Seminar List & Outline Syllabus: Last Update 5/9/13

Strength of Materials T72S01	
1	Bending stresses: Formulae relating stress to bending moment; Section modulus (moment of inertia); Neutral axis for asymmetric sections
2	Beam Theory 1: Derivation of shearing force and bending moment diagrams; Solution of statically determinate problems
3	Beam Theory 2: Derivation of displacements and rotations; Solution of statically indeterminate problems
4	Basic formulation of 3D continuum stresses and strains; Definitions in terms of forces and displacements (small strains); Why the tensors are symmetric; Equilibrium condition, within a body and on a boundary; Isotropic elastic moduli; Derivation of $G = E/2(1+\nu)$; Change of volume, relation to ν.
5	Force on an element of area; Definition of principal stresses and strains; Definition of Tresca and Mises equivalent stresses; Mohr's circles; Hydrostatic and deviatoric stresses;
6	Maths: Tensors and index notation; Transformation of tensors to a different coordinate system (rotations); 2D rotated stresses, formulae for principal stresses and orientation; Eigenvalues and eigenvectors of real symmetric matrices: relevance to principal stresses and their orientation: the reason why principal axes exist.
7	How the continuum elasticity problem is formulated: Equilibrium, Hooke's law and formulation in terms of displacements or use of the compatibility equations. Reduction to a single scalar equation in 2D (Airy functions). Plane stress and plane strain problems. Example solutions.
8a	Basics of plasticity: What is plasticity? Yield criteria, Mises & Tresca; Theoretical strength versus reality (dislocations); Definition of proof stress and UTS; Engineering versus true stress and strain; Graphical construction for engineering stress and UTS from true stress curve; Typical stress-strain curve types; Ductility;
8b	Shear yield strength (Tresca & Mises); Plastic incompressibility; Stress invariants; Constraint; Mises plane strain yield strength;
8c	The deviatoric stress plane; the Mises circle and the Tresca hexagon
8d	Incremental plasticity; Convexity of the yield surface; Normality of the plastic strain increment; Flow rules; Reverse yielding: kinematic hardening versus isotropic hardening and reality; Hysteresis loops, shakedown, ratcheting, residual stresses.
9	The lower bound theorem of plastic collapse: proof and example applications; The reference stress concept: definition and examples. Cases with more than one applied load. The concept of primary and secondary loads and its limitations, elastic follow-up.
10	The upper bound theorem of plastic collapse, proof and examples.
11	Slip line field theory: The hyperbolic nature of the perfect plasticity equations: Cauchy surfaces; Example slip line fields for bent bars, sharp cracks and blunt cracks: the relevance to fracture (constraint elevates hydrostatic stress).
12	Thermal stresses: formulation of the problem; Constrained and unconstrained cases; Uniform temperature gradient gives zero stress if unconstrained; Examples, e.g. temperature gradient through a vessel wall; Flow of heat (or electric current) around a crack (DCPD).
12B	Residual Stresses
12C	Failure Mechanisms