30.001 STRUCTURE AND MATERIALS – SPRING 2022

Course Schedule

WEEK	LESSON	TOPIC	READING REFERENCE	ASSIGNMENTS
Crystal Structure (WP)				
1 **24/1**	1 (ZOOM)	Course Overview. Primary bonds. Secondary bonds. Interatomic forces. Ranking of Moduli for Crystals. Materials classifications. Biodegradable implants. AZ31 metallography.	Ashby 4.1-4.5 James 2.1-2.6 Elliot 3.1-3.3 Ashby 5.1-5.10	**Lab 1: Crystal Structure I**
	2 (ZOOM)	Packing of Atoms in Perfect Crystals. Miller Indices. AZ31 XRD. Mg-Al phase diagram.	James 3.1-3.2 Elliot 4.1-4.4	
	Lab 1 (Physical)	Crystal Structure Lab and Fabrication of SiO_2-Si composite (video viewing)	-	
Physical Basis of Elasticity (WP)				
2 **31/1**	3 (ZOOM)	Physical basis of Modulus. Packing of Atoms in Imperfect Crystals.	Ashby 6.1-6.2 James 4.2-4.5	**Lab 2: Crystal Structure II** **Due: Lab 1**
	-	No Lesson - Chinese New Year	-	
	Lab 2 (Physical)	Crystal Structure Lab and review	-	
Members in Uniaxial Loading (WP)				
3 **7/2**	4 (ZOOM)	Packing of Atoms in Polymers. Case studies of design limited by elasticity of materials.	Elliot 5.1-5.3 Ashby 7.1 James 14.2	**Lab 3: Tensile Test** **Due: Lab 2**
	5 (ZOOM)	Introduction to stress & strain. Structural response (Stress & strain behavior) of bars in uniaxial loading. Young modulus. Deformation behavior of brittle, ductile and composite materials.	Hibbeler 1.3-1.4, 2.1-2.2, 3.1-3.4 Ashby 3.2-3.3	
	Lab 3 (Physical)	Lab Safety/Tensile Lab	-	
Elasticity of Materials (WP)				
4 **14/2**	6 (ZOOM)	Failure behavior of Brittle and Ductile Materials. Ductility. Toughness. Hardness. Thermal expansion.	Hibbeler 3.5, 4.6 Ashby 8.1-8.3	**Lab 4: Case Study - AZ80 Property** **Due: Lab 3**
	7 (ZOOM)	Hooke's Law. Shear stress and strain. Shear modulus. Poisson's ratio. Dilatation stress. Bulk modulus. Relationship between different moduli.	Hibber 1.5, 3.4, 3.6 Ashby 3.1-3.4	
	Lab 4 (Physical)	Journal Club: Analysis of AZ80 metallography, phase diagram, and mechanical properties.	Journal of Materials Research and Technology 2021;12:1039e1050	
Statics: Elements of Equilibrium (GS)				
5 **21/2**	8 (ZOOM)	Review of Forces & Moments. Equilibrium equations for a rigid body. Free body diagrams. Reactions at supports.	Hibbeler 1.1-1.2	**Practice Problem** **Due: Lab 4**

WEEK	LESSON	TOPIC	READING REFERENCE	ASSIGNMENTS
22/2	9 (ZOOM)	Multi-component structure. Reactions at joints. Planar trusses. Two-force members. Equilibrium of a deformable body. Internal forces. Distributed loads.	Hibbeler 1.1-1.2	
24/2	Rec 1 (Physical)	Free Body Diagram Examples	-	
Statically Indeterminate Structures (GS) **Midterm: 01 Mar 2022 (Wed) 2:30-4:30pm**				
6 **28/2**	10 (ZOOM)	Deformation of axially loaded members. Statically indeterminate structures. Kinematic Conditions. Statically indeterminate structures examples	Hibbeler 4.2-4.4	**Lab 5: FEA**
	-	Mid-Term Review/Self Study	-	
	Lab 5 (Physical)	CAD and FEA Analysis	-	
7 **7/3**	**RECESS**			
Generalized Hooke's Law & Twin-Wall Pressure Vessels (WP)				
8 **14/3**	11 (ZOOM)	Stress Tensor: normal & shear stress. Generalized Hooke's Law. Plane Stress and Plane Strain.	Hibbeler 1.4-1.5, 10.6	**HW1 (Generalized Hooke's Law + Thin Wall Pressure Vessels)** **Due: Lab 5**
	12 (ZOOM)	Stress in thin-walled pressure vessels: Cylindrical & Spherical vessels. Strain in thin walled pressure vessels. Pressure Vessels Examples.	Hibbeler 8.1	
	Rec 2 (Physical)	Hooke's Law and Pressure Vessels Examples.	-	
Beams in Bending (GS)				
9 **21/3**	13 (ZOOM)	Introduction to beam bending. Shear & moment diagrams. Graphical method to construct diagrams.	Hibbeler 6.1-6.2	**HW2 (Beam Bending)** **Due: HW1**
	14 (ZOOM)	Bending moment - axial stress field - axial strain field - curvature. The flexure formula. Moment of inertia.	Hibbeler 6.3-6.4	
	Rec 3 (Physical)	Beam Bending Examples.	-	
Beams in Bending and in Torsion (GS)				
10 **28/3**	15 (ZOOM)	Deflection of beams. Slope & deflection vs curvature. Compatibility & boundary conditions.	Hibbeler 12.1-12.3	**HW3 (Beam in Deflection and Torsion)** **Due: HW2**
	16 (ZOOM)	Torsion of axisymmetric shafts: Solid and Tubular shafts. The Torsion Formula. Polar moments of inertia.	Hibbeler 5.1-5.2	
	Rec 4 (Physical)	Beam Deflection and Torsion Examples.	-	
Combined Loading and Stress Strain Transformation (GS)				
11 **4/4**	17 (ZOOM)	State of stress caused by combined loading. Principle of superposition.	Hibber 8.2	**HW4 (Combined Loading)**

WEEK	LESSON	TOPIC	READING REFERENCE	ASSIGNMENTS
	18 (ZOOM)	Transformation of the Cartesian components of the stress tensor in a rotated reference frame. Mohr's circle. Principal directions and principal stresses. Theories of Failure.	Hibber 9.1-9.7, 10.7	**Due: HW3**
	Rec 5 (Physical)	Combined Loading and Stress Transformation Examples.	-	
Modes of Failure, Advance Engineering Materials and Their Properties (WP)				
12 11/4	19 (ZOOM)	Fracture behavior of brittle and ductile materials. Stress concentration. Griffith's Energy Criteria.	Ashby 13.1-13.3, 14.1-14.5	**Practice Problem** **Due: HW4**
	20 (ZOOM)	Fatigue failure: uncracked and cracked components. S-N curve. Crack-growth rate.	Ashby 17.1-17.4	
	-	No Lesson - 3D Workday or Good Friday	-	
Course Wrap Up (WP) and 3D Work Week				
13 18/4	21 (ZOOM)	Industry lecture by Syntellix on biodegradable implants and Course Wrap Up	-	**Due: Prototypes and Posters**
	-	No Lesson - 3D Workday	-	
	-	3D Presentation 22nd April (Friday)	-	
14	**FINAL EXAM** **28th April (Thursday) 9-11 am**			