Theory of Elasticity ME 6102

Semester II - 2003

Scope

The Theory of Elasticity plays today an important role in the design of structure from the more conventional ones such as buildings, machines, and cars, to the most sophisticated structures such as aircrafts, satellites, and the space shuttle. Using Elasticity in the design process enables to attain more efficient structure as it can provide accurate values for the stress, strains and displacements even for structures of complicated geometries and loadings. The present course has two aims:

(a) To provide the student with the mathematical and physical principles of Theory of Elasticity using a large gamut of examples.

(b) To provide the student with various solution strategies while applying them to practical cases.

Instructor

Prof. Mordechai Perl
Building Room
Phone: xxxxxx

Office Hours

Monday: 10:00-12:00
Wednesday: 10:00-12:00

Homework

Week assignments due on Mondays.

Exams and Grades

Homework assignments	20%
Midterm examination	30%
Final Exam	50%
	100%

Curriculum

Lecture No.	Topic	Ref.* [1]	Ref.* [2]
1	Introduction and Historic Overview Introduction to Tensor Algebra a. Summation Convention b. Kronecker's Delta and the permutation Tensor c. Coordinates and Tensors Transformation d. Derivatives Convention		1 7 16
2	Stress a. Notion of Stress b. Stress in Cartesian Coordinates c. Shear Stresses d. Stress at a Point e. Principal Stresses and Principal Coordinates	 2, 74 4 4 74, 77	 12, 13 12 15 12 18
3	f. Maximum Shearing Stresses g. Stress Ellipsoid h. Hydrostatic and Deviatoric Stress Tensors i. Equilibrium Equations and Boundary Conditions	79 76 84	18 15
4	Strain a. Displacements and Strains b. Strain at a Point c. Principal Strains and Principal Coordinates d. Local Rotation e. Hydrostatic and Deviatoric Strain Tensors f. Compatibility Equations	 5 81 82 83 85	 1 4 6 7 10

* The numbers in these columns represent the corresponding articles in the above reference books.

Lecture No.	Subject	Bib. [1]	Bib. [2]
5	Constitutive Equations		
	a. Generalized Hoke's Law	6	20, 21
	b. Relationships between Elastic Moduli	6	23
	General Formulation of Elastic Problem		
	a. Boundary-Value Problems in Elasticity		73
	b. Navier's Equations	87	24
	c. Beltrami-Michell's Equations	85	24
	d. Principle of Superposition	89	78
6	e. Saint-Venant's Principle	19, 28	27
	f. Uniqueness of Solution	96	
	Three-Dimensional Problems		
	a. Bar Stretched by its Own Weight	100	31
	b. Torsion of a Circular Shaft	101	33
	c. Bending of a Prismatic Bar	102	32
7	Two Dimensional Elasticity		
	a. Plane Strain	9	66
	b. Plane Stress	8	67
	c. Airy's Stress Function	17	69
	Plane Problem in Cartesian Coordinates		
	a. Solution by Polynomials	18	
	Mid Term date TBA		

Lecture No.	Topic	Bib. [1]	Bib. [2]
8	Plane Problem in Polar Coordinates a. General Solution b. Thick-Walled Cylindrical Pressure Vessel (Lamé's problem)	 27 28	
9	c. Pure Bending of a Curved Beam d. Stress Concentration around a Circular Hole (Kirsch's problem) e. Rotating Disks	29 35 32	
10	f. Concentrated Line-Force on a Plane (Flamant's problem) g. Force Acting at the End of a Wedge h. Shrink Fit	36 38	
11	Torsion a. Torsion of a uniform circular shaft b. Torsion of non circular cylindrical Bars c. Torsion of Hollow Bars d. Membrane Analogy	 104 105-9 115 107	 33 34, 35
12	Strain Energy a. Strain Energy Density b. Strain Energy Density Function c. Betti-Maxwell Reciprocal Theorem	90 97	 26 109
13	Thermoelasticity a. General Approach b. Plane Thermoelastic Problem in Polar Coordinates	 153 150-1	9
	Final date TBA		

Bibliography

[1] Timoshenko, S.P., and Goodier, J.N., *Theory of Elasticity*, McGraw-Hill (1970).

[2] Sokolnikoff, I.S., *Mathematical Theory of Elasticity*, Krieger Publishing Company (1983).

[3] Shames, I.H., *Mechanics of Deformable Solids*, Krieger Publishing Company (1983).