16.003/16.004 UNIFIED ENGINEERING III, IV
Spring, 2008-09

MATERIALS & STRUCTURES
Contents of Lectures

The following is a detailed syllabus showing the 2 blocks, the 12 units within these blocks, and the topics covered within each unit. The readings assigned for each unit are given along with the lectures(s) in which the unit will be covered. Helpful additional readings are also noted *in italics*. The abbreviation key for the readings is noted below.

TEXTBOOKS:

Crandall, Dahl, and Lardner, *An Introduction to the Mechanics of Solids*, SI version, McGraw-Hill, 1978. (*referred to as* **CDL**)

M.F. Ashby and D.R.H. Jones, *Engineering Materials 1*, Pergamon Press, 1980. (or later version) (*referred to as* **A&J**)

Further useful references:

M.F. Ashby and D.R.H. Jones, *Engineering Materials 2*, Pergamon Press, 1986. (Polymers, metal alloys)
M.F. Ashby, *Materials Selection in Mechanical Design*, Pergamon Press, 1992. (Materials selection and design)
Bickford, *Mechanics of Solids*, Irwin, 1993

***(NOTE:** *Approximate* lecture numbers and dates are given in italics. Since the learning process is dynamic, these can only be planned, but not strictly adhered to. From time to time, any necessary major changes/shifts will be announced)

Block 4: Structural Behavior of Slender Members (1-D)

Unit Number, Title, and Contents	Readings	Lectures*
4.1 *Summary of Equations of Elasticity* Governing equation summary; Boundary Conditions; Solution Approaches	CDL 5.6	*M1* *(2/4)*

Unit Number, Title, and Contents	Readings	Lectures*
4.2 *Rods: Stresses and Deflection* Definition of a Rod (Modeling Assumptions); Governing equations; Solution for General Case; Inconsistency in model; St. Venant's Principle; Use for Deflection of Truss; Remarks on Static Determinance	CDL 3.1	*M1,2,3* *(2/4,6,9)*
Q1TM -- *(2/18)*		
4.3 *Statics of Beams* Definition of a Beam; Beam Types, Uses, and Boundary Conditions; Static Determinance: the Reactions; Internal Forces; Load, Shear and Moment Diagrams: point loads, distributed loads; Formal Relations between Loading, Shear, and Moment (q, S, and M)	CDL 3.2-3.6 *CDL 3.8* *(extension to 3-D)*	*M3,4,5,6* *(2/9,11,13, 17)*
4.4 *Simple Beam Theory* Assumptions on stresses; Assumptions on deformations (Bernouilli-Euler Hypothesis); Resulting equations; Solution: stresses and deflections	CDL 7.1-7.5, 8.1,8.2	*M6,7,8* *(2/17,20,23)*
4.5 *Solutions for Various Beams* Beam Section Properties: symmetric sections, the Centroid, the I-beam; General Case: Statically Determinate Beams; Discontinuous Loading; General Cross-Sections; Statically Indeterminate Beams	CDL 7.6,8.1-8.5	*M8,9,10* *(2/23,25, 3/2)*
4.6 *Torsion of Rods/Shafts* Definition of a Shaft; Governing equations; Solution and Limitations of Model	CDL 6.1-6.5	*M10,11,12* *(3/2,4,9)*
Q3FM -- *(3/18)*		
4.7 *The Column and Buckling* Concept of Structural Stability/Instability; Definition/Model of a Column; (Solution for) Euler Buckling: basic solution (pinned case), other boundary conditions; Effect of Initial Imperfections; Concerns in failure *(in recitation)*	CDL 9.1-9.4 *CDL 9.5,9.6*	*M12,13,14* *(3/9,30, 4/1)*
4.8 *Final Notes on 1-D Structural Members*		*M14,15* *(4/1,3)*

Block 5: Failure: the Material's Role

Unit Number, Title, and Contents	Readings	Lectures*
5.1 *Material Failure/Strength* What is Failure?; Role of Lengthscale; Strain Energy; The Stress-Strain Curve: Yielding and Ultimate; True Stress and True Strain; Viscoelasticity and Creep (Time-Dependence)	A&J 8,11,17 CDL 5.2,5.3, 5.8,5.18	*M15,16* *(4/3,6)*

Unit Number, Title, and Contents	Readings	Lectures*
5.2 *Physical Origins of Failure/Strength* Perfect Model -- energy derivations; Imperfections, the Weakest Link, and the Role of Lengthscale; Dislocations and mechanisms to resist	A&J 9,10,18,19	*M16,17,18* *(4/6,8,13)*
5.3 *Yield (and Failure) Criteria* Maximum Shear Plane; Importance of Hydrostatic Stress; Tresca Criterion; von Mises Criterion; Using Yield (Failure) Crtiteria	CDL 5.11,5.13, 6.9	*M18,19,20* *(4/13,14,17)*
5.4 *Other Consideration in Failure* Stress Concentrations: definition, notch sensitivity; Fracture Mechanics: Griffith equation, Modes, uses; Fatigue	A&J 13,14,15,16 CDL 5.9,5.14, 5.15 *A&J 17-27*	*M20,21* *(4/17,22)*

Q5M -- *(4/29)*