EEE 460 Nuclear Power Engineering (3) [S]

Course (Catalog) Description:
Radioactivity and decay. Radiation interactions and dose. Nuclear reaction, fission and fusion theory. Fission reactors, four factor formula, moderation. Nuclear power, TMI, Chernobyl. Nuclear fuel cycle.
Lecture. Technical Elective.

Prerequisites:
CHM 114 (or 116); MAT 274 (or 275); PHY 241 (or 361).

Textbook:
R. L. Murray and K. E. Holbert, *Nuclear Energy: An Introduction to the Concepts, Systems, and Applications of Nuclear Processes*, 7th ed., Elsevier Butterworth-Heinemann, 2014.

Supplemental Materials:
http://holbert.faculty.asu.edu/eee460/eee460.html.

Coordinator:
K.E. Holbert, Associate Professor

Prerequisites by Topic:
1. Chemistry
2. Differential equations
3. Introductory modern physics

Course Objective:
Provide students with an understanding of the multidisciplinary applications of nuclear concepts in the engineering profession

Course Outcomes:
1. Students will have usable knowledge of the physics behind nuclear concepts
2. Students will understand the effects and uses of radiation
3. Students will understand the principles of power generation via nuclear processes

Course Topics:
1. Thermal and radiant energy, relativistic energy and mass (1 lecture)
2. Atomic and nuclear structure, binding energy/mass defect (2 lectures)
3. Nuclear stability, radioactive decay modes and decay law (2 lectures)
4. Transmutation, compound and serial decay chains (1 lecture)
5. Nuclear reactions and energetics (2 lectures)
6. Neutron cross sections, attenuation and migration (2 lectures)
7. Radiation interactions (gamma, neutron, charged particles) (2 lectures)
8. Nuclear fission and fusion (energy production) (1 lecture)
9. Nuclear energy history (1 lecture)
10. Biological effects of radiation (dose, cancer) (1 lecture)

11. Radiation protection (dose calculation) (1 lecture)
12. Neutron chain reactions, criticality, four factor formula (2 lectures)
13. Power reactors and power plants, economics (2 lectures)
14. Reactor kinetics, reactivity feedback and control, fuel burnup (2 lectures)
15. Reactor safety, Three Mile Island, Chernobyl, Fukushima (2 lectures)
16. Nuclear fuel cycle, radioactive waste disposal (2 lectures)
17. Nuclear propulsion, radioisotopic power (1 lecture)

Computer Usage:
Computer use is integrated within the homework assignments. Students are allowed to use the computer tools of their choice including Excel, Matlab, Mathcad, etc. Typically, the types of homework assignments requiring computer use include solving transcendental equations, and performing numerical integration. In addition, students must use the computer tools to plot results from the analysis of reference data and from the solution of numerical problems.

Laboratory Experiments: None.

Course Contribution to Engineering Science and Design:
This course teaches engineering science through the application of physics principles to engineering problems. For example, students use their physics knowledge to determine the effect of radiation on electronic components in the space environment. This course also affords the student the opportunity to solve open-ended problems involving the selection of a suitable engineering option based upon constraints. For example, students compare and contrast radioisotopic power sources for spacecraft use based upon mass, half-life, and specific power.

Course Relationship to Program Outcomes:
This course contributes to the following program and ABET outcomes:
a: Students must apply both mathematics and physics (and chemistry) to understand and solve problems in this course.
c and **e**: Students perform design-type analyses and solve engineering problems. To a lesser extent students learn how to implement electrical technology in applications such as spacecraft electronics.
j: This course addresses many aspects of contemporary issues, especially since Sept. 11, 2001 and concerns of terrorism.
k: Students utilize modern tools such as the computer to solve problems.

Person preparing this description and date of preparation: Keith Holbert, February 2015.