MT253: Mechanical Behavior of Materials
August-December 2009 Session

Instructor: Prof. U. Ramamurty (ramu@materials.iisc.ernet.in)

Classes: Monday, Wednesday, and Friday 9.00-10.00 AM in Room #LT6

Grading Scheme:

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<th>Component</th>
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<td>Assignments</td>
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<td>Midterm exams</td>
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<td>Final Exam</td>
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<tr>
<td>Term Paper</td>
<td>20 (10 each for report and presentation)</td>
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<td><strong>Total</strong></td>
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**Group Term Paper** (for groups of three):
Step 1) Select a paper after discussions with UR on or before Sept. 1, 2009.
Step 2) This paper must be from 2008 issue of Acta Materialia, and must be concerned with the mechanical properties/behavior of materials.
Step 3) Critically review the paper. (You will have to read a lot of background material to be able to do this. The references given in the paper will help you in this process.)
Step 4) Write a report highlighting the new observations made in the paper and possible drawbacks, loopholes, etc. The report should be of highest professional quality with a clear and concise structure and must be submitted by 15-11-2009.
Step 5) Prepare a PowerPoint Presentation (20-minute duration) that highlights some salient points of the paper. The presentation must be very clear and graphics that are pleasing to the eye.

*The earlier you start on the project, the better grade you are going to get!*

**Reference Books:**

- GE Dieter, Mechanical Metallurgy, McGraw-Hill
- S Suresh, Fatigue of Materials, Cambridge University Press
- MF Ashby and DRH Jones, Engineering Materials 1, Butterworth-Heinemann
- RE Reed-Hill, Physical Metallurgy Principles, D. Van Nostrand Company
- D Hull and DJ Bacon, Introduction to Dislocations, Pergamon
- JP Hirth and J Lothe, Theory of Dislocations, John Wiley & Sons
- TW Clyne’s Lecture Notes, University of Cambridge
Course Outline

Introduction
Stiffness, Strength, and Toughness, Types of mechanical behavior, Relevance, Measurement, data, Macroscopic, continuum behavior, Physical mechanisms controlling behavior

Elasticity
Introduction, Stress, strain, compliance and stiffness tensors, Physical origin of elastic moduli, Generalized Hooke’s law and its application to crystals, Designing for modulus and Composites

Continuum Plasticity
True stress-true strain, Necking and Considère’s Criterion, Yield Criteria and yield locus, Normality, Isotropic and kinematic hardening, Plastic stress-strain relations

Microstructural Aspects of Plasticity
Theoretical shear strength, Dislocations and Burger’s vector, Elastic properties and energy of dislocations, Forces between dislocations, Partial dislocation and stacking faults, Dislocation-dislocation interactions, The Peierls-Nabarro Stress, Origin and multiplication of dislocations, Crystallography of Slip and Independent Slip systems, Slip plane rotation, Twinning and twin geometry, Twinning in HCP crystals

Strengthening Mechanisms
Work hardening, Taylor’s and Kuhlmann-Wilsdorf Theories, Grain boundary strengthening, Hall-Petch and Cottrell theories, Solid solution strengthening, Point defect –dislocation interaction energy, Yield point phenomenon, Precipitation hardening, Dislocation-precipitate interactions

Fracture
Importance of Fracture Mechanics, Griffith Fracture Theory, Crack Driving Force & Energy Release Rate, Modes of fracture, Stress intensity factors, Similitude, Role of Crack-tip Plasticity--Plastic Zone Size & Shape, K-dominance, Fracture Toughness-Microstructural Issues

Fatigue
Total life approaches, Fatigue design approaches, HCF and LCF, Fatigue crack inhibition, Fatigue crack growth, Paris law and models, Threshold, Damage tolerant approach, Striations, Different stages of fatigue crack growth, Examples.