CHEMICAL ENGINEERING MATERIALS WITH LAB
CHT 2220

Class Hours: 2.0  Credit Hours: 3.0
Laboratory Hours: 3.0  Date Revised: Fall 01

NOTE: This course is not designed for transfer credit.

Catalog Course Description:
An analysis of the mechanical, physical, and chemical properties of engineering materials. The mechanisms and control of corrosion of engineering materials in different environments are included. Emphasis is on the determination of suitable materials for use in various chemical processing applications. The laboratory work includes both physical testing for mechanical properties and corrosion testing. Course includes two hours of lectures and three hours of laboratory applications each week.

Entry Level Standards:
Students will need mathematical preparation equivalent to introductory college algebra and background in general chemistry equivalent to one semester of college chemistry. Students should be familiar with the keeping of experimental data in a laboratory notebook.

Prerequisites:
CHEM 1110, MATH 1731

Textbook(s) and Other Reference Materials Basic to the Course:

*Engineering Materials, Properties and Selection* by K.G. Budinski. Prentice Hall Composition Book, 1/4 or 1/5 inch quadrille ruled, 54 sheets, Boorum and Pease Company #09-4158 or equivalent.

I. Week/Unit/Topic Basis:

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<th>Week</th>
<th>Topic</th>
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| 1    | Principles of metallic corrosion  
Corrosion and the selection of materials of construction |
| 2    | Mechanical properties, stress-strain  
Application of mechanical properties to structural failure |
| 3    | Thermal properties, expansion and conductivity  
Combined properties, thermal stress |
| 4    | Electronic structure of matter  
Electrical conductors and semi-conductors |
Test 1
Crystal structure of metals

Plastic deformation and creep of metals
Crystal defects and grain size relation to hardness

Cold-working of metals and hardness, brittleness
Phase diagrams of metal binary alloys

Phase diagrams interpretation; solution-age hardening
Test 2

Ceramic structures and properties
Phase diagrams for ceramic binary mixtures

Novel and high-technology ceramics
Thermoplastic and thermosetting organic polymers

Free radical and condensation organic polymer synthesis
Properties of industrially important plastics

Elastomers, rubber
Test 3

Composite structures mechanical properties. Weathering and chemical attack of plastic materials
Sketching objects in orthographic projection using dimensions and notes.

Steel and cast iron; the iron-carbide (carbon) phase diagrams
Microstructure and mechanical properties of steels

Heat treatment of steel
Test 4

Final Exam

II. Course Objectives*:

A. Select metallic materials of construction for chemical processing equipment such that chemical attack and galvanic corrosion are minimized by proper choice of material composition and its operating environment. I, II, III, V

B. Recognize safe limits of mechanical stress in chemical processing and materials handling equipment such that equipment failure and safety hazard to personnel are minimized for stressed structures. I, II, III, V

C. Relate the compositions and the microstructures of metals and alloys to the qualitative and semi-quantitative prediction of technically important materials properties for chemical process equipment applications. I, II, III, V

D. Relate the compositions and microstructures of ceramics and composites to qualitative and semi-quantitative prediction of technically important materials properties for chemical process equipment applications. I, II, III, V
E. Relate the compositions and the molecular structures of plastics and elastomers to the qualitative prediction of their important technical properties in chemical process equipment applications. I, II, III, V

F. Make sketches of objects in orthographic projection with dimensions. IV

*Roman numerals after course objectives reference goals of the CHT program.

III. Instructional Processes*

Students will:

1. Attend lectures and discuss concepts. Communication Outcome, Problem Solving and Decision Making Outcome, Information Literacy Outcome, Active Learning Strategy

2. Solve assigned problems out of class and be prepared to discuss the problem solutions. Communication Outcome, Problem Solving and Decision Making Outcome, Numerical Literacy Outcome, Information Literacy Outcome, Active Learning Strategy

3. Do library research and prepare reports on new materials and applications. Communication Outcome, Problem Solving and Decision Making Outcome, Technological Literacy Outcome, Information Literacy Outcome, Active Learning Strategy

4. Participate in laboratory experiments which are direct applications of the concepts studied. Communication Outcome, Problem Solving and Decision Making Outcome, Technological Literacy Outcome, Information Literacy Outcome, Active Learning Strategy, Transitional Strategy

5. Perform laboratory experiments, collect data and keep a research style lab notebook. Communication Outcome, Problem Solving and Decision Making Outcome, Technological Literacy Outcome, Information Literacy Outcome, Active Learning Strategy

6. Make sketches of objects. Communication Outcome, Problem Solving and Decision Making Outcome, Technological Literacy Outcome, Information Literacy Outcome, Active Learning Strategy

*Strategies and outcomes listed after instructional processes reference Pellissippi State’s goals for strengthening general education knowledge and skills, connecting coursework to experiences beyond the classroom, and encouraging students to take active and responsible roles in the educational process.

IV. Expectations for Student Performance*

Upon successful completion of this course, the student should be able to:

1. Understand the principles of electrochemical batteries and galvanic corrosion. A

2. Use qualitative and semi-quantitative data on corrosion for selecting materials of construction to be used in chemical process equipment. A

3. Understand the relation of tensile and compressive stresses to the strain properties of metals. B

4. Apply stress-strain principles to predicting mechanical failure and unsafe operating conditions for load-bearing equipment. B

5. Apply data on heat conduction and thermal expansion to the behavior of process equipment. B
6. Interrelate thermal expansion and mechanical stress for predicting process conditions likely to cause mechanical failure of equipment. B

7. Understand the relation of the electronic structure of matter to electrical conductor and semi-conductor properties. C

8. Calculate electrical conductance of practical conductors from materials properties and geometrical parameters data. C

9. Describe the crystal structures of technically important metals and alloys. C

10. Interpret the deformation properties of metals under stress in terms of their crystal slip planes. C

11. Interpret the effects of cold-working of metals in terms of defect structure and grain size. C

12. Relate metallic microstructure to hardness and brittleness properties. C

13. Describe the role of alloying agents and impurities in controlling hardness and brittleness. C

14. Understand the construction and use of binary alloy phase diagrams to find amounts, composition, and identity of phases present. C

15. Relate the amounts and composition of phases in alloys to solution-age hardening processing of alloys. C

16. Understand the definitional structures, compositions, and properties of ceramics. D

17. Understand the construction and uses of 2-component ceramics phase diagrams. D

18. Relate the special properties of new high-technology ceramics to emerging industrial applications. D

19. Understand the definitional molecular structures and chemicals of polymeric plastics. E

20. Define the major classes of polymeric plastics in terms of the chemical reaction mechanisms by which they are produced. E

21. Relate the macro-properties of polymeric plastics to molecular structure and the chemical functional groups incorporated in the structure. E

22. Describe the distinctive three-dimensional molecular structures of elastomers which confer their elasticity. E

23. Relate the processes of crosslinking and vulcanization to controlling the elastic and elastic and plastic properties of polymers and elastomers. E


25. Calculate the transverse stress-strain properties of fibrous composite materials. E

26. Reflect plastic materials for constructing chemical processing equipment based on service conditions. E

27. Understand the use of the iron-carbide and iron-carboy phase diagrams to predict the structure and properties of steels and cast irons. E
28. Understand the use of isothermal transformation diagrams to predict the structure and properties of steels. E

29. Relate the main alloying agents of stainless steel to enhancing corrosion resistance of steels. E

30. Make sketches of various objects in orthographic projection. F

31. Add dimensions and notes to sketches of various objects so that they can be understood and the objects can be fabricated by a craftsman. F

*Letters after performance expectations reference the course objectives listed above.

V. Evaluation:

A. Testing Procedures:

Four one-hour (50-minute) written tests will be given during the semester. A written, one-hour comprehensive final examination will be given after the end of regular classes. Each test has equal weight in calculating the lecture course grade. The final examination has the weight of a single test in calculating the lecture course grade.

B. Laboratory Expectations:

The laboratory course grade is assigned separately from the lecture course grade and is based on report writing, keeping of a laboratory notebook, and experimental competence. Each laboratory session has equal weight in determining the laboratory course grade. The materials of construction report has the weight of two laboratory sessions, for lab sessions 1 and 2. The report on the metallography, hardness, and microstructure of steel (lab session 13) has the weight of two lab sessions.

The schedule of laboratory assignments for each week of the semester is:

1 Laboratory orientation and safety, and library research
2 Library research and report on materials of construction
3 Tensile strength testing of fibers, data collection
4 Tensile strength testing of fibers, computations and statistics
5 Freezing-melting points of ice-salt, data collection
6 Freezing-melting points of ice-sale, phase diagram construction
7 Corrosion of plastics by solvents, sampler preparation
8 Corrosion of plastics by solvents, data collection and statistics
9 Sketching objects in orthographic projection and adding dimensions and notes for use in fabrication of objects
10 Mounting, hardness testing, and grinding metallographic specimen
11 Polishing steel metallographic specimen
12 Etching and photography of metallographic specimen
13 Library research and report on microstructure of steels
14 Corrosion of metals, sample preparation
15 Corrosion of metals, data collection
C. Field Work:

The two required reports which involve library research are treated as field work. A research report covering a new material of construction will be assigned. Each student will make a short oral presentation of his or her report. The written and oral reports will be graded and will together have the weight of a one hour exam.

D. Other Evaluation Methods:

N/A

E. Grading Scale:

The percent grade ranges for the overall course letter grades are:

- 90 – 100  A
- 87 – 89   B+
- 80 – 86   B
- 77 – 79   C+
- 70 – 76   C
- 60 – 70   D
- below 60   F

VI. Policies:

A. Attendance Policy:

Pellissippi State Technical Community College expects students to attend all scheduled instructional activities. As a minimum, students in all courses must be present for at least 75 percent of their scheduled class and laboratory meetings in order to receive credit for the course (Pellissippi State Catalog). Individual departments/programs/disciplines, with the approval of the vice president of Academic and Student Affairs, may have requirements that are more stringent.

**Chemical/Environmental Engineering Technology Program:**
Regular attendance in this course is required. Students who miss the equivalent of 10% of either classroom hours or laboratory may, at the discretion of the instructor, have their course grade dropped by one letter. Students who arrive late for a class after the roll as been called have the responsibility of seeing the instructor after class the change their status from A (absent) to T (tardy).

B. Academic Dishonesty:

In keeping with college-wide policies, the student is expected to adhere to the general rules and regulations relevant to academic and classroom misconduct as outline in the catalog.