Texas A&M University
Departmental Request for a New Course
Undergraduate • Graduate • Professional
• Submit original form and attach a course syllabus.

1. This request is submitted by the Department of MEEN

2. Course prefix, number and complete title of course: MEEN 625 Mechanical Behavior of Materials

3. Course description (not to exceed 50 words): Examination of deformation and microstructure mechanisms responsible for deformation and failure in metals; fatigue, creep, and fracture mechanisms of materials; emphasis on microstructural-mechanical property relationship.

4. Prerequisite(s): Undergraduate-level materials science course

Cross-listed with: MEEN 625

Cross-listed courses require the signature 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 this course be repeated within the same semester? ☐ 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. 05A, unk., 06A (as MEMA 609), 19; 07A, 12; 08A, 13

8. This course will be:
   a. required for students enrolled in the following degree program(s) (e.g., B.A. in history)

      ☐ No

   b. an elective for students enrolled in the following degree program(s) (e.g., M.S., Ph.D. in geography)

      M.S., Ph.D., Mechanical Engineering; Materials Science and Engineering; Aerospace Engineering

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 (excluding punctuation)

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<th>MEEN</th>
<th>625</th>
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<th>BEHAVIOR</th>
<th>MATERIALS</th>
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Approval recommended by: [Signatures]

Head of Department [Signature] [Date]

Head of Department (if cross-listed course) [Signature] [Date]

Submitted to Coordinating Board by:

[Signature] [Date]

Questions regarding this form should be directed to Sandra Williams at 845-8201 or sandra.williams@tamu.edu.
Curricular Services – 10/08

1 of 5 B14
MEEN 625 Mechanical Behavior of Materials – Spring 2009 Syllabus

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

Class Hours: 8:00 – 9:15 AM, TR, ENPH 205
Office Hours: TR, 2:00 – 3:00 PM
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.

90 – 100 → A
80 – 89 → B
70 – 79 → C
60 – 69 → D
< 60 → F

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 and 4: Plasticity
   - Constitutive Yield, Flow and Failure Criteria
     - Tresca
     - Von Mises
     - Kinematic, Isotropic, and Mixed Hardening
     - Plastic Flow under Multiaxial Loading (Levy-Mises Relations)
   - Week 4: Plasticity
     - Single Crystal Plasticity
       - Polycrystal Plasticity and Texture

3. Week 5: Inelastic Deformation
   - Theoretical Strength
   - Lattice Resistance
   - Geometry of Deformation and Crystallography
   - Week 6: Inelastic Deformation
     - Dislocation Motion
     - 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
   - 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

5. Week 10: Fatigue
   Crack Initiation
   Crack Propagation
   - Paris Law
   - Cyclic Plastic Zone Size
   - Load Ratio Effects
   - ΔK<sub>TH</sub> 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
   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 Disability Services, in Cain Hall, Room B118, or call 845-1637. For additional information visit http://disability.tamu.edu.

Academic Integrity Statement
Aggie Honor Code: "An Aggie does not lie, cheat, or steal, or tolerate those who do."
For additional information, please visit: http://www.tamu.edu/aggiehonor