Implementing A Service Introductory Course in Nuclear Science and Engineering

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Abstract

As a graduate only program at The Ohio State University, the Nuclear Engineering Program has only a single undergraduate course on its books that can be taught at the junior and senior level. Other courses in the graduate curriculum are available to seniors who have had the undergraduate course, *Introduction to Nuclear Science and Engineering* . In the past several years, enrollment in this course has dwindled to the point where it was canceled for one quarter just two years ago, and had only 12 students enrolled during two offerings in the 97-98 academic year. This paper describes the reincarnation of this course to make it compelling for students not planning to major in nuclear engineering, and then the advertising that has proven effective to significantly increase enrollments. Success is currently being measured by having 21 students enroll for Fall 1998 and 28 students enroll for Spring 1999. The goal for the 98-99 academic year was to serve 50 students. The goal for future years is to serve a minimum of 100 students, teaching the course twice per year.

Introduction

Nuclear Engineering at The Ohio State University is a graduate only program. However, we strongly encourage honors students to enter the program as college seniors, participating in a BS/MS combined degree program. Also, we have made an "option program" available to undergraduates who have room to take as many as 15 quarter hours in a concentrated technical elective area. For years, the first course in these programs has been a mildly rigorous *Introduction to Nuclear Science and Engineering* course that stressed reactor design through one-group diffusion theory and basic thermal hydraulics, an introduction to radiation interactions, and an introduction to health physics principles.

Enrollment in this introductory course has steadily declined over the past several years to the point where it was too low for faculty to receive full credit for teaching the course. (A minimum enrollment of 12 students is required for full credit in a junior/senior level course. Extra credit is given for courses with over 30 students.) The course is scheduled for fall and spring quarters. Enrollment was so low for Spring 1997 that the course was canceled. In fall of 1997, enrollment was only eight students. Something needed to be done, especially when enrollment for Spring 1998 was only four students.

Rather than cancel the course for the second spring offering in a row, our faculty proposed to teach the course while redesigning it in real time. In later quarters, the course would then be offered more as a service course throughout the University to teach the principles of nuclear

science at a survey level of interest to students with potentially little interest in further pursuit of nuclear studies. At the same time, the course would have sufficient depth that it could be used as a spring board into a nuclear engineering option or graduate program.

Course Redesign

The first step in redesign was to examine the potential audience, determine their preparation for taking a course covering nuclear sciences, and also get some idea for why they might be interested in such a course.

Experience with prior offerings already gave us an idea that the prerequisites would need to be lowered. Requiring math through partial differential equations, as we previously had, excluded too many students. It also isn't needed in a course where rigorous derivations are not taught. Thus, we reduced the math requirement to completion of first-year calculus. Completion of the first year of calculus-based physics was retained. Experience so far in the course with these new prerequisites has been very good.

The second question was why a student might take such a course. What is the potential student interested in learning? So far, we've advertised it as a technical elective in engineering, physics, and chemistry. This has a significant importance to these students. But we also found that the interest is simply to get an understanding of what nuclear science is all about since it isn't covered in any of their other coursework. Our potential audience wants to know a little about the truth, a little about the science, and wants to be able to make some correct decisions about the use of nuclear materials in everyday life, especially regarding the issues surrounding nuclear power. This information resulted in a course design that surveys the breadth of the field of nuclear science and engineering (technology), rather than a course that delves deeply into any particular area, such as reactor engineering.

Course Content

The course is designed around a progression of information to facilitate a series of tours designed to demonstrate the use of nuclear science in our everyday lives and to excite the students into learning more about the subject.

The first day of class starts with a survey to learn why the students have taken the course, how nuclear science has touched their lives in the past, and what they expect to get out of the course. That is, what are their goals for this course? It then segues into a presentation on the breadth of the subject, its impact on our lives today, and its potential for improving life in the future. We want to touch a little on their idealism as young students.

We then introduce basic nuclear concepts such as nuclear reactions, fission, fusion, reaction rates, and interactions with matter. This is done to prepare them for a tour of The Ohio State University Nuclear Reactor Laboratory. On this tour, they will participate in a startup of the reactor, observe the "blue glow," perform two irradiations, measure the spectra from the irradiation products, learn about shielding, and learn about basic radiation protection measurements using pocket dosimeters and hand-held GM counters, or friskers. They also

measure a reactor period, something we haven't talked about in class yet, and observe the prompt drop following a reactor scram. This is a very full three hours!

When they come back to class, we begin the material needed to build a real power reactor, starting with neutron multiplication, and continuing through one-group neutron diffusion, critical size and flux shape, reactor kinetics (back to that reactor period), and a little on the thermal hydraulics of energy removal and safety. This takes us to the midterm.

The incentive for coming back after the midterm is to learn about US commercial reactors, and then to discuss the TMI and Chernobyl events. These class sessions are followed by a tour of a nuclear power plant about three hours from campus. This Saturday tour is a highlight and may be the primary reason some students take the course. We generally spend about two hours in the plant and another two hours in the plant full-function simulator where we run some normal and also some abnormal scenarios. During these operations, we have the students actually operate the reactor controls themselves.

The remaining third of the course deals with health physics, industrial applications, waste management (recycle management?), and risk. This portion of the course includes our final tour which is of the diagnostic and therapeutic facilities of the Ohio State University Arthur G. James Cancer Hospital, also considered a highlight of the class.

Text Material

There is a fourth important element to this course. It is current events. We want these students to know how nuclear science affects their lives and what is going on in nuclear science today. To accomplish this as a goal of the course, we use the American Nuclear Society monthly publication, *Nuclear News*, as a primary resource. And to assure the students have something to take with them from the course, we have them all join ANS as student members. This enables ANS to provide us with copies of *Nuclear News* for each of the three months of the course, and also provides the students with copies for the next nine months. In addition, students are encouraged to bring articles from current magazines and newspapers to class where we apply what we've learned to what the reporters are telling us. It's important to note here that digression is a critical part of this course.

Ron Knief's textbook[1] is used as the primary text. Even though it doesn't cover the breadth of the industry, applications covered include discussions of issues and questions often raised in the public and political arenas, just the kind of questions students are drawn to, and the technical understanding of which are important for nuclear applications to have a viable future.

Finally, a number of handouts are used to introduce the students to medical applications and various industrial applications, including food irradiation. These vary from quarter to quarter as new articles are published and brought to the instructor's attention.

Selling the Course

This redesign effort would all be for naught if no one on campus knew about it. So we have implemented a concerted advertising program consisting, we hope, of three elements. We have control of two of these. They are (1) communicating directly with undergraduate course advisors in engineering and the sciences, and (2) placing posters about the course in strategic locations in classroom buildings. The third is building a reputation for the course that will spread by word of mouth through the student population.

We time our efforts according to the University's computerized registration schedule. The objective is to have all materials in students' hands at least a month before registration opens. The first step is to send email to all the student advisors. The initial email is followed by additional information at about one-week intervals. The idea here is to get the advisors excited about the course so they can pass this excitement on to their students.

The second part of the selling process is to place posters in all high traffic areas of buildings used by engineering, physics, and chemistry students. We typically put up as many as 200 posters, one of which is included at the end of this paper.

Finally, as we can all appreciate, course reputation is important to any service course. We are only beginning here, and hopefully will have survey results in another year or two. If class size continues to remain stable or preferably increase, this may be the only measure we need.

Conclusions

The redesign and sales efforts for Introduction to Nuclear Science and Engineering has proven to be a successful effort during the first year of presentation. Further monitoring of student evaluations will help to keep the course fresh and sufficiently compelling to encourage student registrations.

References

1. Nuclear Engineering: Theory and Technology of Commercial Nuclear Power, by Ronald Allen Knief. Taylor & Francis, 1992.

BRIAN K. HAJEK
Brian Hajek is a Research Scientist and Associate Chair in the Nuclear Engineering Program at The Ohio State University. While he has been at Ohio State for over 30 years with research interests in artificial intelligence, power plant instrumentation and control, and research reactor applications, he is also an active consultant in the power industry, specializing in operator training and examination. His industry experience enables him to bring a unique perspective to teaching this introductory course.

Spring Quarter Technical Elective

Introduction to Nuclear Science & Engineering

Nuclear/Mechanical Engineering 505

Monday, Wednesday, 2:30 - 3:48, Dreese Laboratory 357
Call Number: 13358-1(NE) / 11697-7 (ME)

This course introduces you to the broad range of applications of the atom in the industrial, medical, and power fields. Principles of nuclear interactions with matter are taught along with how these interactions affect technology today and going into the future. The principles of nuclear power plant design, safety, and operation are thoroughly covered.

Class discussions include many of the current events in nuclear science and technology, including advances in industrial and medical applications, new designs for power reactors being built world wide, safety of operating reactors, economics of new construction, disposition of plutonium from past weapons programs, environmental effects, radiation protection, and solutions for disposal or storage of both low-level and high-level nuclear waste.

This class will help you discover the facts about radiation and its effects on the human body. It will help you evaluate the societal impact of controlling various radiation sources. It will help you understand WHY so many are afraid of receiving any additional radiation exposure. It will examine the impact of past events such as the TMI accident.

Several tours are planned of local facilities where nuclear materials are currently being used, including one tour to a nuclear power plant in Northern Ohio.

For additional information, contact Professor Brian Hajek at 292-5405. Please note that only math through Math 153 is required.