Department of Materials Science and Engineering
MET E 463 Metallurgical Engineering
Reliability and Design of Metallurgical Systems (4 credits)
Taught jointly with Cer E 401

Catalog Description:
Properties of commercially important engineering alloys. Metallurgical design problems and failure analysis.

Prerequisite:
Senior standing in Metallurgical Engineering

Textbooks:
1. *Materials Selection in Mechanical Design*
   M. F. Ashby (Pergamon Press, Oxford, UK, First Edition, 1992)
2. *Engineering Materials 3: Materials Failure Analysis*
   Case Studies and Design Implications
   D. R. H. Jones (Pergamon Press, Oxford, UK, 1993)

References:
Engineering Materials-1: An Introduction to Their Properties and Applications,
M. F. Ashby and D. R. H. Jones (Pergamon, Oxford, UK, 1993)
Engineering Materials-2: An Introduction to Microstructures, Processing, and Design,
M. F. Ashby and D. R. H. Jones (Pergamon, Oxford, UK, 1993).
ASM Metals Handbooks, American Society of Metals, Columbus, Ohio, USA.
Materials Selector, Materials Engineering (Panton Publ., Cleveland, OH, 1992).

Course Objectives: After this course, the student will be able to
1. Describe problems of materials systems reliability and design
2. Identify failure mechanisms and common materials failure modes
3. Identify important engineering alloys and their applications
4. Select materials for specific design applications

Lecture Topics Covered:
1. Materials reliability in applications,
2. Materials systems and their design,
3. Failure mechanisms and analysis (including fracture mechanisms, creep and fatigue),
4. Materials selection charts and their uses,
5. Case studies of design and failure analysis,
6. Important commercial alloys and their characteristics.

Team Project:
Course team project consists of a hands-on failure experiments and examination of failure mechanisms, testing of metallic materials, and their evaluation by student teams. Teams choose their project from among those proposed by the instructor; provide independent project solution which is presented to the class.

Laboratory topics:

Five laboratory projects are required selected from the following:

1. Failure analysis, examination of failed metallic parts,
2. Corrosion experiment (2 months),
3. Failure of chain,
4. Fracture Analysis using light optical and SEM and stereomicroscopy,
5. Tool-set tests,
6. Freeze bursting of water pipes,
7. Fatigue of a welded joint.
8. Design of materials for precision tests (AFM centilever/tips)
9. Failure in metallization in integrated circuits
10. Design and failure of impact resistance materials (Layered nanocomposites).

Field trips:

Two field trips to provide to the students some industrial experience: one to a truck company (failure of various parts) and the other to a semiconductor company (failure in metallization joints).

Computer Usage:

1. Three to four homework assignments require the use of computer analysis,
2. Scanning and image analysis of microstructures via computer in the lab,
3. Data acquisition and processing in energy dispersive x-ray spectroscopy (in the SEM) and mechanical tests (e.g., Nanoindentation with AFM).

Class Schedule:

Three 50 minute lecture periods, one 3 hour lab period and independent team projects

Contribution of course to professional component:

This course is the final portion of the capstone experience for our students. It allows them to integrate the knowledge that they have learned into a more coherent whole while solving real materials problems.

Contribution of course to program objectives

This course meets program objectives related to the application of science and engineering principles to the solution of real problems related to structure, processing, properties and applications of materials. It provides hands-on lab work, and the use of experimental, statistical and computational methods in the solution of real problems, which will prepare them for engineering work in their future.

Prepared by: Mehmet Sarikaya, Associate Professor, May 2001