

CHATTANOOGA STATE COMMUNITY COLLEGE  
CHATTANOOGA, TENNESSEE  
ENGINEERING TECHNOLOGY DIVISION

**COURSE SYLLABUS**

**RP 246 Radiological Aspects of Reactor Designs**

**Instructor:** Joe Bynum  
**Phone:**  
**E-mail:**

**Credit Hours:** 4  
**Semester:** Fall 2011  
**Room:**

**Catalog Course Description**

A study of the types of radiation and their properties relative to reactor design. (Class 3 hours, Lab 3 hours)

**Prerequisites:** RP 154

**Corequisites:** None

**Entry Level Standards**

**Textbook/Materials**

1. DOE Fundamentals Handbook, Thermodynamics, Heat Transfer and Fluid Flow (DOE-HDBK-1019/1,2,3-92)
2. DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory (DOE-HDBK-1012/1,2-93)
3. USNRC Reactor Concepts Manual Pressurized Water Reactor (PWR) Systems
4. USNRC Reactor Concepts Manual Boiling Water Reactor (BWR) Systems
5. ACAD 93-008 Standards 1.1.3 Electrical Sciences, 1.1.5 Heat Transfer and Fluid Flow, 1.1.9 Reactor Plant Protection and Safety, 1.2 Basic Systems Knowledge, 1.3 Basic Components Knowledge, 3.1 Plant systems and Components Knowledge: Systems

**Institutional Student Learning Outcomes**

- ISLO2. Competence in a Specialty Area
- ISLO5. Information and Technology

**Program Student Learning Outcomes**

- PSLO2. An ability to conduct experiments, collect, analyze, and interpret data.[ISLO5]
- PSLO11. The ability to use the techniques, skills, and modern engineering tools necessary to function as a Radiation Protection Technician. [ISLO2]

**I. Course Student Learning Outcomes**

- CSLO1 Employ the principles, procedures, and applications of radiation protection. [PSLO2][PSLO11]
- CSLO2 Meet the requirements for formal classroom training for Nuclear Uniform Curriculum Program certification. [PSLO11]
- CSLO3 Describe general systems, basic construction, application, and components of a nuclear power plant. [PSLO11]

## II. Topics:

Week	Topic
1	<b>8-29-9/2</b> Electrical Sciences
2	<b>9/6-9/9</b> Electrical Systems
3	<b>9/12-9/16</b> Fluid flow, fluid properties
4	<b>9/19-9/23</b> Basic Systems Knowledge
5	<b>9/26-9/30</b> Basic Systems Knowledge-PWR (Secondary)
6	<b>10/3-10/7</b> Basic Systems Knowledge-PWR (Primary)
7	<b>10/10-10/14</b> Basic Systems Knowledge-BWR
8	<b>10/19-10/21</b> Basic Components Knowledge-Mechanical Components
9	<b>10/24-10/28</b> Basic Components Knowledge-Electrical Components
10	<b>10/31-11/4</b> Basic Components Knowledge-Radiation Instrumentation
11	<b>11/7-11/11</b> Basic Reactor Operation
12	<b>11/14-11/18</b> Reactor Plant Protection
13	<b>11/21-11/23</b> Reactor Plant Protection
14	<b>11/28-12/2</b> Radiological Incidents
15	<b>12/5-12/9</b> Review
<b>16</b>	<b>12/12-Final Exam 1:00-2:50</b>

Alignment of Assessments with CSLOs (actual assessments are defined below)		
CSLO1	CSLO2	CSLO3
a) Lab assignments b) Quizzes c) Section Tests d) Final Exam	a) Lab assignments b) Quizzes c) Section Tests d) Final Exam	a) Lab assignments b) Quizzes c) Section Tests d) Final Exam

## III. Course Objectives

### Electrical Sciences

- O1 Apply direct current (DC) concepts and laws; and perform calculations and measurements, including the following: [CSLO1-3]
- Basic electrical circuits, such as series and parallel, series-parallel combinations

- Conductors and insulators
  - Direct current (DC) theory and DC sources (such as ideal voltage and current, non-ideal voltage, and current)
  - Electrical laws (such as Ohm's law, Kirchhoff's voltage, and current laws)
  - Electron theory
  - Units of electrical measurement (such as ohms, volts, amps, watts, coulombs, joules)
  - Voltage, current, and resistance (content added: power)
- O2 Apply alternating current (AC) concepts and laws; and perform calculations and measurements, including the following: [CSLO1-3]
- Alternating current (AC) theory and AC sources (such as ideal voltage and current, non-ideal voltage, and current)
  - Basic electrical circuits, such as series and parallel
  - Units of electrical measurement (such as henries, farads, reactance, impedance)
  - (content added: passive components, capacitors, inductors)
  - (content added: single-phase versus three-phase)
  - Voltage, current, and impedance (content added: real, reactive, apparent power, and power factor relationships)

### **Heat Transfer and Fluid Flow**

- O3 Explain principles and concepts related to heat, including the following: [CSLO 1-3]
- Heat transfer mechanisms and heat exchanger construction and types
  - Temperature, including temperature scales, F, C, and K (such as kinetic theory of gases)
- O4 Explain the concepts and principles of steam, including the following: [CSLO 1-3]
- Basic steam-water cycle
  - Boiling and saturation
  - Pressure-temperature relationship
  - Properties of steam and water, including pressure-temperature relationship, basic steam-water cycle, steam tables, boiling, saturation temperature/pressure, and thermal efficiency
  - Steam tables
- O5 Explain principles of heat transfer, including the following: [CSLO 1-3]
- Heat transfer mechanism, such as conduction, convection, and radiation
  - Heat exchangers
  - Latent and sensible heat
  - Thermal efficiency
- O6 Explain principles of fluid flow, including the following: [CSLO 1-3]
- Effects of throttling on flow and pressure
  - Filling and venting-understanding the concept of high point vents relating to air binding and water hammer
  - Fluid properties and mechanics, including laminar and turbulent flow filling and venting, and the effects of throttling
  - Pump theory, including cavitation
  - Water hammer types and mechanisms

## **Reactor Plant Protection**

- O7 Explain basic concepts related to reactor plant protection: [CSLO 1-3]
- Administrative controls and procedural concepts
  - Automatic reactor plant protection concepts
  - Defense in depth
  - Fission product barriers
  - Limiting conditions for operation
  - Safety limits
- O8 Explain basic concepts related to accident analysis: [CSLO 1-3]
- Anticipated radiation levels
  - Design basis accidents
  - Description
  - Effect on workplace
  - Evacuation criteria
  - (content added: Final Safety analysis Report)
  - Recovery process mitigation
  - Symptoms and indications
- O9 Explain basic concepts related to transient prevention and mitigation of core damage and accident management, including the following: [CSLO 1-3]
- Core cooling mechanisms
  - Core damage
  - Hydrogen hazards during accidents
  - Critical parameter monitoring during accident conditions
  - Radiation hazards and radiation monitoring response
- O10 Summarize basic information about major industry operating experience, including the Three Mile Island Nuclear Station accident, the Chernobyl Nuclear Power Plant accident, the Salem Generating Station turbine blade throw, the Browns Ferry Nuclear Plant fire, the Idaho Falls stuck rod accident, and the Davis-Besse Nuclear Power State event. [CSLO 1-3]

## **Basic Systems Knowledge**

- O11 Explain the basic operation of the following subsystems: [CSLO 1-3]
- Chemical and volume control (PWR)
  - Circulation water
  - Condensate
  - Containment
  - Containment spray
  - Control rod drive mechanism
  - Emergency core cooling systems
  - Emergency power
  - Environmental monitoring
  - Feedwater
  - Main steam
  - Offgas (BWR)
  - Post accident sampling
  - Pressurizer (PWR)
  - Radiation monitoring
  - Reactor coolant
  - Reactor water cleanup (BWR)
  - Recirculation (BWR)

- Residual heat removal/shutdown cooling
- Suppression pool (BWR)

### **Basic Components Knowledge**

- O12 Describe the theory, construction, and application of the following mechanical components: [CSLO 1-3]
- Air compressors (such as rotary, reciprocating, and centrifugal)
  - Heat exchangers (such as cross-flow, counter-flow and parallel flow); steam condensers and steam generators (U-tube and once-through)) - Include discussion on heat transfer across the heat exchanger and indications of heat exchanger fouling
  - Pumps, ejectors, and educators, such as for pumps (centrifugal, positive displacement)-Include centrifugal pump laws, series, and parallel operation; net positive suction head; requirements of minimum flow and effects of dead-heading pump; can causes and indications of cavitation and how to prevent it.
  - Strainers, filters, and traps, including demineralizers, screens, and centrifuges for process filtration systems
  - Steam traps (such as lever-operated, piston-operated and float-operated)
  - Steam turbines (such as impulse and reaction turbines, turbine arrangements and steam flow, high-pressure and low-pressure turbines)
  - Valves (such as gate, globe, butterfly, ball, check, needle, diaphragm-operated, plug, pressure relief and safety) and dampers (pneumatic, hydraulic) and limitation of different valve types (for example, gate valve not good for throttling)
- O13 Describe the theory, construction and application of diesel engines including the following: accessories/support systems, failure mechanisms and systems, main structural components, main moving components, principles of operations. [CSLO 1-3]
- O14 Describe the theory, construction and application of air conditioning, heating and ventilation systems, including refrigeration machines and the basic refrigeration cycle [CSLO 1-3]
- O15 Describe the theory, construction, and application of structural and auxiliary equipment, including the following: [CSLO 1-3]
- boilers (such as electric, gas-fired, fuel-oil-fired)
  - elevators (such as basic operation of and basic rescue methodology)
  - fire barriers (such as purpose and construction of and identification of barrier degradation)
  - hangers and snubbers for support and restraint (such as discussion of water hammer and different types, including water slug, valve slam, column rejoining, and condensate induced)
  - hoists and cranes (such as manual and electric)
- O16 Describe the theory, construction, and application of rotating equipment including the following: generators, motors, motor-generators. [CSLO 1-3]
- O17 Describe the theory, construction and resistive electrical equipment including the following: heaters, heat tracing (such as reasons for using heat tracing) [CSLO 1-3]
- O18 Describe the theory, construction and application of electrical supply components

including the following: batteries and chargers, circuit breakers (such as protection), inverters and uninterruptible power supplies, switchgear, load centers, and motor control centers (such as protective relaying and schematics of a basic system from high voltage to lower voltage), transformers (such as step-up transformers and stepdown transformers, winding configurations) [CSLO 1-3]

- O19 Describe the theory, construction and application of electrical control components including the following: cables (such as routing for train separation and methods of fire detection/protection for cables/cable trays), control circuits (such as proportional, integral and derivative or a combination thereof), meters (such as voltage and current and how a change in meter indication could indicate circuit degradation of a change in process (pump discharge valve opened for increased flow)), relays (such as schematics to show operation of relays that energize to actuate, deenergize to actuate, time delay energize and time delay deenergize) [CSLO 1-3]
- O20 Describe the theory, construction and application of valve actuator types (such as motors, pneumatic, hydraulic) including the following: manual operation (such as methods used for different types of actuators), position indication (such as methods for indication, local and remote indications and observation of process indications to determine valve position), impact of environmental conditions [ CSLO 1-31-13]
- O21 Describe the theory and application of electronic equipment including the following: analyzers (such as H<sub>2</sub>, O<sub>2</sub> and chemical), signal converters [CSLO 1-3]
- O23 Draw a basic system block diagram [CSLO 1-3]
- O24 Identify conditions that preclude safety work in the vicinity of system components [CSLO 1-3]
- O25 Identify the basic interrelationships with other plant systems [CSLO 1-3]

### **Basic Reactor Operation**

- O26 Explain basic reactor operation to include [CSLO 1-3]
- basic reactor types
  - reactor parameters
  - reactivity (including reactivity coefficients: temperature, void, fuel (Doppler))
  - response to control rods/boron/fission product poisons
  - reactor startup and shutdown
  - reactivity events
  - general design overview of the station reactor type(s)
  - basic reactor core parameters
  - reactivity control methods
- O26 Identify specific isotopes of concern in power reactors during operation and following shutdown (such as H-3, N-16, Ar-41, Cr-51, Mn-54, Fe-55, Co-58, Co-60, Zn-65, Kr-85, Kr-88, Zr-95, Ag-110m, I-131-135, Xe-133-135, Cs-134, Cs-137 and transuranics). [CSLO 1-3]
- O27 Describe the processes and characteristics of heavy charged particle (alpha particles, protons) interaction with matter to include - range of alpha

- O28 particles in air, water, and tissue [CSLO 1-3]  
Describe recent significant radiological incidents at this plant or at other nuclear power plants.  
[CSLO 1-3]

#### IV. Assessment

Grades will be determined in the following manner:

	<u>Assessment Method</u>
A1. Tests	=50% Test
A2. Assignments/Quizzes	=10% Test/Performance
A3. Lab	=20% Performance
A4. Final Exam	= <u>20% Test</u>
	100%

A1. Tests: A minimum of three [3] tests and or final exam will be given. Each test and final exam may consist of multiple choice or discussion type questions along with problems. The tests will generally not be comprehensive, but will cover the material since the previous test. The final exam may or may not be comprehensive at the discretion of the instructor. The tests and final exam will count 70% of the overall grade. [CSLO 1,2,3]

A2. Assignments/Quizzes may be made by the instructor. Assignments must be completed in a professional manner and turned in when scheduled. At the discretion of the instructor, late assignments may not be accepted. Quizzes may be given at random times during the semester. The quizzes are designed to encourage keeping up with course material, class attendance, and participation. The assignments and quizzes will count for 10%--20% of the overall grade. [CSLO 1,2,3]

A3. Lab: Lab expectations will include lab attendance, activities, and reports. Lab will count 10% of the final grade. [CSLO 1,2,3]

A4. Final Exam: The final exam will be given during the scheduled final exam period. The final exam will be open book and notes. The final exam will count for 20% of the overall grade. [CSLO 1,2,3]

A5. Work Ethic: This class will support the Chattanooga State W. E. Succeed campaign in which the four areas of teamwork, integrity, productivity, and professionalism will be practices. Students are expected to be present and on time in all classes. In addition, all work must be submitted by the due date. Work not submitted by the due date will have points deducted. After the third day, late work is not accepted. If a student misses a test or quiz, he or she must have a valid reason and make arrangements for a make-up. If the student does not contact the instructor within one day of missing the test or quiz, a "0" will be recorded. [CSLO 1,2,3]

Certification: Students will be required to make a minimum of an 80 to obtain the Nuclear Uniform Curriculum Certification of completion.

## V. Grading Scale

90—100	A
80—89.9	B
70—79.9	C
65—69.9	D
0—64.9	F

## VI. Course Delivery Format

Standard Format

## VIII. College Policies

**This class is governed by the policies and procedures stated in the current Chattanooga State Student Handbook. Additional or more specific guidelines may apply.**

### **ADA Statement**

Students who have educational, psychological, and/or physical disabilities may be eligible for accommodations that provide equal access to educational programs and activities at Chattanooga State. These students should notify the instructor immediately, and should contact Disabilities Support Services within the first two weeks of the semester in order to discuss individual needs. The student must provide documentation of the disability so that reasonable accommodations can be requested in a timely manner. All students are expected to fulfill essential course requirements in order to receive a passing grade in a class, with or without reasonable accommodations.

### **Disruptive Students**

The term “classroom disruption” means – student behavior that a reasonable person would view as substantially or repeatedly interfering with the activities of a class. A student who persists in disrupting a class will be directed by the faculty member to leave the classroom for the remainder of the class period. The student will be told the reason(s) for such action and given an opportunity to discuss the matter with the faculty member as soon as practical. The faculty member will promptly consult with the division dean and the college judicial officer. If a disruption is serious, and other reasonable measures have failed, the class may be adjourned, and the campus police summoned. Unauthorized use of any electronic device constitutes a disturbance. Also, if a student is concerned about the conduct of another student, he or she should please see the teacher, department head, or division dean.

### **Affirmative Action**

Students who feel that he or she has not received equal access to educational programming should contact the college affirmative action officer.

### **Academic Integrity/Academic Honesty**

In their academic activities, students are expected to maintain high standards of honesty and integrity. Academic dishonesty is prohibited. Such conduct includes, but is not limited to, an attempt by one or more students to use unauthorized information in the taking of an exam, to submit as one's own work, themes, reports,



drawings, laboratory notes, computer programs, or other products prepared by another person, or to knowingly assist another student in obtaining or using unauthorized materials. Plagiarism, cheating, and other forms of academic dishonesty are prohibited. Students guilty of academic misconduct, either directly or indirectly through participation or assistance, are immediately responsible to the instructor of the class. In addition to other possible disciplinary sanctions, which may be imposed through the regular institutional procedures as a result of academic misconduct, the instructor has the authority to assign an "F" or zero for an activity or to assign an "F" for the course.

### **SMOKING/TOBACCO USE**

Chattanooga State Technical Community College recognizes the increasing weight of scientific evidence that smoking is harmful not only to the "active" smoker but also to the "passive" smoker who is exposed to others' smoke. Smoking is defined as the lighting or carrying of a lighted cigarette, cigar, pipe, or similar device.

Smoking is prohibited in all college buildings, owned or leased. Additionally, smoking will not be allowed in any college owned vehicles. All building entrances are posted as non-smoking areas. Signs stating "No Smoking within 50 ft of Entrance" are posted at all entrances. Signs are posted at all exits stating "Smoking Prohibited within 50 ft of Building."

The use of mouth tobacco (to include dipping, chewing, etc.) is prohibited in all Chattanooga State buildings, facilities, and vehicles.

The policy applies to all campuses and to the entire college community, including employees, students, and visitors. It is the responsibility of all faculty, staff, and students to adhere to, enforce, and inform visitors of the College's smoking policy. If a student continues to disregard the posting, he/she will be reported to the Dean of Student Affairs. If an employee continues to disregard the posting, he/she will be reported to their respective Vice-President.

### **DESIGNATED SMOKING AREAS**

The College has designated "Smoking" areas on campuses and at the sites. These areas can be located on the campus map.

### **CAMPUS AWARENESS PLAN**

The policy shall be published in the College catalog, student handbook, and the policies and procedures manual. Periodic notices shall be placed in other college publications.

Flyers will be posted on all bulletin board and e-mail notices will be sent each semester, which will inform college visitors as well as students, staff, and faculty of the College's position on this issue.

**The instructor reserves the right to modify this syllabus in writing during the course of the semester.**

### **Children**

It is Tennessee Board of Regents policy that children are not permitted in the classrooms or laboratories. If you have children who must stay home for some

reason, you must make other arrangements for their care than bringing them with you to class.

Tigermail is the official means of communication for the College.

**The instructor reserves the right to modify this syllabus in writing during the course of the semester.**

## **IX. Instructor Policies**

### **Cell Phones**

Activation of these devices represents a distraction and their use during lectures and labs (including instant messaging, games, and etc.) will be considered extremely disruptive to the learning environment. Please turn off (or set to vibrate) all such devices before entering the classroom. Please excuse yourself from the room if an emergency requires you to make or receive a phone call during class. If your cell phone goes off during a testing period, five points will be deducted from your test

### **Use of Computers/Printers**

The use of a computer is mandatory for all students. Students will have access to the computers in C24, C33, C54, C84, & C87. These computers are connected to the ET server and can be used to access Microsoft Office and other software. There may be times when one of the computer rooms will not be available; these times will be posted with as much advance notice as possible. **It is the student's responsibility to see that his or her username and password are working properly and that his or her password is protected.** It is also the student's responsibility to back-up needed files. The school will not be responsible for any computer files that get "lost" or damaged.

Back-up documentation for this class (such as the class syllabus, handouts, description of class assignments, etc.) will be available to the students through eLearn. Printers are to only be used by Engineering Technology students for assignments related to engineering and engineering technology classes or labs. Paper availability may be subject to print management activities and will be requested through assigned faculty. Please help conserve paper.

### **Classrooms & Labs**

Food and drinks are prohibited in all Engineering Technology classrooms, with the exception of water in a closed container. All food and drinks are prohibited in labs located in the Branch Center for Technology. Any form of tobacco products are also prohibited in accordance with College and TBR policy.

**To Log-in C24, C33, C54, C84 & C87: Username:** ET\_last name first initial middle initial (*no spaces*)

**Password:** student

**Domain (log-in):** CSTCC

**Note:** *Be sure to change your password after your initial log-in.*