Miami Dade College

Course Competencies Template - Form 112

GENERAL INFORMATION	
Name: Diane King	Phone #: 7-7021
Course Prefix/Number: ETP2201	Course Title: Reactor Theory for Nuclear Operations
Number of Credits: 2	
Degree Type	☐ B.A. ☐ B.S. ☐ B.A.S ☐ A.A. ☒ A.S. ☐ A.A.S. ☐ C.C.C. ☐ A.T.C. ☐ V.C.C
Date Submitted/Revised: 06-24-2011	Effective Year/Term: 2011-1
☒ New Course Competency ☐ Revised Course Competency	
Course to be designated as a General Education course (part of the 36 hours of A.A. Gen. Ed. coursework): ☐ Yes ☒ No	
The above course links to the following Learning Outcomes: ☐ Communication ☒ Numbers / Data ☒ Critical thinking ☐ Information Literacy ☐ Cultural / Global Perspective	☐ Social Responsibility ☐ Ethical Issues ☐ Computer / Technology Usage ☐ Aesthetic / Creative Activities ☒ Environmental Responsibility
Course Description (limit to 50 words or less, must correspond with course description on Form 102): This course introduces fundamental nuclear reactor theory and operations principles for students who are preparing for careers in nuclear operations. Students will learn principles related to neutron theory, reactor operational physics, nuclear control rods, and factors impacting reactor operations. Prerequisites: ETP1230, PHY1025. A.S. degree credit only. (1 hr. lecture, 2 hr lab)	
Prerequisite(s): ETP1230; PHY1025	Corequisite(s):

Course Competencies: (for further instruction/guidelines go to: http://www.mdc.edu/asa/curriculum.asp)

Competency 1: The student will demonstrate an understanding of nuclear control rods by:

1. Describing the different materials used in control rod construction, including their neutron absorption characteristics.
2. Predicting the direction of change in reactor power/K_{eff} for a change in control rod position.
3. Defining:
   - reactor trip (or SCRAM)
   - control rod worth
   - differential rod worth (DRW)
   - integral rod worth (IRW)
4. Explaining the effects on control rod worth and flux distribution for changes in moderator temperature, boron concentration, and fission product poisons.

5. Stating the purposes of flux shaping, rod sequencing and overlap.
6. Explaining the concept and purpose of rod insertion limits.
7. Describing power peaking and hot channel factors and the effects of control rods on power peaking or hot channel factors.
8. Describing axial flux imbalance (AFD), including long range effects.
9. Defining and explaining quadrant power tilt (symmetric offset) ratio, and calculating quadrant power tilt ratio (QPTR).

Competency 2: The student will demonstrate an understanding of the neutron life cycle by:

1. Defining the effective multiplication factor and discussing its relationship to the state of the reactor.
2. Defining critical, subcritical, and supercritical with respect to the reactor and in terms of the effective neutron multiplication factor.
3. Describing the neutron life cycle using the following terms:
   - fast fission factor
   - fast non-leakage probability
   - resonance escape probability
   - thermal non-leakage probability
   - thermal utilization factor
   - reproduction factor
4. Defining *reactivity*, *excess* reactivity ($_{excess}$), and k_{excess} .
5. Calculating the value of k_{eff} using the six factor formula for a given neutron population from one generation to another.
6. Calculating values for reactivity and $k_{eff,}$ using appropriate data.
7. Listing the units of reactivity and converting from one unit to another.

Competency 3: The student will demonstrate an understanding of reactor kinetics and neutron sources by:

1. Describing sources of neutrons during operation and during shutdown.
2. Explaining the necessity for installed neutron sources in a reactor core.
3. Explaining the concept of subcritical multiplication.
4. Performing calculations involving steady state count rate, k_{eff} and source range indication.
5. Defining and explaining the principles associated with:
   - startup rate
   - reactor period
   - delayed neutron fraction
   - effective delayed neutron fraction
   - average effective delayed neutron
6. Using the power equation, solve problems for the following:
   - power changes
   - startup rate
   - reactor period
7. Defining *doubling time* and calculating it using the power equation.
8. Explaining *prompt critical*, *prompt jump*, and *prompt drop*.

Competency 4: The student will demonstrate an understanding of fission product poisons by:

1. Defining fission product poison.
2. Explaining the characteristics of Xenon-135 as a fission product poison, including how it is produced, compensated for, and safely removed.
3. Explaining the following processes and stating their effect on reactor operation:
   - equilibrium xenon
   - xenon behavior following power changes
   - xenon behavior following a reactor trip
4. Plotting the curve and explaining the reason for the reactivity insertion by Xenon-135 versus time for the following:
   - initial reactor startup and ascension to rated power
   - reactor startup with xenon-135 already present in the core
   - power changes from one steady state power level to another
   - reactor trip
   - reactor shutdown
5. Explaining the characteristics of Samarium-149 as a fission product poison, including its production and safe removal.
6. Plotting the curve and explaining the reason for the reactivity insertion by Samarium-149 versus time for the following:
   - initial reactor startup and ascension to rated power
   - reactor shutdown
7. Comparing the effects of Samarium-149 on reactor operation with those of Xenon-135.

Competency 5: The student will demonstrate an understanding of neutrons by:

1. Explaining basic neutron theory and defining common terminology.
2. Using the Chart of the Nuclides and/or appropriate data, calculate the following:
   - the mass defect of an atom
   - the binding energy of an atom
   - the binding energy per nucleon of an atom
3. Explaining how the energy released from an average fission event is distributed among the particles and rays released during the fission process.

Competency 6: The student will demonstrate an understanding of reactor operational physics by:

1. Defining explaining and calculating shutdown margin (SDM).
2. Listing the reactivity control mechanisms that exist during the approach to criticality.
3. Defining, explaining and calculating an estimated critical rod position (ECP) using a 1/M plot.
4. Describing count rate and instrument response that should be observed for rod withdrawal during the approach to criticality.
5. Listing the parameters that should be monitored and controlled during the intermediate phase of a reactor startup (from criticality to POAH, i.e., point of adding heat).
6. Describing reactor power response prior to reaching the POAH.
7. Describing the means by which reactor power will be increased to rated power.
8. Describing the monitoring and control of reactor power and primary temperature from 0% to 15% (B&W).
9. Describing the monitoring and control of T_{ave}, T_{ref}, and power during power operation.
10. Explaining the effects of control rod motion, boration, and dilution on reactor power.
11. Explaining the relationship between steam flow and reactor power given specific conditions.

12. Explaining reactor response to a control rod withdrawal or insertion.
13. Describing the means by which power is reduced in preparation for a normal plant shutdown.
14. Explaining the shape of the curve of reactor power versus time after a reactor trip.
15. Defining *decay heat*.
16. Identifying the advantages and disadvantages that nuclear poisons present to steady state and long term operation of a reactor.