Texas A&M University
Departmental Request for a New Course
Undergraduate • Graduate • Professional
Submit original form and 25 copies. Attach a course syllabus to each.

1. This request is submitted by the Department of Mechanical Engineering
2. Course prefix, number and complete title: MEEN 609 Materials Science
3. Course description (not more than 50 words): Structure and properties of solid materials.
4. Prerequisite(s): Graduate Classification and approval of instructor
   Cross-listed with MEMA 609
   Cross-listed courses require the signatures of both department heads.
5. Is this a variable credit course? Yes ☐ No ☐ If yes, from _______ to _______.
6. Is this a repeatable course? Yes ☐ No ☐ If yes, this course may be taken _______ times. Will the course be repeated within the same semester/term? Yes ☐ No
7. Has this course been taught as a 489/689? Yes ☐ No ☐ If yes, how many times? _______ Indicate the number of students enrolled for each academic period it was taught.
8. This course will be:
   a. required for students enrolled in the following degree program(s) (e.g., B.A. in history)
   b. an elective for students enrolled in the following degree program(s) (e.g., M.S., Ph.D. in geography)
9. If other departments are teaching or are responsible for related subject matter, the course must be coordinated with these departments. Attach approval letters.
10. Prefix | Course # | Title (exclude punctuation) | Lect. | Lab | SCH | Subject Matter Content Code | Admin. Unit | Acad. Year | FICE Code | Level
     MEEN 609 MATERIALS SCIENCE | 0 | 3 | 0 | 0 | 0 | 3 | 1 | 4 | 9 | 0 | 1 | 0 | 0 | 6 | 1 | 9 | 2 | 0 | 0 | 8 | 0 | 9 | 0 | 1 | 0 | 3 | 6 | 6
     Do not complete shaded area.

Approval recommended by:
[Signature] 11/8/07
[Signature] 11-26-07
Head of Department
Chair, College Review Committee
[Signature] 11/16/07
[Signature] 11-26-07
Head of Department (if cross-listed course)
Dean of College

Submitted to Coordinating Board by:
Dean of College

Director of Academic Support Services

* Attach a syllabus according to the guidelines on the Internet site www.tamu.edu/admissions/oaras. To have this form reviewed, please send to Linda F. Lacey, Mail Stop 1265 or fax to 847-8737.
MEEN 609 – Materials Science – Syllabus

Instructor: Prof. Ibrahim Karaman
322 ENPH, 862-3923, ikaraman@tamu.edu

Class Hours: 8:00 – 9:15 AM, TR, ENPH 215
Office Hours: TR, 9:30 – 10:30 AM

Website: http://www1.mengr.tamu.edu/MESAM/index.html

Grading: Homeworks 35%
1 Midterm 30%
Final 35%

Note: If the student misses the exam because of the medical reasons, he/she needs to bring a letter from the doctor.

Prerequisite: An undergraduate level Materials Science and Engineering course

Suggested Reading:


Reference will be made to the above texts, but the course material will not exactly correspond to the text. Homeworks will be assigned on each Thursday, and will be due the following Thursday at the beginning of the class.

Course Objectives: The main objective of this course is to examine deformation, microstructural mechanisms that are responsible for deformation and failure in metals, fatigue, creep and fracture mechanisms of materials. Special emphasis will be given to the microstructure-mechanical property relationship.

This course is designed to help students learn to:
(1) Predict elastic deformations in isotropic, anisotropic and composite materials;
(2) Predict the yielding failure of engineering materials and components under multiaxial stress states;
(3) Explain the effect of microstructural features and deformation mechanisms on flow of materials.
(4) Analyze crack growth behavior of engineering materials;
(5) Predict the fatigue life of engineering components subjected to cyclic loading
(6) Predict creep deformation and rupture life of engineering materials and components

Topics:
1. Week 1: Elasticity
   Stress & Strain, Compliance and Stiffness tensors
   Isotropic and Anisotropic Stress-Strain Relations
   Elastic Properties of Materials

Week 2: Elasticity
   Transformation of Stresses and Strains
   Complex and Principal Stresses and Strains
   Hydrostatic Stress and Dilatation
   Equivalent Stress and Strain
   Equilibrium and Compatibility
   Elastic Constitutive Relationships
   Physical Origin of Elastic Moduli
Elastic Behavior in Anisotropic Materials: Single Crystals

Week 3: Elasticity
   Elastic Behavior of Composites
   Viscoelasticity

2. Week 3: Plasticity
   Single Crystal Plasticity
   Polycrystal Plasticity and Texture

Week 4: Plasticity
   Constitutive Yield, Flow and Failure Criteria
      Tresca
      Von Mises
      Romberg-Osgood
      Kinematic, Isotropic, and Mixed Hardening
   Plastic Flow under Multiaxial Loading (Prandtl-Reuss Equations)

3. Week 5: Inelastic Deformation
   Theoretical Strength
   Lattice Resistance
   Geometry of Deformation and Crystallography

Week 6: Inelastic Deformation
   Dislocation Motion, Kinetics of Plastic Flow
   Dislocation Interaction
   Grain Boundaries and Nanocrystalline Materials

Week 7: Inelastic Deformation
   Twinning and Martensitic Transformation
   Strengthening Mechanisms

4. Week 8: Fracture Mechanics
   Linear Elastic Fracture Mechanics
      Brittle Fracture
      Theoretical Cohesive Strength
      Orowan (stress concentration) Approach
      Griffith (Energy Balance) Approach
      Griffith Multiaxial Stress Criterion
      Strain Energy Release rate
      Fracture Modes, Stress Intensity factor

Week 9: Fracture Mechanics
   Crack Tip Plasticity
      Plastic Zone Size
      Effective Stress Intensity Factor
      Crack Tip Opening Displacement
      Plane Stress vs. Plane Strain
   Environmentally Assisted Fracture
      Hydrogen Assisted Cracking
      Stress Corrosion Cracking
   Fracture Surfaces

5. Week 10: Fatigue
   Crack Initiation
   Crack Propagation
Paris Law
Cyclic Plastic Zone Size
Load Ratio Effects
$\Delta K_{TH}$ Thresholds
Stress/Strain Life Analysis
Low Cycle Fatigue
High Cycle Fatigue
Role of Mean Stress
Miner's Rule

Week 11: Fatigue
Damage Tolerant Design
Models of Crack Growth
Striation Growth
Crack Closure
Variable Amplitude Loading
Multiaxial Fatigue
Microstructural Mechanisms of Fatigue

6. Week 12: Creep
Phenomenological Description of Creep
Mechanism of Creep Deformation

Week 13: Creep
Deformation Mechanism Maps
Creep Crack Growth
Creep under Multiaxial Stress States

Americans with Disabilities Act (ADA) Policy Statement
The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact the Department of Student Life, Services for Students with Disabilities, in Room 126 of the Koldus Building or call 845-1637.

Academic Integrity Statement
Aggie Honor Code: "An Aggie does not lie, cheat, or steal, or tolerate those who do."
It is the responsibility of students and instructors to help maintain scholastic integrity at the university by refusing to participate in or tolerate scholastic dishonesty (Student Rule 20. Scholastic Dishonesty, http://student-rules.tamu.edu). New procedures and policies have been adopted effective September 1, 2004. Details are available through the Office of the Aggie Honor System (http://www.tamu.edu/aggiehonor/). An excerpt from the Philosophy & Rationale section states:
"Apathy or acquiescence in the presence of academic dishonesty is not a neutral act -- failure to confront and deters it will reinforce, perpetuate, and enlarge the scope of such misconduct. Academic dishonesty is the most corrosive force in the academic life of a university."
Americans with Disabilities Act (ADA) Policy Statement

The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact the Department of Student Life, Services for Students with Disabilities, in Room B118 of Cain Hall or call 845-1637.

Academic Integrity Statement

"An Aggie does not lie, cheat, or steal or tolerate those who do."

"The Aggie Code of Honor is an effort to unify the aims of all Texas A&M men and women toward a high code of ethics and personal dignity. For most, living under this code will be no problem, as it asks nothing of a person that is beyond reason. It only calls for honesty and integrity, characteristics that Aggies have always exemplified. The Aggie Code of Honor functions as a symbol to all Aggies, promoting understanding and loyalty to truth and confidence in each other."

http://student-rules.tamu.edu/aggiecode.htm