CE-801 Advanced Structural Mechanics

Code	Credit Hours	Category
CE-801	3	Core

Course Description:

This course provides students with advanced knowledge and analytical tools essential for the analysis and application of structural mechanics. Students will explore a wide array of topics, including indicial notation, Cartesian tensors, kinematics, stress tensors, and stress-strain relationships. The curriculum integrates theoretical concepts with practical applications, ensuring that students can apply their knowledge to solve real-world structural problems. Topics such as matrix notation, Cartesian coordinate systems, Lagrangian and Eulerian descriptions, strain tensors, principal stresses, and plane strain and stress will be thoroughly covered. This comprehensive approach aims to prepare students for advanced structural analysis and design challenges in their professional careers.

Text Book:

- S. Timoshenko, and J. N. Goodier, (1987): Theory of Elasticity, 3rd Edition, McGraw-Hill, New York.

Reference Books:

- Y. C. Fung and Pin Tong, (2001): Classical and Computational Solid Mechanics, World Scientific Publishing Company, Singapore.
- George E. Mase (1970): Schaum's Outlines: Continuum Mechanics, Mc-Graw-Hill, New York.
- Pisidhi Karsudhi (1990): Foundations of Solid Mechanics, Kluwer Academic Publishers.
- T. J. Lardner and R. R. Archer (1994): Mechanics of Solids: An Introduction, McGraw-Hill International Editions, Singapore.

Prerequisites:

- BE (Civil, Architecture, Construction Engineering & Management)

Assessment System

Component	Percentage Range
Quizzes	10-15%
Assignments	10-15%
Mid Terms	20-30%
ESE	40-50%

Project (optional) 10-15%

Teaching Plan:

Week No	Topic	Learning Outcomes
1	Indicial Notation and Cartesian Tensors	- Matrix notation - Cartesian coordinate system - Indicial notation - Change of coordinate system - Cartesian tensors
2	Motion of a Continuous Body (Kinematics)	- Lagrangian and Eulerian descriptions - Introduction to the strain tensor - The small-strain tensor - Physical meaning of the strain tensor - Change of coordinate system - Principal strains and principal directions
3	Stress Tensors	- Introduction to the stress tensors - Change of coordinate system - Principal stresses and principal directions - Equations of motion – Principle of virtual work
4	Introduction to the Stress – Strain Relationship	- Generalization of Hooke's law to 3D - Elastic symmetry & isotropic and anisotropic linear elasticity - Incompressibility - Plane strain and plane stress - The compatibility equation and boundary conditions in 2D and 3D
5	Solution of Problems in 2D Elasticity	- Governing equations - Saint Venant's principle (end effects) - Elastic solutions by polynomial stress functions
6	Linear Elastic Fracture Mechanics	- Introduction to mechanisms of fracture and crack growth - The elastic crack-tip stress field - Energy release rate - The J-integral
7	One Dimensional Rate-Independent Plasticity and Viscoplasticity.	- Frictional and rheological models - Isotropic and kinematic strain hardening
8	Indicial Notation and	- Matrix notation

	Cartesian Tensors	- Cartesian coordinate system - Indicial notation - Change of coordinate system - Cartesian tensors
9	**Mid Term Exam/ OHT, (As per NUST Exam Policy)**	
10	Motion of a Continuous Body (Kinematics)	- Lagrangian and Eulerian descriptions - Introduction to the strain tensor - The small-strain tensor - Physical meaning of the strain tensor - Change of coordinate system - Principal strains and principal directions
11	Stress Tensors	- Introduction to the stress tensors - Change of coordinate system - Principal stresses and principal directions - Equations of motion – Principle of virtual work
12	Introduction to the Stress – Strain Relationship	- Generalization of Hooke's law to 3D - Elastic symmetry & isotropic and anisotropic linear elasticity - Incompressibility - Plane strain and plane stress - The compatibility equation and boundary conditions in 2D and 3D
13-14	Solution of Problems in 2D Elasticity	- Governing equations - Saint Venant's principle (end effects) - Elastic solutions by polynomial stress functions
15	Linear Elastic Fracture Mechanics	- Introduction to mechanisms of fracture and crack growth - The elastic crack-tip stress field - Energy release rate - The J-integral
16	One Dimensional Rate-Independent Plasticity and Viscoplasticity	- Frictional and rheological models - Isotropic and kinematic strain hardening
17	Stress Tensors	- Introduction to the stress tensors - Change of coordinate system - Principal stresses and principal directions - Equations of motion – Principle of virtual work
	ESE	