Unit I

Chapter 1 : Simple Stresses and Strains 1-1 to 1-53

Syllabus : Simple Stress and Strain : Introduction to types of loads (Static, Dynamic & Impact Loading) and various types of stresses with applications, Hooke's law, Poisson's ratio, Modulus of Elasticity, Modulus of Rigidity, Bulk Modulus. Interrelation between elastic constants, Stress-strain diagram for ductile and brittle materials, factor of safety, Stresses and strains in determinate and indeterminate beam, homogeneous and composite bars under concentrated loads and self-weight.

1.1 Introduction 1-1

1.1.1 Deformation 1-1

1.2 Types of loads 1-1

1.3 Stress (σ) 1-2

1.4 Strain 1-5

1.4.1 Types of strain 1-5

1.4.2 Differentiate between Linear and Lateral Strain 1-6

1.4.3 Poisson's ratio (μ or 1/m) 1-6

1.5 Elasticity 1-7

1.6 Hooke's law 1-7

1.7 Modulus of Elasticity or Young's Modulus "E" 1-7

1.8 Modulus of Rigidity 1-7

1.9 Standard Stress Strain Curve for Mild Steel Bar 1-10

1.10 Stress Strain Curve for HYSD Bar 1-11

1.11 Stress Strain Curve for Brittle Material 1-12

1.12 Factor of safety 1-12

1.12.1 Margin of Safety 1-12

1.13 Proof Stress 1-13

1.14 Percentage Elongation 1-13

1.15 Solved Numericals on Stress Strain Diagram 1-13

1.16 Volumetric Strain due to Uniaxial Force or Uniaxial Stress Systems 1-14

1.17 Biaxial Stress System 1-15

1.18 Triaxial Stress System 1-15

1.18.1 Bulk Modulus (K) 1-15

1.19 Relation Between Modulus of Elasticity "E" and Bulk Modulus "K" 1-16

1.20 Shear Stress 1-16

1.20.1 Shear Strain 1-16

1.21 Modulus of Rigidity or Shear Modulus 1-16

1.22 Relation between Modulus of Elasticity (E) & Modulus of Rigidity (G) 1-17

1.23 Relation between Modulus of Elasticity (E), Modulus of Rigidity (G) and Bulk Modulus (K) 1-17

1.24 Principle of Superposition 1-25

1.24.1 Deformation of body or bars of stepped cross section subjected to axial load 1-25

1.24.2 Concept of maximum and minimum stress induced in the section 1-25

1.24.3 Numericals Based on Members in series (Statically determinate members) 1-29

1.25 Composite Section 1-38

1.25.1 Modular Ratio 1-39

1.25.2 Stresses in Composite Section 1-39

1.25.3 Numerical Based on Stresses in Composite Section 1-39

1.26 Statically Indeterminate Structure 1-45

Chapter 2 : Thermal Stresses and Strains 2-1 to 2-11

Syllabus : Thermal stresses in plain and composite members.

2.1 Temperature Stresses and Strain 2-1

Unit II

Chapter 3 : Shear Force and Bending Moment Diagrams 3-1 to 3-44

Syllabus : SFD & BMD: Introduction to SFD, BMD with application, SFD & BMD for statically determinate beam due to concentrated load, uniformly distributed load, uniformly varying load, couple and combined loading, Relationship between rate of loading, shear force and bending moment, Concept of zero shear force, Maximum bending moment, point of contra-flexure.

3.1 Beam 3-1

3.1.1 Span of a Beam 3-1

3.2 Types of Supports 3-1

3.3 Types of Beams 3-1
3.4 Types of Loads 3-2
3.5 Shear Force and Bending Moment 3-2
3.5.1 Shear Force 3-2
3.5.2 Bending Moment 3-3
3.6 Shear Force and Bending Moment Diagrams 3-3
3.6.1 Relation between S.F & B.M at Section 3-4
3.6.2 Relation between Shear Force and Rate of Change of Loading 3-4
3.7 Point of Contrashear (Point of zero shear force) 3-4
3.8 Point of Contraflexure 3-4
➢ **Model Question Paper (In Sem.) ..... M-1 to M-4**

Unit III

Chapter 4 : Slope and Deflection of Beams 4-1 to 4-42

Syllabus : Slope & Deflection on a Beam : Introduction to slope & deflection on a beam with application, slope, deflection and Radius of Curvature, Macaulay's Method, Slope and Deflection for all standard beams.

4.1 Concept of Slope and Deflection 4-1
4.1.1 Stiffness of Beam 4-1
4.2 Relation among Bending Moment, Slope, Deflection and Radius of Curvature 4-1
4.2.1 Differential Equation for Deflection 4-1
4.2.2 Double Integration Method for Slope and Deflection 4-2
4.3 Boundary Conditions of Beams 4-3
4.4 Double Integration Method (Macaulay's Method) to Find Slope and Deflection for Simply Supported Beam and Cantilever Beam Subjected to Concentrated Load and Uniformly Distributed Load 4-3
4.4.1 Macaulay's Method for Slope and Deflection 4-3
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4.5 Application of Macaulay's Method to Simply Supported Beam Subjected to Concentrated and Uniformly Distributed Load 4-15
4.6 Application of Macaulay's Method to Cantilever Beam .. 4-26
4.7 Application of Macaulay's Method to Overhang Beams 4-34
4.8 Application of Macaulay's Method to Beam subjected to Couple 4-36

Chapter 5 : Bending and Shear Stresses 5-1 to 5-64

Syllabus :

- **Bending Stress on a Beam:** Introduction to bending stress on a beam with application, Theory of Simple bending, assumptions in pure bending, derivation of flexural formula, Moment of inertia of common cross section (Circular, Hollow circular, Rectangular, I & T), Bending stress distribution along the same cross-section.
- **Shear Stress on a Beam:** Introduction to transverse shear stress on a beam with application, shear stress distribution diagram along the Circular, Hollow circular, Rectangular, I & T cross-section.

5.1 Introduction to Moment of Inertia 5-1
5.1.1 Radius of gyration 5-1
5.1.2 Section Modulus (Z) 5-1
5.2 Parallel Axis Theorem 5-2
5.3 Perpendicular Axis Theorem 5-2
5.3.1 Polar Moment Of Inertia (I_P) 5-2
5.3.2 Moment of Inertia for some plane figure 5-3
5.4 Introduction to Bending and Shear Stress in Beam 5-5
5.5 Theory of Simple Bending or Pure Bending 5-5
5.5.1 Pure Bending 5-6
5.5.2 Neutral Axis (N. A) 5-6
5.6 Assumptions in Theory of Pure Bending 5-6
5.6.1 Derivation of flexure formula for pure Bending 5-7
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5.8 Maximum Bending Stress (σ_b) 5-8
5.9 Bending Stress Distribution Diagram for Rectangular Section 5-8
5.9.1 Bending Stress Distribution Diagram for Various Symmetrical Sections [For Simply Supported Beam] 5-9

5.9.2 Bending Stress Distribution Diagram for Various Symmetrical Sections [for Cantilever Beam] 5-9
5.9.3 Bending Stress Distribution Diagram of Unsymmetrical Sections (For Simply Supported Beam) 5-10
5.9.4 Bending Stress Distribution Diagram of Unsymmetrical Section (For Cantilever Beam) 5-10
5.10 Flexural Rigidity 5-10
5.11 Maximum Bending Moments for Same Standard Cases 5-10
5.12 Solved Numericals based on Flexural Formula 5-11
5.13 Numerical based on to find UDL "w" 5-23
5.14 Shear Stresses 5-35
5.14.1 Basic Concept of Shear Stresses 5-35
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5.14.2 Shear Stress Equation 5-35
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5.14.9 Numericals based on Shear Stress Equations 5-42

Unit IV

Chapter 6 : Torsion 6-1 to 6-43

Syllabus :

- **Torsion of Circular Shafts:** Introduction to torsion on a shaft with application, Basic torsion formulae and assumption in torsion theory, Torsion in stepped and composite shafts, Torque transmission on strength and rigidity basis, Torsional Resilience.
- **Torsion on Thin-Walled Tubes:** Introduction of Torsion on Thin-Walled Tubes Shaft and its application.

6.1 Torsion 6-1
6.2 Torque or Torsion or Twisting Moment 6-1
6.2.1 Pure Torsion 6-1
6.3 Assumptions in theory of Pure Torsion 6-1
6.4 Torsional Equation or Torsional Formula 6-2
6.4.1 Derivation of Torsional Formula 6-2
6.5 Polar Modulus for Solid and Hollow Circular Shaft 6-3
6.6 Strength of Circular Shaft 6-3
6.7 Torsional Rigidity 6-4
6.8 Torsional Stiffness and Torsional Flexibility 6-4
6.9 Torsional Resistance for Solid and Hollow Shaft or Shear Stress Distribution for Solid and Hollow Circular Shaft 6-4
6.10 Power Transmitted by Shaft 6-4
6.11 Replacement of Section 6-5
6.12 Torsion OR Thin Walled Tubes 6-41

Chapter 7 : Buckling of Columns 7-1 to 7-23

Syllabus : Buckling of Columns : Introduction to buckling of column with its application, Different column conditions and critical, safe load determination by Euler's theory. Limitations of Euler's Theory.

7.1 Concept of Compression Member 7-1
7.2 Classification of Columns 7-2
7.3 Euler's Theory for Long Columns 7-3
7.4 Eulers' formula for buckling load 7-3
7.4.1 Application of Euler's Equation to Calculate Buckling Load 7-7
7.4.2 Limitations of Euler's Formula 7-7
7.5 Factor of Safety (F.O.S.) 7-8
7.6 Safe Load 7-8
7.7 Working Load 7-8
7.8 Design Load 7-8
7.9 Strength of Column or Load Carrying Capacity of the Column 7-8
7.10 Solved Examples Based on Euler's Formula 7-8
7.11 Numericals Based on to Find Diameter of Section (Design of Section) 7-19
7.12 Numericals Based on Finding λ = Slenderness Ratio 7-21

Unit V

Chapter 8 : Principal Stresses and Strains 8-1 to 8-34

Syllabus : Principal Stresses: Introduction to principal stresses with application, Transformation of Plane Stress, Principal Stresses and planes (Analytical method and Mohr's Circle), Stresses due to combined Normal and Shear stresses.

8.1 Introduction 8-1

8.2 Some Important Definition to Understand the Principal Stresses and Strains 8-1

8.3 Normal and Tangential Stresses (Shear Stresses) on Oblique Plane 8-2

8.4 Type 1 : When Member is Subjected to Uniaxial Force System OR Uniaxial Stress System 8-2

8.5 Body Subjected to Principal Stresses on Two Mutually Perpendicular Planes 8-4

8.6 Body Subjected to Pure Shear Stresses 8-7

8.7 To Find Principal Stresses due to Normal and Shear Stresses on Two Mutually Perpendicular Planes 8-8

8.7.1 Principal Planes and Principal Stresses 8-8

8.8 Solved Problems based on Principal Stresses and Principal Planes 8-10

8.9 Mohr's Circle Method OR Graphical Method 8-21

8.9.1 Mohr's Circle Method is used to find the normal stress (σ_n) and Tangential stress (σ_t) 8-21

8.10 Determination of Principal Stresses for Two Dimensional Direct Stress System with Shear Stress by Mohr's Circle Method 8-22

8.11 Solved Problems Based on Mohr's Circle Method 8-24

Chapter 9 : Theories of Failure 9-1 to 9-17

Syllabus : Theories of Elastic failure: Introduction to theories of failure with application, Maximum principal stress theory, Maximum shear stress theory, Maximum distortion energy theory, Maximum principal strain theory, Maximum strain energy theory.

9.1 Introduction 9-1

9.2 Maximum Principal Stress Theory [M.P.S.T.] 9-1

9.3 Maximum Shear Stress Theory [M.S.S.T.] 9-2

9.4 Maximum Principal Strain Theory [M.P.St.T.] 9-3

9.5 Maximum Strain Energy Theory or Total Strain Energy Theory [T.St.E.T.] 9-3

9.6 Maximum Distortion Energy Theory [M.D.E.T.] OR Shear Strain Energy Theory 9-5

9.7 Solved Numericals Based on Theories of Failure 9-6

Unit VI

Chapter 10 : Combined Loading and Stresses 10-1 to 10-57

Syllabus : Introduction to the Combined Loading and various stresses with application, Free Body Diagram and condition of Equilibrium for determining internal reaction forces, couples for 2-D system, Combined stresses at any cross-section or at any particular point for Industrial and Real life example for the following cases: Combined problem of Normal type of Stresses (Tensile, Compressive and Bending stress), Combined problem of Shear type of stresses (Direct and Torsional Shear stresses), Combined problem of Normal and Shear type of Stresses..

10.1 Introduction to Combined Loading 10-1

10.1.1 Components and their loads and resulting Stresses and Strains 10-1

10.2 Method of Analysis 10-2

10.3 Members subjected to combined loads 10-3

10.3.1 Combined Bending and Twisting 10-3

10.4 Direct and Bending Stresses for Eccentrically Load Short Column 10-3

10.4.1 Introduction 10-3

10.5 Axial Load or Direct Load 10-4

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10.5.2 Eccentric Load 10-4

10.5.3 Effect of Eccentric Load 10-4

10.4 Resultant Stress Intensities 10-5

10.5 Stress Distribution at Base 10-5

10.6 No Tension Condition OR Zero Stress Condition 10-6

10.7 Limiting Eccentricity (e) 10-6

10.8 Middle Third Rule [Limit of Eccentricity] OR Limiting Eccentricity for Rectangular Section 10-6

10.9 Core of a Section OR Limit of Eccentricity for a Circular Section 10-7

10.10 Core of a Section OR Kernel of Section 10-7

10.11 Limit of Eccentricity for a Hollow Circular Section 10-8

10.12 Eccentricity for Hollow Rectangular Section 10-8

10.13 Combined Problems of Stresses [Tensile, Compressive and Bending Stresses].....10-9

10.14 Combined Problems of Shear Type of Stresses [Direct and Torsional Shear Stresses] and Combined Problems of Normal and Shear Type of Stresses 10-30

- **Model Question Paper (End Sem.) ..... M-1 to M-8**

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