
Mon. 5:00-6:20, Wed. 5:00-6:20

Class Location: SEC - 210

Index Number: 10220

3 Credits

Instructor: Dr. Jerry Scheinbeim, (sounds like Shine-bime), Distinguished Professor

Office location: C-164

Office Hours: Monday, Wednesday, 3:00 – 4:00 pm

mailto:jis@rci.rutgers.edu

Teaching Assistant: Thomas Linz

Office Location: BME 219

Office Hours: Mon. 1:00-2:00 pm

mailto:tml127@scarletmail.rutgers.edu

Grader: Dheeraj Reddy

Office Location: C-117

Office Hours: Wed. 4:00-5:00 pm

mailto:dd719@scarletmail.rutgers.edu


Course Information:

A. Course Description: atomic/molecular level structures of basic materials, i.e., metals, ceramics, polymers and composites. Properties, including mechanical properties like elasticity and plasticity, are understood in terms of bonding and microstructure of materials. Emphasis is placed on the relationships between structure, processing, and resultant properties of materials.

Course Objectives:

A. In this course, students will learn the following:
   1. The relationships between bonding and microstructure in materials.
   2. The differences between the structure/properties relationships
   3. An understanding of the differences in metals, ceramics, polymers and composite
      properties in terms of microstructure (structure-properties relationships).
   4. An understanding of the processing of materials for specific applications.

Assessment: Exam 1: 35%, Exam 2: 45%, Homework: 20%

Course Content:

I. Introduction:

   Discuss the Materials Science Approach (and the tetrahedron)
   Discuss the Meaning of Structure/Properties Relationships of Materials
   Discuss Engineering and Real Stress and Strain

II. Cohesion in Materials:

   Review of atomic structure
   Thermodynamics vs kinetics: Relationship to the states of matter
   Bonding (Primary bonding: ionic, metallic, and covalent bonding, Secondary bonding:
   the 3 types of dipole-dipole bonding, van der Waals bonding, and hydrogen bonding)
   Thermal expansion (the shape of the potential energy vs separation curve)
   General crystal structures (crystal systems, Miller indices of points, directions,
   and planes)

II. Structure and Processing of Engineering Materials:

   Metals (HCP, FCC, BCC structures, alloys and phase diagrams)
   Ceramics (crystalline ceramics, glass ceramics, the softening point, (the
   glass transition), semi-crystalline ceramics
   Polymers (semi-crystalline polymers, polymer spherulites, amorphous polymers, the
   glass transition (the softening point), uniaxial (and biaxial) drawing processes
   and anisotropy of properties
   Polymers (Elastomers and thermoplastic elastomers)
   Composites (particulate, fibrous, and laminated)

III. Mechanical Properties of Materials:

   Typical Engineering Stress-Strain Behavior of Materials
   Elastic Properties of Crystalline, Semi-Crystalline, and Amorphous Materials
   Rubber Elasticity, Thermoplastic Elastomers
Plastic Deformation of Crystalline, Semi-Crystalline, and Amorphous Materials
Plastic Deformation of Metals and Polymers
Viscosity of Polymer Solutions and Suspensions (laticies), Shear Stress vs Shear Strain Rates (Newtonian flow vs shear thickening and shear thinning)

IV. **Material failure:**

Crack propagation in brittle and ductile materials
Fatigue failure in materials

V. **Other Properties of Materials:**

Electrical properties of materials (conduction properties, ferroelectric and ferromagnetic properties)
Optical properties (birefringence and polarization effects)

**ABET Outcomes and Assessment:**

**Program outcomes achieved in this course**

(a) an ability to apply knowledge of mathematics, science and engineering;
(e) an ability to identify, formulate and solve engineering problems;
(i) a recognition of the need for, and an ability to engage in life-long learning; and
(j) a knowledge of contemporary issues.

The achievement of outcomes (a), (e), (i) and (j) will be assessed in this course as follows:

**Outcome (a):** an ability to apply knowledge of mathematics, science, and engineering

Problems in exams, and homework will check the students’ ability to apply knowledge of mathematics, science and engineering in problem solving.

**Outcome (e):** an ability to identify, formulate and solve engineering problems

Problems in exams and homework will require students to identify and formulate, and solve engineering problems.

**Outcome (i):** a recognition of the need for, and an ability to engage in, life-long learning

**Outcome (j):** knowledge of contemporary issues