INSTRUCTION

PROFESSOR K. KOMVOPOULOS

Freshman Seminars: Impact of Science and Technology on Today's World and Moral Values (ME 24)

(Undergraduate course, freshman level)

Content

Mechanical Behavior of Engineering Materials (ME 108)

(Undergraduate course, junior/senior level)

Content

Part I

Introduction
Microstructure and Deformation of Materials
Alloying and Hardening
Heat Treatment
Slip Planes, Dislocations, Twinning
Introduction to Mechanical Testing
Stress and Strain
Complex Stress/Strain States
Special topics on Complex Stress States
Yielding and Fracture Criteria
Plastic Deformation

Part II

Ductile and Brittle Fracture
Fracture Mechanics
Fatigue, Stress-based Approach
Fatigue, Strain-based Approach
Cumulative Fatigue Damage
Notch Effects in Fatigue
Crack Growth
Time-dependent Deformation, Creep
Friction and Wear of Materials
Micromechanics

Labs

(1) Heat treatment, Phase diagrams, Metallography, Hardness
(2) Deformation due to Monotonic Loading & Fracture toughness
(3) Time- and Rate-dependent Deformation (Viscoelasticity)
(4) Deformation due to Cyclic Loading
(5) Fatigue
(6) Wear

Mechanical Behavior of Engineering Materials (ME 224)

(Graduate course)

Content

Introduction
Stress/Strain, Deformation
Theoretical Strength of Solids
Elastic Behavior (linear, rubber-like, viscous, iso-/anisotropic)
Inelastic Behavior
Principal Stresses/Stress Invariants
Spherical and Deviatoric Components of Stress Tensor
Stress Space
Linear-Elastic Stress-Strain Relationships
Mechanistic Models
Yield Criteria, Yield Surface
Incremental Plasticity (Flow Rule and Strain Hardening Rule)
Isotropic Hardening
Fatigue (Stress Concentration, Notch Sensitivity, Endurance Limit)
Failure Criteria
High-/Low-Cycle Fatigue
Strain-Life Approach
Stress-Life Approach
Notches, Neuber's Rule
Cumulative Fatigue Damage
Crack Initiation
Crack Propagation
Fatigue, Life Predictions
Fracture (mechanisms, modes, and toughness)
High-Temperature Deformation, Mechanisms
Creep Resistance, Creep Deformation Maps
Dislocations, Types and Properties
Moving Dislocations and Interactions
Strengthening Mechanisms
Contact Fatigue
Wear, Delamination

Fracture Mechanics of Engineering Materials (ME 225)

(Advanced graduate course)

Content

Tribology (ME 226)

(Advanced graduate course)

Content

Introduction
Surface interactions at various scales
Historical development of the study of nanomechanical surface interactions
Early friction and wear theories
Basic aspects of tribology problems

Surfaces
Nano-/macro-topography
AFM and STM surface imaging
Surface roughness parameters
Topography characterization (deterministic vs stochastic methods)
Real contact area (scale effects)

Material Properties
Bulk and surface material properties
Chemical reactivity
Surface energy
Work of adhesion
Material compatibility

Contact Surface Interactions
Origins of friction
Analysis of various friction nano-/micro-mechanisms
Friction force measurements at different scales
Concept of friction space
Friction mechanisms and adhesion in NEMS/MEMS and hard-disk drives
Nanoscale friction mechanisms
Implications of friction in nanotechnology and biotechnology

Lubrication
Lubrication regimes
Effect of load, speed, and roughness on lubrication efficiency
Solid film lubrication
Boundary lubrication and modeling
Self-assembled monolayers
Solid-like behavior on confined monolayers
Frictional heating and lubricant effect
Chemical reactivity and additive functionality
Extreme-pressure lubricants and viscosity improvers
Antiwear additives
Ultrathin solid and liquid films at various temperatures

Rheological behavior of lubricant monolayers
Elastohydrodynamic lubrication

Wear
Types and uses of wear
Measurement of wear
Adhesion and asperity removal during sliding
Size and shape of adhesive wear particles
Abrasion, polishing, and grinding
Surface fatigue
Impact contact
Corrosion
Erosion
Fretting
Stick-slip
Nano-/micro-scale wear processes
Wear coefficient tables

Material Response to Surface Tractions
Introduction to contact mechanics
Hertz analysis
Contact analysis of layered media
Scale effects on contact deformation
Response of elastic-plastic solids to sliding/rolling contact loading
Plastic flow of the near-surface layer; shakedown, cyclic plasticity, and ratcheting
Void and crack nucleation
Crack propagation under mixed-mode loading
Delamination wear
Microstructure effects on delamination wear
Ultrathin-film mechanical property characterization methods
Nanoindentation and nanowear measurement and molecular dynamics modeling

Friction and Wear of Polymers and Polymeric Composites
Phenomenological observations
Basic friction mechanisms of polymers
Wear model for fiber-reinforced polymeric composites
Friction and wear of biopolymers
Molecular analysis of stretched polymers
Basic surface physical chemistry of polymers

Chemical Wear
Brief introduction to metal cutting
Cutting tool materials
Abrasion; solution and diffusion wear
Tool wear monitoring techniques
Hard and soft protective overcoats

Special Topics
Surface texturing at various scales

Modulated/patterned surfaces
Soft and hard overcoats
Ion implantation
Chemical and physical chemical vapor deposition
RF sputtering
Plasma spraying
Cathodic vacuum arc deposition
Laser surface alloying and cladding