Birla Institute of Technology & Science, Pilani
Hyderabad Campus

FIRST SEMESTER 2020-2021
Course Handout Part II

Date: 11-08-2020

In addition to part-I (General Handout for all courses appended to the time table) this portion gives further specific details regarding the course.

Course No.	**: ME G641**
Course Title	**: THEORY OF ELASTICITY & PLASTICITY**
Instructor-in-Charge	**: BRAJESH KUMAR PANIGRAHI**

1. Course Description: The theory of elasticity continues to play an essential role in mechanical, civil, materials, and aerospace engineering applications. Indeed, many important mechanical systems, ranging from space crafts to trabecular bones, are studied within the context of linear elastic theory. The studies deal with the determination of stresses and displacements in common structural forms- plates, beams, shells etc. subjected to external forces. The course covers basic theory of elasticity, 2-D and 3-D problems of elasticity, Theories of plastic flow, Flow of ideally plastic and strain hardening metals, and theory of metal forming processes.

2. Scope and Objective of the Course: The objective of this course is to introduce the student to the analysis of linear elastic solids under application of loads. The material presented in this course will provide the foundation for pursuing other solid mechanics courses such as theory of plates and shells, elastic stability, composite structures and fracture mechanics. Students are also encouraged to do assignments and practice coding using the ANSYS/ABAQUS/MATLAB package to solve problems of elasticity and plasticity to compare the analytical solutions.

3. Textbooks:

T1 Timoshenko S. P. & Goodier J. N., Theory of Elasticity, 3rd Edition, Mc-Graw Hill, 1982.

T2 Chakrabarty J., Theory of Plasticity, Mc-Graw Hill Book Company, Singapore, 1987.

4. Reference books

R1 M. Filonenko-Borodich, Theory of Elasticity, Foreign Language Publishing House, Moscow.

R2 T.G. Sitharam, L. GovindaRaju, Applied Elasticity, Interline Publishing ISBN: 81-7296083-2.

R3 Alexander Mendelson Plasticity-Theory & application, The Macmillan Company, New York, 1968.

R4. Martin H Sadd, Elasticity: Theory, Applications and Numerics, Elsevier Butterworth–Heinemann, New York.

5. Course Plan:

Lecture No.	Learning objectives	Topics to be covered	Chapter in the Text Book
1-2	Introduction to Elasticity	Elasticity, Stress, Component of Stress and strain, Hooke's Law	Ch 1-2 of T1, R2
3-7	Plane stress and plane strain	Stress at point, strain at point, Measurement of surface strain, construction of Mohr circle, differential equation of equilibrium, compatibility equation	Ch 2 of T1, R2
8-18	2D Problems in Rectangular coordinates	Saint-Venant's Principle, Determination of displacements, Bending of beam, 2D problems in the form of Fourier series.	Ch 3 of T1, R2
19-25	2D Problems in Polar Coordinates	General equations, Pure bending of curved beam, strain component, Effect of circular hole on stress distribution, stresses in circular disk, Generalized solution of the 2D problem in polar coordinates.	Ch 4 of T1, R2
26-28	Photoelastic and Moire Experimental Methods	Experimental methods and verifications, photoelastic stress measurement, Examples, Determination of principle stresses, Moire method	Ch 5 of T1
29-34	Analysis of stress strain in 3D	Principle stresses, Stress Invariants, Homogeneous deformation, strain at point, Principle axes of strain	Ch 7 of T1
35-38	Torsion	Torsion of straight bar, rectangular bar, energy method, torsion of hallow shaft, circular shaft with variable diameter.	Ch 10 of T1
39-41	Basic of Plasticity	Stress strain behavior in plastic region, Work hardening, Hardening laws, Influence of pressure, strain rate and temperature, Analysis of strain rate, Concepts of stress rate	Ch 1 of T2
41-43	Foundation of Plasticity	Criterion of yielding, Isotropic Hardening, Anisotropic, The rule of plastic flow, Constitutive relations, Application of plasticity for sheet metal processes.	Ch 2 of T2

Practical No.	Experiment Title
1	Computation and Simulation Lab: Introduction to LAB Course (Basics of Coding using Matlab, Basics of ABAQUS,Understanding structure of input files, Multiple steps etc.)

2	Basic computational solid mechanics, Basics of ABAQUS, Contacts, Pre-processing, Post processing
3	Basic example of bending of cantilever beam with all pre and post processing, which includes how to extract results and Interpretation. Validating with Theory of Elasticity approach.
4	Comparison of FEM and Analytical results (Theory of Elasticity Approach) of Axisymmetric objects : Thick Cylinders
5	Comparison of FEM and Analytical results (Theory of Elasticity Approach) of Axisymmetric objects : Rotating Disks
6	Comparison of FEM and Analytical results (Theory of Elasticity Approach) for plates with a circular hole
7	Experimental Stress Analysis using Polariscope : 1. Disk with diametric compression
8	Experimental Stress Analysis using Polariscope : 2. Tensile/Compressive tests
9	Experimental Stress Analysis using Polariscope :3. TBT specimen
10	Experimental Stress Analysis using Polariscope : 4. Plate with circular hole
11	Experiment on Tensile testing using different strain rates
12	Experiment on Tensile testing on elevated temperatures

6. Evaluation Scheme:

Component	Duration	Weightage (%)	Date & Time	Nature of Component
Test 1	30 min	15	During Class Hours (between Sept.10 –Sept. 20)	Open Book
Test 2	30 min	15	During Class Hours (between Oct 09 –Oct 20)	Open Book
Test 3	30 min	15	During Class Hours (between Nov.10 – Nov.20)	Open Book
Projects	-	10	To be announced by IC	Open Book

Lab	-	15	Continuous throughout the semester	Open Book
Comprehensive Exam	120 min	30	07/12 FN	Open Book

7. **Chamber Consultation Hour: It will be announced in the class.**
8. **Notices concerning the course: All notices concerning the course are displayed on CMS only.**
9. **Make-up Policy: No makeup for Project presentations, Quizzes, Lab component and Case studies. Makeup for Tests and comprehensive examination will be given for genuine cases with prior permission.**
10. **Academic Honesty and Integrity Policy: Academic honesty and integrity are to be maintained by, all the students throughout the semester and no type of academic dishonesty is acceptable.**

Dr. Brajesh Kumar Panigrahi

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