number at receiving institution)

Course Title

Semester and year	Instructor
Course contact and delivery times	Instructor contact information
Course web site	Instructor "office hours"

- Receiving institution administrative facilitator name and information (if syllabus is for a receiving institution).
- Course catalog listing with identification of prerequisite or possible co-requisite courses or permission
- Course catalog description
- Required materials, including any texts and personal equipment such as calculators
- Recommended materials, if any
- Stated course goals
- List of course topics
- List of specific course objectives
  1. Specific objective 1.
  n. Specific objective *n*
- General course objectives
  1. General objective 1.
  2. General objective 2
- Course policies and administration:
  1. Attendance policy, if any
  2. Special policies for the course, if any (e.g. on collaboration, calculators that can be used on exams, penalties for late work.)
  3. Statement of how any special needs will be accommodated – for example, a statement about the services available to assist students with disabilities of identified as requiring special services or special exam conditions
  4. Method of evaluation: This might include a list of papers, exams, and other assessments that will contribute to the students' grades, along with the exact or approximate value of those assessments or categories of assessments, either in points or percent of total grade.
  5. Statement on academic standards/ dishonesty policy
- Other useful information, where applicable, may also be included at the instructor's discretion, for example:
  1. Time and location of final exam and how exams will be proctored
  2. Projected schedule of assignments, quizzes, tests and other course work

Appendix 3. Draft Assessment Form

Name: _____
Date: _____

NE 123
Nuclear Engineering
Fall 2008
Assessment of Course General Objectives

Explanation

The percent of students enrolled in the class that demonstrated minimum competency in the listed primary objectives is **listed** in the column "Percent of Students". The minimum competency is based on a minimum 70% score[1] according to every assessment method.

Number of students enrolled was _____

Course Objective	Assessment Method	Percent of Students
General objective 1	Quiz 2	90
	HW 4	
General objective 2	HW 1	100
	Exam 1, Prob 4	
General objective 3	Exam 2, Prob 5	100
	HW 2	
	Quiz 5	

The minimum competency was met: Yes _____ No _____.

If No, state below the steps to be taken to improve the situation.

[1] For classes of 6 or under, the minimum score is 66%