SOUTHEAST COMMUNITY COLLEGE
CONSTRUCTION, MANUFACTURING AND TECHNOLOGY DIVISION
Energy Generation Operations Technology Program
Revision Date: August 21, 2023
Syllabus Statements

I. CATALOG DESCRIPTION

Course Number:	ENER2220
Course Title:	Reactor Plant Materials
Prerequisite(s):	ENER2102 and ENER2530
Catalog Description:	This course provides students with an understanding of the various materials used in the operation of a nuclear power plant. Topics include phase balance of materials, mechanical properties and behavior of materials, environmental effects on materials, and nuclear-specific topics such as fuel pellets, fuel rod cladding, control rods, radiation effects on materials, enrichment of radioactive isotopes and fuel pellet fabrication.
Credit Hours:	2
Class Hours:	30
Lab Hours:	0
Total Contact Hours:	30

II. COURSE OBJECTIVES: *Course will:*

A. Explain the basic structure of metals and how those structures are affected by various processes and irradiation.
B. Explain commonly used materials and their characteristics.
C. Explain thermal stress and thermal shock effects on a system.
D. Explain brittle fracture characteristics, mechanisms and temperature effects to reactor plant materials.
E. Introduce the chemical interaction of general and specific types of corrosion.
F. Describe the chemical measures taken to retard the corrosion.
G. Introduce reactor vessel components relating to the fuel and control mechanisms.

III. STUDENT LEARNING OUTCOMES AND GENERAL EDUCATION LEARNING OUTCOMES:

A. Student Learning Outcomes: *Student will be able to:*
1. Discuss basic material properties
2. Explain and define the various negative effects of thermal shock (stress) to a reactor system.
3. Discuss operational limitations used to prevent brittle fracture
4. Explain the characteristics of, and control methods for corrosion types common in a nuclear reactor plan.
5. Explain the effects of radiation exposure on various plant materials

B. General Education Learning Outcomes
1. GELO #3: Critical Thinking & Problem Solving
Outcome 1: Collect, identify, interpret and analyze data.

IV. CONTENT/TOPICAL OUTLINE

A. Structure of Metals
1. Atomic bonding
2. Common lattice types
3. Grain structure and boundary

- **4.** Polymorphism
- **5.** Alloys

B. Properties of Metals
- **1.** Stress
- **2.** Strain
- **3.** Young's Modulus
  - **a.** Hooke's Law
  - **b.** Young's Modulus (Elastic Modulus)
- **4.** Stress-Strain relationship
- **5.** Physical properties
- **6.** Working of metals
- **7.** Corrosion
  - **a.** Pit and crevice
  - **b.** Denting
  - **c.** Galvanic
  - **d.** Chloride stress
  - **e.** Caustic stress
  - **f.** Stress corrosion cracking and inter-granular corrosion stress corrosion cracking
  - **g.** Microbiologic induced corrosion
- **8.** Hydrogen embrittlement
  - **a.** Zirconium
  - **b.** Stainless Steel
  - **c.** Benefits of hydrogen

C. Effects of contaminants on corrosion
- **1.** Fatigue failure/work hardening
- **2.** Vibration induced cracking

D. Thermal Stress
- **1.** Thermal shock
- **2.** Pressurized thermal shock
- **3.** Locations of concern

E. Fracture Mechanics
- **1.** Fracture Mechanisms
- **2.** Minimum Pressure Limitations
- **3.** Stress Control

F. Brittle Fracture
- **1.** Brittle fracture mechanism
- **2.** Minimum Pressurization-Temperature (MPT) curves
- **3.** Heat-up and Cool-down rate limitations

G. Plant Materials
- **1.** Selecting materials
- **2.** Fuel materials
- **3.** Cladding and reflectors
- **4.** Control materials
- **5.** Shielding materials
- **6.** Nuclear reactor core problems
- **7.** Plant material problems
- **8.** Atomic displacement due to irradiation
- **9.** Thermal and displacement spikes due to irradiation
- **10.** Effect due to neutron capture
- **11.** Radiation effects in organic compounds

12. Reactor use of aluminum

H. Reactor Water Chemistry
- **1.** Interaction of radiation (Synthesis)
- **2.** Chemistry parameters

I. Principles of Water Treatment
- **1.** Water treatment processes
- **2.** Dissolved gases, suspended solids, and pH control
- **3.** Water purity

J. Core Materials
- **1.** Uranium enrichment
- **2.** Fuel pellet construction
- **3.** Fuel rod construction
- **4.** Control Rod Construction

K. Radiation effects
- **1.** Neutron Irradiation
- **2.** Gamma Irradiation

V. INSTRUCTIONAL MATERIALS

A. Required Text(s): None

B. Other Resources: Internet and *DOE Fundamentals Handbooks: Material Science I & II* and *Chemistry I & II* (Provided by the Instructor)

C. Outside Reading/Research required: Internet Research assignments

D. Supplies: None

VI. METHODS OF PRESENTATION/INSTRUCTION

A. Methods of presentation typically include a combination of the following:
- **1.** Hybrid

VII. METHODS OF EVALUATION

A. Methods of evaluation, although determined by the individual instructor, traditionally includes a combination of the following:
- **1.** Class participation
- **2.** Regular assignments
- **3.** Written exams and/or quizzes
- **4.** Performance and observational assessments

VIII. SPECIFIC COURSE REQUIREMENTS

A. A minimum grade of "C" or 70% is required to receive credit for this course.

B. A minimum grade of "B" or 80% is required to achieve the NUCP certificate, in accordance with ACAD 08-006, Revision 1, dated October 2016.

C. Cheating within the Construction and Electronic Occupations Division: Any violation of academic integrity on assignments, quizzes, or tests will result in a grade of 0 on that assignment, quiz, or test. A second violation in any course after the initial infraction will result in a grade of F for that course. Any additional violations while in the program will result in a suspension from the program. For additional information, refer to the *Academic Integrity* pamphlet available from Student Services.

D. Credit by Examination: Credit for the course CANNOT be earned through Credit by Examination.