UNIT I

Chapter 1 : Mechanics and Force System 1-1 to 1-10

Syllabus :

Significance and relevance : Mechanics, applied mechanics, statics, dynamics.

Space, time, mass, particle, body, rigid body.

Scalar and vector quantity, Units of measurement (SI Units) - Fundamental units and derived units.

Force : unit, representation as a vector and by Bow's notation, characteristics and effects of a force, Principle of transmissibility of force, Force system and its classification.

1.1 Significance and Relevance 1-1
1.1.1 Mechanics 1-1
1.1.2 Applied Mechanics 1-1
1.1.3 Space 1-2
1.1.4 Time 1-2
1.1.5 Particle 1-2
1.1.6 Mass 1-2
1.1.7 Weight 1-2
1.1.8 Body 1-2
1.1.9 Rigid Body 1-2
1.2 Scalar Quantity and Vector Quantity 1-2
1.2.1 Scalar Quantity 1-2
1.2.2 Vector Quantity 1-2
1.2.3 Difference Between Scalar and Vector Quantities 1-2
1. 3 Unit of Measurement 1-3
1.3.1 Unit 1-3
1.3.2 Fundamental or Basic Units 1-3
1.3.3 Derived Units 1-3
1.3.4 Systems of Units 1-3
1.4 Force 1-3
1.4.1 Definition of Force 1-3
1.4.2 SI Unit of Force 1-3
1.4.3 1 N Force/Unit Newton Force 1-3
1.4.4 Graphical Representation of Force 1-4
1.4.5 Bow's Notation Method 1-4
1.4.6 Characteristics of Force 1-4
1.4.7 Effects of a Force on a Body 1-5
1.4.8 Principle of Transmissibility of a Force 1-5
1.4.9 Force System 1-5
1.5 Some Important Laws and Terms 1-8
1.6 MSBTE Question 1-10

UNIT II

Chapter 2 : Simple Lifting Machine 2-1 to 2-31

Syllabus :

Simple lifting machine, load, effort, mechanical advantage, applications and advantage, applications and advantages

Velocity ratio, efficiency of machines, law of machine.

Ideal machine, friction in machine, maximum Mechanical advantage and efficiency, reversible and non-reversible

machines, condition for reversibility.

Velocity ratios of Simple axle and wheel, Differential axle and wheel, Worm and worm wheel, Single purchase and double purchase crab winch, Simple screw jack, Weston's differential pulley block, geared pulley block.

Graphs of load verses Effort, Load verses ideal Effort, load verses Effort lost in friction, Load verses MA, Load verses Efficiency.

2.1 Introduction 2-1
2.2 Definitions of Some Technical Terms 2-1
2.2.1 Load (W) 2-1
2.2.2 Effort (P) 2-1
2.2.3 Mechanical Advantage (M.A) 2-1
2.2.4 Velocity Ratio (V. R) 2-2
2.2.5 Input 2-2
2.2.6 Output 2-2
2.2.7 Efficiency (η) 2-2
2.3 Law of Machine 2-2
2.3.1 Definition 2-2
2.3.2 Relation between W and P 2-2
2.3.3 Use of Law of Machine (m and c must be known) 2-3
2.3.4 Maximum Mechanical Advantage of a Machine 2-3
2.3.5 Maximum Efficiency of a Machine 2-3
2.4 Ideal Machine 2-3
2.5 Relation between M.A., V.R. and η of a Lifting Machine 2-4
2.6 Ideal Effort 2-4
2.7 Ideal Load 2-4
2.8 Load Lost in Friction and Effort Lost in Friction 2-4

2.8.1 Effort Lost in Friction 2-4

2.8.2 Load Lost in Friction 2-4

2.9 Reversibility of a Machine 2-5

2.9.1 Conditions for the Machine to be Reversible 2-5

2.10 Self Locking Machine (Non-Reversible Machine) 2-5

2.11 Velocity Ratio for Different Machines 2-5

2.11.1 Simple Axle and wheel 2-5

2.11.2 Differential Axle and wheel 2-6

2.11.3 Worm and Worm Wheel 2-7

2.11.4 Single Purchase Crab 2-8

2.11.5 Double Purchase Crab 2-9

2.11.6 Simple Screw Jack 2-10

2.11.7 Weston's Differential Pulley Block 2-11

2.11.8 Geared Pulley Block 2-12

2.12 Graphs For Lifting Machine 2-23

2.12.1 Load (w) verses Effort (P) 2-23

2.12.2 Load (W) verses Percentage Efficiency (%η) 2-23

2.12.3 Load (W) Verses Mechanical Advantage (M.A.) 2-24

2.12.4 Load (W) Verses Effort Lost in Friction (Pf) 2-24

2.13 Problems based on graphs 2-24

2.14 MSBTE Questions 2-31

UNIT III

Chapter 3 : Resolution and Composition 3-1 to 3-49

Syllabus :

Resolution of a force : Orthogonal and Non Orthogonal components of a force, moment of a force, Varignon's Theorem.

Composition of forces : Resultant, analytical method of determination of resultant for concurrent non concurrent and parallel co-planar force systems , Law of triangle, parallelogram and polygon of forces.

Graphic statics, graphical representation of force, Space diagram, force diagram, polar diagram and funicular polygon

Graphical method of determination of resultant for concurrent and parallel co-planar force systems.

3.1 Introduction 3-1

3.1.1 Resolution of a Force 3-1

3.2 Component of Force or Resolved Part of Force 3-1

3.3 Methods of Resolution 3-1

3.3.1 Resolution of a Force into Two Non-Perpendicular Components 3-2

3.3.2. Resolution of a Force into two Mutually Perpendicular Components 3-4

3.4 Moment of a Force 3-8

3.4.1 Classification of Moments According to Direction of Rotation 3-8

3.4.2 Geometrical Meaning of Moment of a Force 3-9

3.5 Couple 3-9

3.5.1 Definition 3-9

3.5.2 Characteristics of Couple 3-10

3.5.3 Properties of Couple 3-10

3.6 Law of Moment 3-12

3.7 Varignon's Theorem of Moment 3-13

3.8 Composition of Forces 3-13

3.8.1 Introduction 3-13

3.8.2 Resultant Force 3-13

3.8.3. Analytical Method 3-13

3.9 Analytical Method for Concurrent Force System 3-13

3.9.1 Law of parallelogram 3-13

3.10 Explanation for Examples Based on Forces Acting on Pentagon and Hexagon 3-15

3.10.1 Pentagon 3-15

3.10.2 Hexagon 3-17

3.11 Graphical Method 3-34

3.12 Graphic Statics 3-34

3.13 Graphical Representation of a Force 3-34

3.14 Space Diagram 3-34

3.15 Vector Diagram 3-35

3.16 Polar Diagram and Funicular Diagram 3-36

3.16.1 Polar Diagram 3-36

3.16.2 Funicular Polygon 3-36

3.17 Triangle Law of Forces 3-36

3.18 Polygon Law of Forces 3-36

3.19 Solved Examples 3-37

3.20 MSBTE Question 3-49

UNIT IV

Chapter 4 : Equilibrium 4-1 to 4-40

Syllabus :

Equilibrium and Equilibrant, Free body and Free body diagram, Analytical and graphical conditions of equilibrium.

Equilibrium of force systems analytically

Lami's Theorem,

Types of beam, supports (simple, hinged, roller and fixed) and loads acting on beam (vertical and inclined point load, UD load, couple), span of beam

Beam reaction for cantilever, simply supported beam with or without overhang – subjected to combination of Point load and UD load or Vertical Point load and couple.

Beam reaction graphically for simply supported beam subjected to vertical loads only.

4.1 Introduction 4-1
4.1.1 Equilibrant 4-1
4.1.2 Relation between Resultant and Equilibrant 4-1
4.1.3 Differentiate between Resultant and Equilibrant 4-2
4.2 Free Body and Free Body Diagram 4-2
4.2.1 Definition of Free Body 4-2
4.2.2 Definition of Free Body Diagram (F.B.D) 4-2
4.2.3 Significance of F.B.D 4-2
4.2.4 Analytical Condition of Equilibrium 4-2
4.3 Lami's Theorem 4-3
4.3.1 Limitations of Lami's Theorem 4-3
4.3.2 Signification of Lami's Theorem 4-3
4.4 Beams 4-4
4.4.1 Definition of Beam 4-4
4.4.2 Types of Beams 4-4
4.4.3 Types of End Supports 4-4
4.4.4 Classification of Loads 4-5
4.4.5 Reactions of Simply Supported Beam by Analytical Method 4-5
4.5 Graphical Method for Solving Equilibrium Problems 4-6
4.5.1 Graphical Conditions of Equilibrium 4-6
4.5.2 Important Conditions of Equilibrium 4-7
4.5.3 Procedure for problems by graphical method 4-7
4.6 Numericals Based on Equilibrium 4-8
4.7 MSBTE Questions 4-40

UNIT V

Chapter 5 : Friction 5-1 to 5-19

Syllabus :

Friction and its relevance in engineering, types and laws of friction, limiting equilibrium, limiting friction, co-efficient of friction, angle of friction, angle of repose, relation between co-efficient of friction and angle of friction.

Equilibrium of bodies on level surface subjected to force parallel and inclined to plane.

Equilibrium of bodies on inclined plane subjected to force parallel to the plane only.

FBD of ladder in friction

5.1 Introduction 5-1
5.2 Friction 5-1
5.2.1 Advantages of Friction 5-1
5.2.2 Disadvantages of Friction 5-1
5.2.3 Frictional Force / Friction and its Significance 5-1
5.2.4 Classification or Type of Friction 5-2
5.2.5 Limiting Equilibrium 5-2
5.2.6 Limiting Friction 5-3
5.2.7 Coefficient of Friction (μ) 5-3
5.2.8 Theory of Friction 5-3
5.2.9 Angle of Friction (ϕ) 5-4
5.2.10 Cone of Friction 5-4
5.2.11 Relation between Co-efficient of Friction and Angle of Friction 5-4
5.2.12 Angle of Repose (α) 5-4
5.2.13 Relation Between Angle of Friction ϕ and Angle of Repose 5-5
5.2.14 Relation between Angle of Repose (α), Angle of Friction (ϕ) and Coefficient of Friction (μ) 5-5
5.2.15 Ladder Friction 5-7
5.3 MSBTE Questions 5-19

UNIT VI

Chapter 6 : Centroid and Centre of Gravity 6-1 to 6-60

Syllabus :

Centroid of geometrical plane figures (Square, rectangle, triangle, circle, semi-circle, quarter circle)

Centroid of composite figures composed of not more than three geometrical figures

Centre of Gravity of simple solids (Cube, cuboid, cone, cylinder, sphere, hemisphere)

Centre of Gravity of composite solids composed of not more than two simple solids.

6.1 Introduction 6-1

6.1.1. Centroid (C or C. G.) 6-1

6.1.2 Centre of Gravity 6-2

6.1.3 Centroid Vs Centre of Gravity 6-3

6.1.4 Centroidal Axis 6-3

6.1.5 Reference Axis 6-3

6.1.6 Mathematical Expression for Centroid 6-4

6.2 Centroid of Composite Figures 6-7

6.2.1 Composite Figures 6-7

6.3 Centroid of Composite Geometrical Figures 6-9

6.3.1 Step for Calculation of Centroid of Composite Geometrical Figures 6-9

6.3.2 For Further Simplification of Problems let us Understand the Position of CG with Respect to Reference Axis 6-10

6.4 Centre of Gravity (C. G.) 6-41

6.4.1 Centre of Gravity of Simple Solids 6-41

6.4.2 Centre of Gravity of Composite Solid 6-43

6.5 MSBTE Questions 6-60

❑❑❑