

Developing Elective Courses on Nuclear Energy

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Abstract – With energy demands rising and climate change escalating, one of the few available means of producing large amounts of energy without greenhouse gas emission is nuclear, a technology that has been dismissed in the past thirty years for safety and environmental concerns. North Carolina A&T State University has recently received a nuclear education grant from NRC (Nuclear Regulatory Commission) to develop course modules and elective courses on nuclear energy to raise awareness of nuclear power and its related issues in security, safety, and nuclear environmental protection. Course modules are developed to supplement a required freshman engineering course GEEN 100 Introduction to Engineering. The modules give an overview of nuclear engineering so that first year students can learn about career options in this field. Two new elective courses are being developed. An engineering elective is for engineering seniors on nuclear energy and nuclear engineering. Another elective is for all majors, and it will focus on a secure energy future, covering nuclear energy among other alternatives.

Keywords: Nuclear Energy, Course Modules

INTRODUCTION

Most of our freshmen were born after the Chernobyl catastrophe in 1986 and the Three Mile Island accident in 1979. Nuclear energy has long been negatively perceived. Over 100 plants were cancelled in the 1970's, a process hastened by the Three Mile Island accident in 1979. Currently, there are 103 commercial nuclear power plants in the United States, producing about 20 percent of America's electricity.

As high oil prices and the global warming become more apparent, it is clear that a secure energy future can not rule out nuclear power, as nuclear power will reduce oil dependency and nuclear power plants do not emit greenhouse gases such as carbon dioxide. The Bush administration views nuclear energy as part of the energy policy and envisions starting to build nuclear power plants again by the end of this decade [1].

COURSE MODULES AND ELECTIVE COURSES

GEEN 100 Engineering Design and Ethics (Introduction to Engineering) is a required course for all engineering disciplines at North Carolina A & T State University. The course introduces students to all engineering disciplines, but only skims over nuclear engineering. In this project, course modules will be developed on nuclear engineering: nuclear power plants, nuclear materials in medical and industrial application, nuclear waste (transportation, storage, and disposal of nuclear materials), and other relevant subjects. The course modules include videos, PowerPoint slides and course notes for instructors and assignments for students. Once course modules are fully developed, the course modules will be contained in a DVD so that an instructor can use it easily and effectively in a classroom. The course module will give an overview of nuclear engineering to students to broaden their career options.

An engineering elective (MEEN 685 Nuclear Energy and Nuclear Engineering) will be offered in Spring 2008. The course is open to seniors and graduate students in all engineering disciplines (mechanical, electrical, industrial,

chemical, civil, and architectural), and it is intended to prepare students for the workforce and/or graduate studies in the nuclear engineering field. Topics will include: introduction to nuclear engineering, atomic and nuclear physics, fission, nuclear reactors and power plants, nuclear fuels and waste handling, safety and security.

The second elective course will be a sophomore/junior level elective on nuclear energy for all majors with an interdisciplinary approach, and is scheduled to be offered in Summer 2008. The course is intended to address energy challenges for America's future. It will cover nuclear energy, renewable energy, and future technologies in energy. It will also address the safety, security and environmental impact of nuclear energy. The course is intended to build a well-informed public, knowledgeable of how nuclear plants are operated, maintained, and regulated, and how energy can be produced safely without damaging the environment.

North Carolina A&T State University started a new general education sequence named University Studies (UNST) in Fall 2006. The UNST replaces a cafeteria style general education (an unstructured list of social sciences and humanities electives) with a more coherent and circumscribed course sequence. In the new UNST sequence, all freshmen will take the same UNST foundation courses: University Experience, Critical Writing, Contemporary World, Analytical Reasoning, and African American Experience.

In the sophomore and junior years, the UNST requires 12 credit hours of theme-based courses, and the themes include: Science, Technology and Society; Energy, Environment and Society; Health, Lifestyles and Society; Community, Conflict and Society. Courses in the theme clusters are expected to be multi-disciplinary, and a course may fit in two or more themes. At this time, new courses that are relevant and contemporary are still being developed for UNST. This proposed elective course, tentatively entitled "Contemporary Issues in Nuclear Energy" can easily fit in two UNST themes: the Science, Technology and Society theme and the Energy, Environment and Society theme.

Nuclear Power

The courses will address nuclear energy opportunities and challenges by first reviewing energy resources. Alternative energy sources (solar power, geothermal energy, wind power, and biomass) still have a long way to go before they can produce consistent and significant amounts of energy. Oil and natural gas are getting scarce and increasingly depending on undemocratic and repressive regimes (Russia, Persian Gulf, Middle East, and West Africa.) In addition, oil resources will be earmarked for transportation purposes and other end-uses, for which we have few or no substitutes. Nuclear energy will be an important energy source for the world in years to come, and it will also be part of our national energy security. The courses will address the safety, environmental impact, and security of nuclear power. Topics include: global warming and carbon emission, oil production and energy security, nuclear and nuclear power plants, nuclear waste, safety and security.

Many cases can be studied as class projects. For example, Three Mile Islands accident and Chernobyl disaster can be addressed from multiple aspects. Movies like "China Syndrome" and "Silkwood" can also be used as case studies to address the myth, hype, and truth. Renewable energy (geothermal, hydraulic, solar, and wind) can all be class projects. New technologies in energy such as coal gasification, carbon sequestration, and new reactor designs can all be class project topics.

Safety, Security, and Environment

After the Three Mile Island (TMI) accident in 1979 and the Chernobyl catastrophe in 1986, many people are skeptical about nuclear safety. In these courses, different nuclear reactors will be discussed to learn the strengths and weaknesses of each design. Reactors in existing power plants in the U.S. will be highlighted to address the operation safety. TMI and Chernobyl accidents will be discussed

After 9/11, there are additional safety concerns on nuclear power plants against terrorist attacks. Actually, the containment buildings housing reactors are designed and constructed to withstand tremendous physical forces such as earthquakes, tornados, and even the direct impact of a large aircraft. The design prevents radioactive material from escaping into the environment even if there are serious mechanical failures or operator errors at the plant.

Nuclear power plants have numerous security features. These include armed security forces; physical intrusion barriers; and advanced surveillance equipment that continually monitors the areas surrounding the plant. Other security issues that will be addressed include transportation and storage of nuclear waste.

Spent fuel rods remain radioactive for hundreds of thousands of years. Therefore, successful spent fuel storage and management is important to public support for nuclear power. For decades, Americans have stored their radioactive waste on-site at power plants, awaiting a permanent solution, the Yucca Mountain Repository in Nevada. While on-site storage of spent fuel is a technically viable solution for most nuclear plants, it is not a permanent solution. The Yucca Mountain Repository, which is years behind schedule and billions over budget, has encountered severe local opposition.

France has nearly 80 percent of the country's electricity from nuclear power plants, and they reprocess spent fuel rods to reuse it. The reprocess reduces the amount of nuclear waste, but one of the by-products of this is high-grade plutonium that can be used for nuclear weapons [2]. A better security plan is needed before reprocessing can be accepted in this country and worldwide. These courses will address different aspects of nuclear power and nuclear weapon proliferation.

Field Trips and Resources

The Nuclear Engineering Program at North Carolina State University (NCSU) has the nation's first university nuclear reactor. Field trips to NCSU will be scheduled to view the research reactor. In conjunction with this trip, we will also visit Shearon Harris Nuclear Power Plant of Progress Energy, which is in New Hill, NC, about one hour away from NCSU and 2 hours away from this campus. Field trips to the McGuire nuclear Power Plants (I and II) of Duke Energy in Cornelius, NC, about 1.5 hours away from the campus, will also be scheduled.

Because of the depressed enrollment of nuclear engineering in the past decades, there are a limited number of textbooks suitable for our courses and courses modules. On the other hand, relevant resources are available on the internet. For example, Teachers' Lesson Plans of Nuclear Regulatory Commission [3] provide some useful information. The Science Club of The Nuclear Research Institute [4] also provides a rich resource. MIT Open Courseware [5] provides useful course notes. Also, Electric Power Research Institute [6] has an on-line journal, addressing many issues about nuclear power. Wikipedia [7] provides lots of information in nuclear energy and engineering, and faculty and students in these courses can learn something from these sites in the beginning, and will probably contribute to its contents along the way.

DISCUSSION

The course modules and elective courses are intended to engage students and to stimulate their interests in this field to broaden the participation in nuclear engineering. As many engineers in the nuclear industry are scheduled to retire in the next 10 years, filling the pipeline with qualified engineers is vital to the future of this industry. As the interest of nuclear power plants reemerges, the demand for engineers to operate nuclear reactors and handle nuclear waste generated will only increase.

North Carolina Agricultural and Technical State University is a public, doctoral/research, land-grant University. For many years, the College of Engineering has been the nation's leading producer of African American engineers. The project is intended to help prepare a diversified workforce for nuclear energy and nuclear engineering.

The curriculum will build capacity in both faculty and students in a university without a nuclear engineering program. Even though only a limited number of students are expected to enter the nuclear engineering field, a heightened awareness of nuclear power by a larger portion of the population benefits all.

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