Teach To India Publication

Mechanical Engineering

(Competitive Exams – Objective Special)

State PSC Polytechnic Lecturer

UPSC ESE, GATE

AE Exams, PSU

Language: English

Key Features:

- Subject-wise Premium MCQs
- Each MCQ With Detailed Solutions
- *Syllabus- state PSC & Core Competitive 13 Subjects*

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Exam-Oriented, Suitable For:

State PSC (Lecturer/Asst. Professor), GATE / ESE (IES), State AE & JE, PSU Recruitments (BHEL, BEL, SAIL, ONGC, NTPC, IOCL, etc.), DRDO, ISRO Scientist-C, State University & Polytechnic Lecturer/Asst. Professor Exams, and M. Tech / Ph.D. Entrance Exams (IITs, NITs & Central Universities).

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Colophon:
This book is printed on environmentally responsible paper. The layout, typesetting, and graphics have been optimized for language clarity and accessibility, suitable for technical and vocational training.

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Book Introduction

This book has been carefully designed to meet the requirements of students and professionals preparing for a wide range of competitive examinations in Mechanical Engineering. It comprehensively covers the core subjects commonly included in **State PSC Lecturer/Assistant Professor examinations, GATE, Engineering Services Examination (ESE), State AE & JE recruitments, PSU technical recruitment examinations, DRDO, ISRO, University and Polytechnic Lecturer recruitment examinations**, as well as **M.Tech. and Ph.D**. **entrance examinations** conducted by **IITs, NITs, and Central Universities**.

The book contains carefully selected multiple-choice questions with detailed explanations to strengthen conceptual understanding and improve problem-solving skills. The questions have been designed across different cognitive levels—including **remembering, understanding, application, and analysis**—to help students develop both theoretical knowledge and examination confidence.

The content has been organized subject-wise according to the latest examination trends, enabling systematic preparation and quick revision. It serves as a comprehensive practice resource for self-study, classroom learning, and competitive examination preparation.

Acknowledgment

This book has been prepared with due care and based on the official syllabus prescribed for various Mechanical Engineering competitive examinations, including the **UPPSC syllabus** covering the **core thirteen subjects**. During the preparation of this book, the author consulted various standard textbooks, technical references, academic publications, and publicly available educational resources. The author sincerely acknowledges the valuable contributions of researchers, educators, and subject experts whose work has helped enrich the quality and accuracy of this publication. Every effort has been made to present the content in an original, student-friendly, and examination-oriented manner.

Syllabus

Subject Name	Part-1
Engineering Mechanics	Analysis of Force Systems, Friction, Centroid and Centre of Gravity, Trusses, Bending Moment and Shear Force diagrams, Kinematics and Kinetics of Rigid Bodies.
Mechanisms and Machines	Velocity and Acceleration analysis, Cams and Followers, Gears and gear trains, Clutches, Brakes and Dynamometers, Flywheel and Governors, Braks and Dynamometers, Balancing of rotating and Reciprocating Masses, Balancing of Multi Cylinder Engines, Free and Forced Vibration, Gyroscopic Stabilization, Whirling of Shafts.
Mechanics of Solids	Stresses and Strains, Compound Stresses and Strains, Torsion of circular Shafts, Slope and Deflection, Unsymmetrical bending, Curved Beams, Thin and Thick Cylinders, thin Spheres, Helical and Leaf Springs, Buckling of Columns.
Design of Machine Elements	Design for Static and Dynamic Loading, Theories of failures, Fatigue, Design of Rivetted, Welded and Bolted Joints, Shafts, Gears, Bearings, Clutches and Brakes.
Engineering Materials	Crystal Systems and Crystallography, Crystal Imperfections, Phase Diagrams, Iron Carbon Equilibrium Diagram, Heat Treatment, Ferrous and Non-Ferrous Metals and Alloys, Mechanical Properties and Testing.
Manufacturing	Metal Casting, Metal joining, Metal forming, Mechanics of Metal cutting, Machining and Machine Tool Operations, Unconventional Machining, Limits, Fits and Tolerances, Inspection: Surface Roughness and its measurement; Comparators, Computer Integrated Manufacturing, Flexible Manufacturing Systems, Jigs and Fixtures.
Industrial Engineering	Production Planning and Control, Inventory Control, Operations Research, CPM and PERT
Mechatronics and Robotics	Microprocessors and Micro Controllers, Architecture, Programming, Computer Interfacing, Programmable Logic Controllers, Sensors and Actuators, Piezoelectric Accelerometers, Hall Effect Sensors, Optical Encoder, Resolver, Induction, Pneumatic and Hydraulic Actuators, Stepper Motor, Control System, Mathematical Modelling of Physical Systems, Control Signals, Controllability and Observability. Robotics : Robot Classification, Robot Specification, Notation, Direct and Inverse Kinematics, Homogeneous Co-ordinates and Arm Equations of four Axis SCARA Robot.
	Part-2
Thermodynamics	Thermodynamic Systems and Processes, Properties of Pure Substances, Concepts and Applications of Zeroth, First and Second Law of Thermodynamics, Entropy, Availability and Irreversibility, detailed Analysis of Thermodynamic Cycles, Ideal and Real gases, Fuels and Combustion.
Fluid Mechanics	Basic Concepts and Properties of Fluids, Manometry, Fluid Statics, Buoyancy, Equations of Motion, Bernoulli's Equation and Applications, Viscous Flow of incompressible fluids, Laminar and turbulent flows, Flow through pipes and head losses in Pipes, Isentropic and Adiabatic Flows, Normal Shock Waves.
Heat Transfer	Modes of Heat Transfer, Steady and unsteady heat Conduction, Themocouple time constant, critical thickness of insulation, Heat Transfer from Fins, Momentum and energy Equations for Boundary Layer flow on a Flat Plate. Free and Forced convection Radiative heat transfer, Stefan-Boltzmann law, Shape Factor, Black and Grey Body radiation, heat exchanger, Boiling and Condensation, Heat Exchanger Performance Analysis, LMTD and NTU-Effectiveness Methods.
Energy Conversion	SI and CI engines, Performance Characteristics and Testing of IC Engines, Fuels, Combustion Phenomena in SI and CI Engines, Carburetion and Fuel Injection Systems, Emission and Emission Control. Reciprocating and Rotary Pumps, Pelton wheels, Francis and Kaplan Turbines, velocity Diagrams, Impulse and Reaction Principles, Steam and Gas Turbines, Rankine and Brayton Cycles with regeneration and reheat, High Pressure Boilers Drafts, Condensers. Unconventional Power

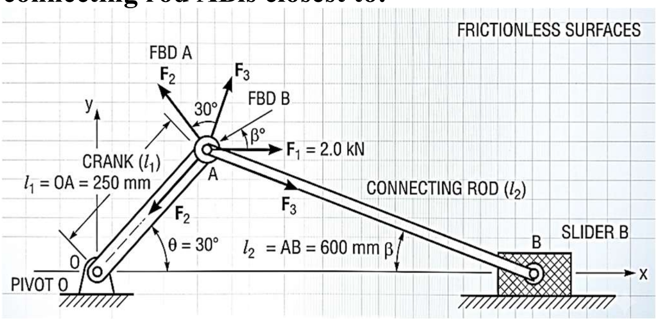
	Systems Including Nuclear, MHD, Biomass, Wind and Tidal Systems. Utilization of Solar Energy, Reciprocaing and Rotary Compressor; Theory and applications, Theory of Propulsions, Pulsejet and Ramjet Engines.
Environmental Control	Vapour Compression, Vapour Absorption, Steam jet and Air Refrigeration Systems, Properties of Refrigerant and their Nomenclature, Psychrometric Properties and Proceses, Psychrometric Relations, Use of Psychrometric chart, Load Estimation, Supply Air Conditions, Sensible Heat Factor, Air Conditioning; System Layout, Comfort Chart, Comfort and Industrial Air Conditioning.

Table of Contents

Part-1

1. Engineering Mechanics

Q1. A force system in which all forces act along lines that are parallel to each other and lie in the same plane is called.
(a) Coplanar concurrent force system
(b) Non-coplanar concurrent force system
(c) Coplanar parallel force system
(d) General spatial force system
Ans. c | Sol. : A coplanar parallel force system consists of forces whose lines of action are parallel and lie in a single plane, such as loads acting on a simply supported beam.
Q2. The condition for equilibrium of a rigid body in a plane requires:
(a) ΣFx = 0 only
(b) ΣFy = 0 only
(c) ΣM = 0 only
(d) ΣFx = 0, ΣFy = 0, and ΣM = 0
Ans. d | Sol. : Complete static equilibrium in two dimensions requires that the algebraic sum of horizontal forces, vertical forces, and moments about any point must all be zero.
Q3. According to Lami's theorem, three coplanar concurrent forces keeping a body in equilibrium are proportional to:
(a) Their magnitudes
(b) Their directions
(c) The cosines of opposite angles
(d) The sines of opposite angles
Ans. d | Sol. : Lami's theorem states that each force is proportional to the sine of the angle between the other two forces acting at the point of concurrency.
Q4. The magnitude of the axial force developed in the connecting rod ABis closest to:



(a) 1.49 kN (Compression)
(b) 1.83 kN (Compression)
(c) 2.41 kN (Compression)
(d) 3.00 kN (Compression)
Ans. a | Sol. : Vertical coordinate of point A:

$$y_A = OA\sin 30^\circ = 250 \times 0.5 = 125 \text{ mm}$$

Angle of connecting rod with the horizontal:

$$\beta = \sin^{-1}\left(\frac{125}{600}\right) \approx 12^\circ$$

At pin A, three concurrent forces are in equilibrium:

- External force $F_1 = 2\text{kN}$ (horizontal),
- Axial force in crank F_2,
- Axial force in connecting rod F_3.

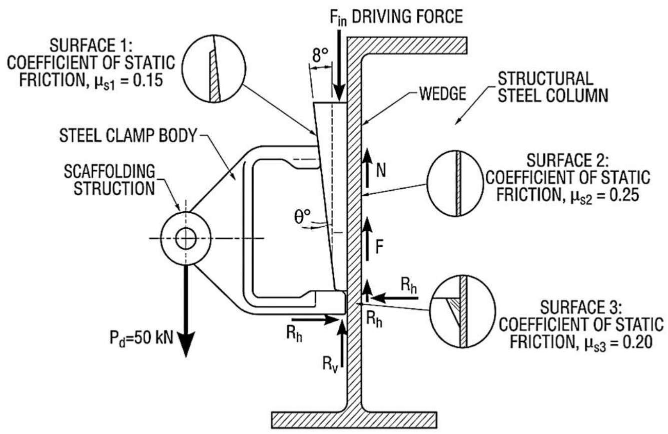
Applying Lami's theorem,

$$\frac{F_1}{\sin 138^\circ} = \frac{F_3}{\sin 150^\circ}$$

$$F_3 = 2\left(\frac{\sin 150^\circ}{\sin 138^\circ}\right) = 2\left(\frac{0.5}{0.6691}\right) \approx 1.49 \text{ kN}$$

Since the force acts toward the joint, the connecting rod is in compression.

Q5. A couple produces:
(a) Translation only
(b) Rotation only
(c) Both translation and rotation
(d) No effect on the body
Ans. b | Sol. : A couple consists of two equal and opposite parallel forces separated by a distance, producing a pure rotational effect without translation.
Q6. The angle of friction is defined as the angle between:
(a) Normal reaction and resultant reaction
(b) Applied force and weight
(c) Weight and normal reaction
(d) Friction force and applied force
Ans. a | Sol. : The angle of friction is the angle made by the resultant reaction with the normal reaction when the body is on the verge of motion.
Q7. The coefficient of friction is equal to:
(a) tan φ
(b) sin φ
(c) cos φ
(d) cot φ
Ans. a | Sol. : The coefficient of friction (μ) is equal to the tangent of the angle of friction (φ), i.e., μ = tan φ.
Q8. The angle of repose is the angle at which a body just begins to slide on an inclined plane. It is equal to:
(a) Angle of inclination
(b) Angle of friction
(c) Complement of angle of friction
(d) Twice the angle of friction
Ans. b | Sol. : The angle of repose is numerically equal to the angle of friction because both correspond to the limiting equilibrium condition.
Q9. Which of the following surfaces is most likely to reach the limiting friction condition first, thereby governing the possibility of slipping of the clamp?



(a) Surface 1 (μ = 0.15)
(b) Surface 2 (μ = 0.25)
(c) Surface 3 (μ = 0.20)
(d) Surfaces 2 and 3 simultaneously
Ans. a | Sol. : The surface with the lowest coefficient of static friction reaches the limiting friction state first because

$$F_{\max} = \mu N$$

For the given surfaces,

- Surface 1: $\mu = 0.15$
- Surface 2: $\mu = 0.25$
- Surface 3: $\mu = 0.20$

Since

$$0.15 < 0.20 < 0.25,$$

Surface 1 has the least frictional resistance and is therefore the critical interface where slipping is most likely to initiate.

Q10. The centroid of a semicircular area of radius R lies at a distance of:
(a) $\frac{R}{2}$
(b) $\frac{2R}{\pi}$
(c) $\frac{4R}{3\pi}$
(d) $\frac{3R}{4\pi}$
Ans. c | Sol. : The centroid of a semicircular area is located at a distance $\frac{4R}{3\pi}$from its diameter along the axis of symmetry.

Q11. The centroid of a rectangular area lies at:
(a) One-fourth of its dimensions
(b) One-third of its dimensions
(c) The geometric centre
(d) The top corner
Ans. c | Sol. : Due to symmetry, the centroid of a rectangle coincides with its geometric centre.

Q12. The centre of gravity of a uniform circular disc is located at:
(a) Radius/2 from the centre
(b) Diameter/4 from the centre
(c) Circumference
(d) Its geometric centre
Ans. d | Sol. : For a homogeneous circular disc, the centre of gravity lies exactly at its geometric centre.

Q13. The centroid of a triangle lies at:
(a) Midpoint of a side
(b) Circumcentre
(c) Intersection of medians
(d) Intersection of altitudes
Ans. c | Sol. : The centroid of a triangle is the common intersection point of its three medians.

Q14. The centre of gravity of a body depends upon:
(a) Shape and mass distribution
(b) Colour of the body
(c) Surface roughness
(d) Temperature only
Ans. a | Sol. : The centre of gravity is determined by the geometry and distribution of mass within the body.

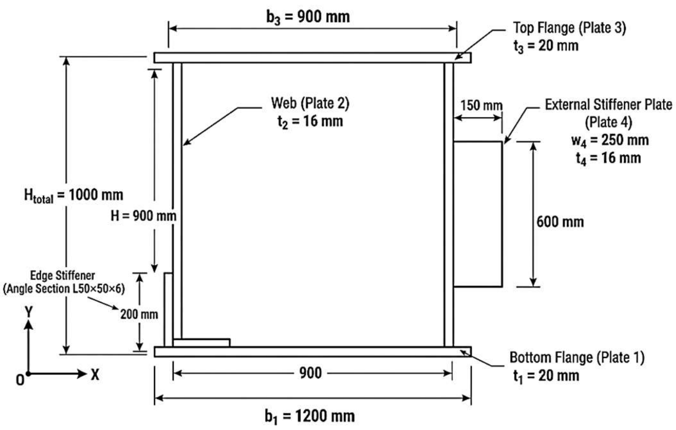
Q15. A perfect frame satisfies the condition:
(a) m = 2j
(b) m = 2j − 3
(c) m = j − 1
(d) m = 3j − 2
Ans. b | Sol. : For a plane pin-jointed truss to be perfect, the number of members (m) and joints (j) must satisfy m = 2j − 3.

Q16. The method of joints in truss analysis is based on:
(a) Rotational equilibrium only
(b) Dynamic equilibrium
(c) Equilibrium of forces at each joint
(d) Energy principles
Ans. c | Sol. : The method of joints applies ΣFx = 0 and ΣFy = 0 at each joint to determine unknown member forces.

Q17. A member carrying no force under a given loading condition is called a:
(a) Compression member
(b) Tension member
(c) Redundant member
(d) Zero-force member
Ans. d | Sol. : Zero-force members exist in trusses to maintain stability and may not carry load for certain loading configurations.

Q18. In a pin-jointed truss, members are assumed to carry:
(a) Bending moments only
(b) Axial forces only
(c) Shear forces only
(d) Torsional moments only
Ans. b | Sol. : Ideal truss members are two-force members and therefore carry only axial tension or compression.

Q19. Taking the origin (0, 0) at the bottom-left corner of the section as shown in the figure, the y-coordinate of the centroid of the composite section is closest to:



(a) 495 mm
(b) 510 mm
(c) 542 mm

(d) 565 mm
Ans. b | Sol. : Areas:

- Bottom flange:
$$A_1 = 1200 \times 20 = 24000 \text{ mm}^2$$
- Two webs:
$$A_2 = 2(1000 \times 15) = 30000 \text{ mm}^2$$
- Top flange:
$$A_3 = 900 \times 25 = 22500 \text{ mm}^2$$

Total area,
$$A = 24000 + 30000 + 22500 = 76500 \text{ mm}^2$$

Centroid locations from the bottom:

- Bottom flange:
$$y_1 = 10 \text{ mm}$$
- Webs:
$$y_2 = 20 + \frac{1000}{2} = 520 \text{ mm}$$
- Top flange:
$$y_3 = 20 + 1000 + \frac{25}{2} = 1032.5 \text{ mm}$$

Using
$$\bar{y} = \frac{\sum Ay}{\sum A}$$
$$\bar{y} = \frac{24000(10) + 30000(520) + 22500(1032.5)}{76500}$$
$$\boxed{\bar{y} \approx 510 \text{ mm}}$$

Q20. A force of 100 N acts at a perpendicular distance of 0.5 m from a point. The moment about the point is:
(a) 25 N·m
(b) 50 N·m
(c) 100 N·m
(d) 200 N·m
Ans. b | Sol. : Moment = Force × Perpendicular distance = 100 × 0.5 = 50 N·m.

Q21. The unit of coefficient of friction is:
(a) N
(b) N·m
(c) m/s^2
(d) Dimensionless
Ans. d | Sol. : The coefficient of friction is a ratio of frictional force to normal reaction and therefore has no units.

Q22. For impending motion, the frictional force is equal to:
(a) Zero
(b) μN
(c) N/μ
(d) $\mu^2 N$
Ans. b | Sol. : At the limiting condition, the frictional force attains its maximum value, F = μN.

Q23. The centroid of a straight line segment lies at:
(a) One-third of its length
(b) Midpoint of the segment
(c) One-fourth of its length
(d) One end of the segment
Ans. b | Sol. : The centroid of a uniform straight line lies exactly at its midpoint due to symmetry.

Q24. A truss member subjected to pulling action is known as a:
(a) Compression member
(b) Torsion member
(c) Tension member
(d) Shear member
Ans. c | Sol. : A member experiencing axial elongation under load is called a tension member.

Q25. In rigid body kinetics, Newton's second law for rotation about a fixed axis is expressed as:
(a) F=ma
(b) M=Iα
(c) M=Iω
(d) F=Iα
Ans. b | Sol. : The rotational analogue of Newton's second law states that the net moment equals the mass moment of inertia times angular acceleration.

Q26. A force system in which the resultant force and resultant moment are both zero is said to be in:
(a) Dynamic equilibrium
(b) Stable equilibrium
(c) Static equilibrium
(d) Neutral equilibrium
Ans. c | Sol. : Static equilibrium exists when the algebraic sum of all forces and moments acting on a body is zero, satisfying ΣF = 0 and ΣM = 0.

Q27. A body subjected to three coplanar non-parallel forces will remain in equilibrium only if the forces are:
(a) Equal in magnitude
(b) Concurrent
(c) Parallel
(d) Perpendicular
Ans. b | Sol. : For equilibrium under three non-parallel coplanar forces, their lines of action must intersect at a common point; otherwise, an unbalanced moment will exist.

Q28. The principle of transmissibility of force states that:
(a) A force can be replaced by any larger force in the same direction
(b) A force may be moved anywhere on its line of action without changing the external effect on a rigid body
(c) Forces always act through the centroid
(d) The resultant force depends on the point of application only

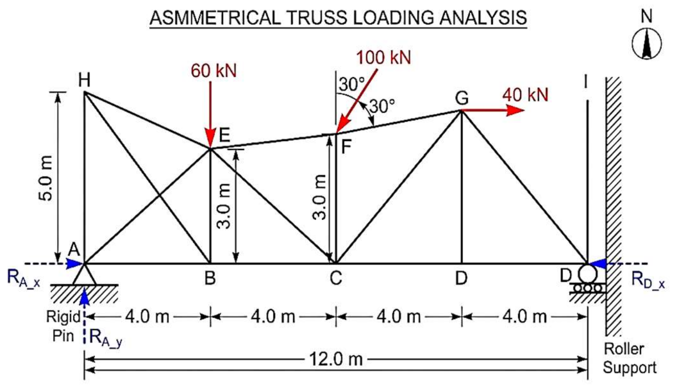
Ans. b | Sol. : The transmissibility principle applies to rigid bodies and states that shifting a force along its line of action does not alter its external mechanical effect.

Q29. If two forces of 10 N and 15 N act at right angles, the magnitude of their resultant is:

(a) 5 N
(b) 18.03 N
(c) 25 N
(d) 12.5 N

Ans. b | Sol. : The resultant is R = √(10² + 15²) = √325 = 18.03 N according to the Pythagorean theorem.

Q30. The resultant external load acting on the truss (excluding support reactions) has a magnitude closest to:



(a) 150.0 kN
(b) 164.8 kN
(c) 172.5 kN
(d) 186.6 kN

Ans. a | Sol. : Resolve the **100 kN** inclined force:

Horizontal component:

$$F_x = 100\sin 30^\circ = 50\ \text{kN}(\leftarrow)$$

Vertical component:

$$F_y = 100\cos 30^\circ = 86.6\ \text{kN}(\downarrow)$$

Resultant horizontal force:

$$\Sigma F_x = 40 - 50 = -10\ \text{kN}$$

(10 kN towards the left)

Resultant vertical force:

$$\Sigma F_y = -(60 + 86.6) = -146.6\ \text{kN}$$

Magnitude of resultant:

$$R = \sqrt{(-10)^2 + (-146.6)^2}$$

$$R = \sqrt{100 + 21491.6} = \sqrt{21591.6} \approx 146.9\ \text{kN}$$

The closest option is:

$$\boxed{150.0\ \text{kN}}$$

Q31. The frictional force developed between two surfaces before motion begins is called:

(a) Rolling friction
(b) Kinetic friction
(c) Limiting friction
(d) Viscous friction

Ans. c | Sol. : Limiting friction is the maximum static friction that acts just before the body starts moving.

Q32. The coefficient of friction is defined as the ratio of:

(a) Applied force to weight
(b) Limiting friction to normal reaction
(c) Normal reaction to limiting friction
(d) Frictional force to area of contact

Ans. b | Sol. : The coefficient of friction is given by μ = F/N, where F is limiting friction and N is the normal reaction.

Q33. The angle of friction is the angle between:

(a) Weight and normal reaction
(b) Applied force and friction force
(c) Resultant reaction and normal reaction
(d) Weight and resultant reaction

Ans. c | Sol. : The angle of friction is the angle made by the resultant reaction with the normal reaction at impending motion.

Q34. For a body resting on a rough inclined plane, motion will begin when the angle of inclination becomes equal to:

(a) Angle of repose
(b) Angle of projection
(c) Angle of contact
(d) Angle of inclination of the force

Ans. a | Sol. : The angle of repose is the maximum inclination at which a body remains at rest and is equal to the angle of friction.

Q35. Rolling friction is generally:

(a) Greater than sliding friction
(b) Equal to sliding friction
(c) Less than sliding friction
(d) Independent of surface conditions

Ans. c | Sol. : Rolling friction is much smaller because rolling motion avoids continuous surface interlocking and deformation associated with sliding.

Q36. The centroid of a uniform semicircular area lies on its axis of symmetry at a distance of:

(a) 2R/π from the center
(b) 4R/3π from the diameter
(c) R/2 from the diameter
(d) 3R/4 from the center

Ans. b | Sol. : The centroid of a semicircular area is located at 4R/3π from its base diameter along the axis of symmetry.

Q37. The centroid of a rectangle lies at:

(a) One-fourth of its dimensions
(b) The midpoint of its diagonals
(c) The top-right corner
(d) The base center

Ans. b | Sol. : The diagonals of a rectangle bisect each other, and their intersection gives the centroid.

Q38. The centre of gravity of a body is the point through which:

(a) The resultant friction acts
(b) The normal reaction acts

(c) The entire weight of the body is assumed to act
(d) The applied force always passes
Ans. c | Sol. : The centre of gravity is the point at which the total gravitational force on the body may be considered concentrated.

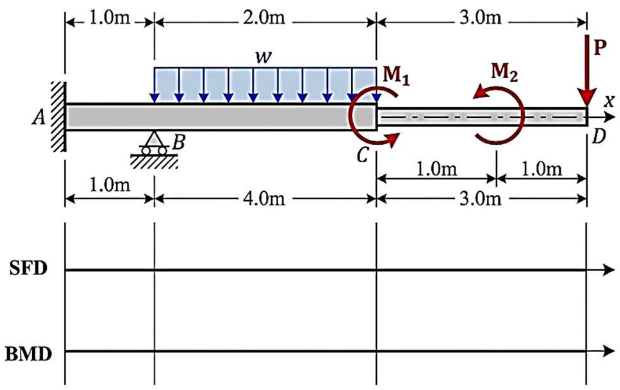
Q39. For a homogeneous body, the centre of gravity coincides with the:
(a) Neutral axis
(b) Elastic center
(c) Centroid
(d) Shear center
Ans. c | Sol. : In a body of uniform density, the centroid and centre of gravity occupy the same location.

Q40. The centroid of a triangular area is located at:
(a) Half the height from the base
(b) One-third the height from the base
(c) Two-thirds the height from the base
(d) One-fourth the height from the base
Ans. b | Sol. : The centroid of a triangle lies at a distance h/3 from the base or 2h/3 from the opposite vertex.

Q41. The method commonly used to determine the forces in all members of a truss simultaneously is:
(a) Method of sections
(b) Method of joints
(c) Graphical method
(d) Virtual work method
Ans. b | Sol. : The method of joints applies equilibrium equations at each joint to determine member forces systematically.

Q42. The method of sections is particularly useful when:
(a) Forces in all members are required
(b) Only support reactions are needed
(c) Forces in a few specific members are to be determined
(d) The truss is indeterminate
Ans. c | Sol. : The method of sections allows direct evaluation of selected member forces without analyzing the entire truss.

Q43. what is the net change in the bending moment between sections immediately to the left of Cand immediately to the right of C?



(a) Increase of 30 kN·m
(b) Decrease of 30 kN·m
(c) Increase of 100 kN·m
(d) No change in bending moment
Ans. b | Sol. : A concentrated applied couple causes an instantaneous jump in the bending moment diagram (BMD) without affecting the shear force diagram.
At section C, the applied moment is:

$$M_1 = 30 \text{ kN} \cdot \text{m}$$

Since the applied couple is clockwise, using the conventional sign convention (positive sagging moment), the bending moment diagram experiences a negative jump equal to the magnitude of the applied couple.
Therefore,

$$\Delta M = -30 \text{ kN} \cdot \text{m}$$

Hence, the bending moment decreases by 30 kN·m as the section crosses point **C**.

Q44. A truss member subjected to compression is known as:
(a) Tie
(b) Cable
(c) Strut
(d) Link
Ans. c | Sol. : A strut is designed to withstand compressive forces within a truss system.

Q45. For a perfect plane truss, the relationship between the number of members (m) and joints (j) is:
(a) m = j
(b) m = 3j – 2
(c) m = 2j – 3
(d) m = j + 1
Ans. c | Sol. : A stable and statically determinate plane truss satisfies the condition m = 2j – 3.

Q46. If a truss member carries zero force under a given loading condition, it is called a:
(a) Redundant member
(b) Dummy member
(c) Zero-force member
(d) Secondary member
Ans. c | Sol. : Zero-force members maintain structural stability and geometry even though they do not carry load for a particular loading case.

Q47. At a joint of a truss, if only two non-collinear members meet and no external load acts, then both members are:
(a) Compression members
(b) Tension members
(c) Zero-force members
(d) Redundant members
Ans. c | Sol. : Equilibrium requires both non-collinear members to carry zero force when no external load or support reaction is present at the joint.

Q48. The support that provides only one reaction perpendicular to the supporting surface is a:
(a) Fixed support
(b) Hinge support
(c) Roller support
(d) Built-in support

Ans. c | Sol. : A roller support permits movement along the supporting surface and provides only one normal reaction.

Q49. The resultant of two equal forces acting at an angle of 120° is:

(a) Equal to each force
(b) Zero
(c) Twice each force
(d) Half of each force

Ans. a | Sol. : For two equal forces F inclined at 120°, $R = \sqrt{(F^2 + F^2 + 2F^2\cos 120°)} = F$.

Q50. The frictional force during actual sliding motion is called:

(a) Static friction
(b) Limiting friction
(c) Kinetic friction
(d) Rolling resistance

Ans. c | Sol. : Kinetic friction acts when relative motion already exists between contacting surfaces and is generally smaller than limiting friction.

Q51. A body is subjected to three coplanar concurrent forces of 30 N, 40 N, and 50 N. If the first two forces act mutually perpendicular, the system will be in equilibrium when the 50 N force acts:

(a) Along the direction of the 30 N force
(b) Opposite to the resultant of 30 N and 40 N forces
(c) Perpendicular to the resultant of 30 N and 40 N forces
(d) Parallel to the 40 N force

Ans. b | Sol. : The resultant of 30 N and 40 N perpendicular forces is $\sqrt{(30^2 + 40^2)} = 50$ N. For equilibrium, the third force must be equal and opposite to this resultant.

Q52. A 200 N block rests on a rough horizontal surface with coefficient of static friction 0.3. The minimum horizontal force required to initiate motion is:

(a) 40 N
(b) 50 N
(c) 60 N
(d) 80 N

Ans. c | Sol. : Limiting friction = $\mu N = 0.3 \times 200 = 60$ N. Motion begins when the applied force equals the limiting friction.

Q53. A ladder leans against a smooth wall and rests on a rough floor. The friction force acting at the wall is:

(a) Equal to the ladder weight
(b) Zero
(c) Maximum
(d) Equal to the floor friction

Ans. b | Sol. : A smooth wall offers no frictional resistance; therefore, only a normal reaction acts at the wall.

Q54. Two forces of 100 N and 150 N act at an angle of 60°. The magnitude of their resultant is:

(a) 180 N
(b) 218 N
(c) 250 N
(d) 300 N

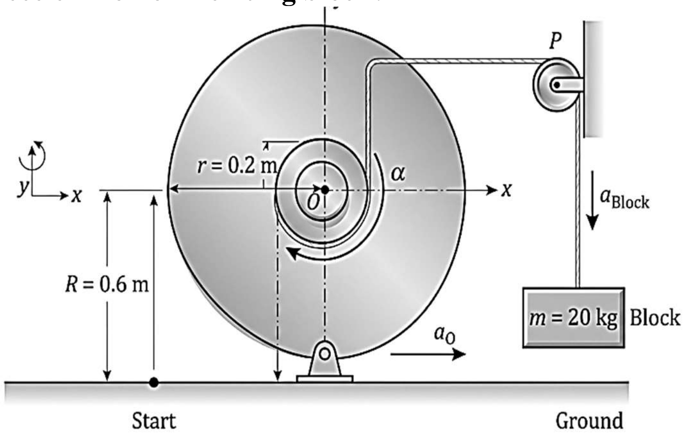
Ans. b | Sol. : $R = \sqrt{(100^2 + 150^2 + 2\times100\times150\times\cos 60°)} = \sqrt{47500} \approx 218$ N.

Q55. The centroid of a semicircular area of radius R from its diameter lies at:

(a) R/2
(b) 2R/π
(c) 4R/3π
(d) 3R/4

Ans. c | Sol. : The standard location of the centroid of a semicircle from its base diameter is 4R/3π.

Q56. What is the magnitude of the instantaneous acceleration of the 20 kg block?



(a) 0.8 m/s^2 downward
(b) 1.6 m/s^2 downward
(c) 4.8 m/s^2 downward
(d) 9.6 m/s^2 downward

Ans. b | Sol. : Since the cable is inextensible and there is no slipping between the cable and the inner drum,

$$a_{\text{cable}} = r\alpha$$

Given,

$$r = 0.2 \text{ m}, \alpha = 8 \text{ rad/s}^2$$

Therefore,

$$a_{\text{block}} = 0.2 \times 8 = 1.6 \text{ m/s}^2$$

The ideal pulley changes only the direction of motion, not the magnitude of acceleration.
Hence,

$$\boxed{a_{\text{block}} = 1.6 \text{ m/s}^2}$$

Q57. A 500 N block on a 30° inclined plane has a coefficient of friction 0.2. The friction force available is:

(a) 50 N
(b) 86.6 N
(c) 100 N
(d) 120 N

Ans. b | Sol. : Normal reaction N = 500 cos30° = 433 N. Friction = $\mu N = 0.2 \times 433 = 86.6$ N.

Q58. For a body in complete equilibrium under a coplanar force system, the required conditions are:

(a) $\Sigma Fx = 0$ only
(b) $\Sigma Fy = 0$ only
(c) $\Sigma M = 0$ only
(d) $\Sigma Fx = 0$, $\Sigma Fy = 0$, and $\Sigma M = 0$
Ans. d | Sol. : Translational and rotational equilibrium together require all force components and moments to balance.

Q59. The centroid of a rectangular plate of dimensions 8 m × 4 m is located at:
(a) (2 m, 1 m)
(b) (4 m, 2 m)
(c) (8 m, 4 m)
(d) (6 m, 3 m)
Ans. b | Sol. : The centroid of a rectangle lies at its geometric center, i.e., (8/2, 4/2).

Q60. In a simple truss, if m is the number of members and j is the number of joints, the condition for perfect framing is:
(a) $m = j$
(b) $m = 2j$
(c) $m = 2j - 3$
(d) $m = 3j - 2$
Ans. c | Sol. : A plane truss is perfectly framed when the number of members satisfies $m = 2j - 3$.

Q61. The angle of friction for a surface with coefficient of friction 0.577 is approximately:
(a) 20°
(b) 30°
(c) 45°
(d) 60°
Ans. b | Sol. : $\tan \varphi = \mu = 0.577$. Therefore, $\varphi \approx 30°$.

Q62. A body weighing 1000 N is pulled horizontally with a force of 400 N. If μ = 0.5, the body will:
(a) Move with acceleration
(b) Remain at rest
(c) Move at constant velocity
(d) Experience zero normal reaction
Ans. b | Sol. : Maximum friction = 0.5 × 1000 = 500 N, which exceeds the applied force of 400 N. Hence, the body remains stationary.

Q63. The centroid of a quarter-circle of radius R measured from each straight edge is:
(a) $4R/3\pi$
(b) $R/2$
(c) $2R/\pi$
(d) $3R/4\pi$
Ans. a | Sol. : The centroid coordinates of a quarter-circle are both equal to $4R/3\pi$.

Q64. The method commonly used to determine forces in individual truss members one joint at a time is:
(a) Method of sections
(b) Method of joints
(c) Virtual work method
(d) Energy method
Ans. b | Sol. : The method of joints applies equilibrium conditions at each pin joint to determine member forces sequentially.

Q65. A force of 80 N acts at 60° to the horizontal. Its horizontal component is:
(a) 40 N
(b) 69.3 N
(c) 80 N
(d) 20 N
Ans. a | Sol. : Horizontal component = 80 cos60° = 40 N.

Q66. A uniform rod has its center of gravity exactly at its midpoint. This indicates that the rod is:
(a) Non-homogeneous
(b) Symmetrical and homogeneous
(c) Tapered
(d) Subjected to external loading
Ans. b | Sol. : For a uniform and symmetrical body, the center of gravity coincides with its geometric center.

Q67. A truss member carrying a tensile force of 25 kN is classified as:
(a) Compression member
(b) Zero-force member
(c) Tie member
(d) Strut member
Ans. c | Sol. : Members subjected to tensile forces are called ties, whereas compression members are called struts.

Q68. A block on a rough surface is on the verge of sliding. At this condition, friction is:
(a) Less than μN
(b) Greater than μN
(c) Equal to μN
(d) Zero
Ans. c | Sol. : At impending motion, friction reaches its maximum value called limiting friction, equal to μN.

Q69. The centroid of a circular area of diameter 10 cm lies at a distance of:
(a) 2.5 cm from the circumference
(b) 5 cm from the center
(c) At the geometric center
(d) 10 cm from the edge
Ans. c | Sol. : Due to complete symmetry, the centroid of a circle coincides with its geometric center.

Q70. In the method of sections, a maximum of how many unknown member forces should be cut for direct solution using equilibrium equations?
(a) One
(b) Two
(c) Three
(d) Four
Ans. c | Sol. : In planar trusses, only three independent equilibrium equations are available; therefore, at most three unknown member forces can be determined directly.

Q71. A force system in which all forces are parallel and lie in the same plane is called:
(a) Coplanar concurrent system
(b) Coplanar parallel system
(c) Non-coplanar system
(d) General force system

Ans. b | Sol. : In a coplanar parallel force system, all forces act in a single plane and remain mutually parallel.

Q72. A 600 N crate rests on a floor with $\mu = 0.25$. The limiting friction force is:
(a) 100 N
(b) 125 N
(c) 150 N
(d) 200 N
Ans. c | Sol. : Limiting friction = $\mu N = 0.25 \times 600 = 150$ N.

Q73. The center of gravity of a body shifts when:
(a) The material density changes non-uniformly
(b) The body is perfectly symmetrical
(c) The body remains homogeneous
(d) The body is unloaded
Ans. a | Sol. : Non-uniform mass distribution changes the location of the center of gravity.

Q74. A pin-jointed truss has 8 joints. For perfect stability, the required number of members is:
(a) 11
(b) 13
(c) 16
(d) 18
Ans. b | Sol. : For a perfect plane truss, $m = 2j - 3 = 2(8) - 3 = 13$ members.

Q75. Two equal forces of 100 N act at 120° to each other. Their resultant is:
(a) 100 N
(b) 173.2 N
(c) 200 N
(d) Zero
Ans. a | Sol. : $R = \sqrt{(100^2 + 100^2 + 2 \times 100 \times 100 \times \cos 120°)} = \sqrt{10000} = 100$ N.

Q76. A simply supported beam is subjected to two equal and opposite horizontal forces acting along the same line but separated by a distance. The resulting effect on the beam is:
(a) Pure translation
(b) Pure rotation without translation
(c) Both translation and rotation
(d) No effect on the beam
Ans. b | Sol. : Two equal and opposite parallel forces separated by a distance form a couple. A couple produces a pure moment causing rotation without any resultant force or translation.

Q77. A rigid body is in equilibrium under three coplanar non-parallel forces. If two forces intersect at a point, the third force must:
(a) Be parallel to either force
(b) Pass through the same point of intersection
(c) Be perpendicular to both forces
(d) Have zero magnitude
Ans. b | Sol. : For equilibrium under three non-parallel coplanar forces, the lines of action of all three forces must be concurrent; otherwise, an unbalanced moment will exist.

Q78. A force of 100 N acts at 60° to the horizontal. Another force of 80 N acts horizontally in the opposite direction. The horizontal component of the resultant force is:
(a) 30 N
(b) 50 N
(c) 20 N
(d) 70 N
Ans. a | Sol. : Horizontal component of the first force = $100 \cos 60° = 50$ N. Resultant horizontal force = $50 - 80 = -30$ N, indicating 30 N opposite to the positive direction. Magnitude is 30 N.

Q79. A body remains in equilibrium under a system of coplanar forces. If $\Sigma Fx = 0$ and $\Sigma Fy = 0$ but $\Sigma M \neq 0$, the body will:
(a) Remain completely at rest
(b) Translate without rotating
(c) Rotate without translating
(d) Experience no acceleration
Ans. c | Sol. : Zero resultant force prevents translation, but a non-zero moment produces angular acceleration, causing rotation.

Q80. The principle of transmissibility of forces is applicable only when analyzing:
(a) Deformation of bodies
(b) Internal stresses
(c) External effects on rigid bodies
(d) Thermal expansion
Ans. c | Sol. : The principle states that a force can be moved along its line of action without changing the external effect on a rigid body, though internal stresses may change.

Q81. A block on a rough inclined plane is just about to slide downward. Increasing the angle of inclination slightly will:
(a) Increase the normal reaction and decrease friction
(b) Decrease both normal reaction and frictional force
(c) Increase frictional force beyond its limiting value
(d) Keep friction unchanged
Ans. b | Sol. : Increasing the inclination reduces the normal reaction. Since limiting friction equals μN, the maximum available friction also decreases.

Q82. Two blocks of equal weight are placed on horizontal surfaces with coefficients of friction 0.2 and 0.4 respectively. If the same horizontal force is applied to both, the block with $\mu = 0.2$ will:
(a) Require greater force to move
(b) Experience identical friction
(c) Move earlier than the other block
(d) Remain stationary while the other moves
Ans. c | Sol. : Lower coefficient of friction produces a smaller limiting friction force, so motion begins earlier.

Q83. The angle of friction is 30°. The coefficient of friction is approximately:
(a) 0.577
(b) 0.866
(c) 1.000

(d) 0.500
Ans. a | Sol. : $\mu = \tan\varphi = \tan 30° = 0.577$.

Q84. For self-locking in a screw jack, the condition is:
(a) Helix angle greater than angle of friction
(b) Helix angle equal to 90°
(c) Angle of friction greater than helix angle
(d) Coefficient of friction equal to zero
Ans. c | Sol. : Self-locking occurs when friction prevents reverse motion, requiring the angle of friction to exceed the helix angle.

Q85. A ladder rests against a smooth vertical wall and a rough floor. If the coefficient of friction at the floor decreases, the ladder is more likely to:
(a) Rotate about its center
(b) Slip outward at the base
(c) Move upward along the wall
(d) Remain unaffected
Ans. b | Sol. : Reduced floor friction lowers resistance to horizontal motion, causing the base to slip away from the wall.

Q86. A body placed on a rough surface experiences an applied force less than the limiting friction. The frictional force developed is:
(a) Equal to μN
(b) Zero
(c) Equal to the applied force
(d) Greater than the applied force
Ans. c | Sol. : Static friction is self-adjusting and matches the applied force until the limiting value μN is reached.

Q87. The centroid of a semicircular area lies:
(a) On its diameter at a distance $\frac{2R}{\pi}$
(b) On its axis of symmetry at a distance $\frac{4R}{3\pi}$from the diameter
(c) At the geometric center of the circle
(d) At a distance $\frac{R}{2}$from the diameter
Ans. b | Sol. : The centroid of a semicircular area is located on the axis of symmetry at $\frac{4R}{3\pi}$from the base diameter.

Q88. Removing a circular hole from a rectangular plate shifts the centroid:
(a) Toward the hole
(b) Away from the hole
(c) To the geometric center of the rectangle
(d) Vertically downward only
Ans. b | Sol. : The removed area is treated as negative area, causing the centroid of the remaining section to move away from the hole.

Q89. For a homogeneous body placed in stable equilibrium, the center of gravity occupies:
(a) The highest possible position
(b) The lowest possible position
(c) A position independent of geometry
(d) A position outside the body
Ans. b | Sol. : Stable equilibrium corresponds to minimum potential energy, achieved when the center of gravity is at its lowest position.

Q90. The centroid of an L-shaped section is best determined using:
(a) Direct integration only
(b) Polar coordinates
(c) Method of composite areas
(d) Finite element analysis
Ans. c | Sol. : Complex sections are conveniently divided into standard geometric shapes, and the composite area method is applied.

Q91. A cone and a cylinder have equal base radius and height. The center of gravity of the cone lies:
(a) Higher than that of the cylinder
(b) Lower than that of the cylinder
(c) At the same height
(d) Outside the cone
Ans. b | Sol. : The centroid of a solid cone is at h/4 from its base, whereas that of a cylinder is at h/2.

Q92. The centroid of a triangular lamina is located at:
(a) Midpoint of each side
(b) One-third of the altitude from the base
(c) Two-thirds of the altitude from the base
(d) At the circumcenter
Ans. b | Sol. : The centroid lies at the intersection of medians and is located one-third of the altitude above the base.

Q93. In a symmetric body with uniform density, the centroid and center of gravity:
(a) Always differ
(b) Coincide
(c) Depend only on external loading
(d) Cannot be determined analytically
Ans. b | Sol. : Uniform density ensures that the geometric centroid coincides with the center of gravity.

Q94. A truss member carrying zero force under a particular loading condition may become a load-carrying member when:
(a) The material changes
(b) Support conditions remain unchanged
(c) The loading pattern changes
(d) The member length increases
Ans. c | Sol. : Zero-force members depend on geometry and loading conditions; altered loading can activate such members.

Q95. At a joint in a plane truss, three members meet, two of which are collinear and no external load acts at the joint. The third member is:
(a) In compression
(b) In tension
(c) A zero-force member
(d) Subjected to bending
Ans. c | Sol. : Equilibrium requires the non-collinear member to carry zero force when no external load is applied at that joint.

Q96. The method of sections is preferred over the method of joints when:
(a) Forces in all members are required
(b) The truss is statically indeterminate

(c) Forces in only a few specific members are needed
(d) Dynamic loading exists
Ans. c | Sol. : The method of sections directly determines forces in selected members without analyzing the entire truss.

Q97. A pin-jointed plane truss has 10 joints and 17 members. Its determinacy status is:
(a) Stable and determinate
(b) Unstable
(c) Stable and indeterminate
(d) Mechanism
Ans. a | Sol. : For a plane truss, m = 2j – 3. Here, 17 < 2(10) – 3 = 17. Equality holds, so it is just determinate. However, actual stability depends on geometry; if properly triangulated, it is stable and determinate.

Q98. In a simply supported symmetric truss carrying a central load, the member forces on either side of the center are:
(a) Independent of symmetry
(b) Equal in magnitude and opposite in nature
(c) Zero throughout
(d) Randomly distributed
Ans. b | Sol. : Structural symmetry and symmetric loading produce equal force magnitudes in corresponding members, though one may be in tension and the other in compression.

Q99. If a truss member is subjected to bending moments in addition to axial force, the fundamental assumption violated is:
(a) Material homogeneity
(b) Small deformation theory
(c) Pin-jointed connection assumption
(d) Static equilibrium
Ans. c | Sol. : Ideal truss analysis assumes frictionless pin joints so that members carry only axial forces. Bending indicates violation of this assumption.

Q100. A solid cylinder and a solid sphere of equal mass and radius roll down an incline without slipping. Which reaches the bottom first?
(a) Cylinder
(b) Sphere
(c) Both simultaneously
(d) Cannot be determined
Ans. b | Sol. : The sphere has a smaller mass moment of inertia ratio $(2/5)mr^2$than the cylinder $(1/2)mr^2$, resulting in greater acceleration.

Q101. A force that causes clockwise rotation of a beam section is considered to produce a:
(a) Positive bending moment
(b) Negative bending moment
(c) Zero bending moment
(d) Torsional moment
Ans. b | Sol. : According to the conventional sign convention, a clockwise bending effect at a section produces a negative bending moment, resulting in a hogging curvature.

Q102. A simply supported beam carrying a concentrated load at its midpoint experiences maximum bending moment at:
(a) Left support
(b) Right support
(c) Midpoint of the beam
(d) One-fourth span from the support
Ans. c | Sol. : For a centrally loaded simply supported beam, the maximum bending moment occurs at the center and is equal to WL/4.

Q103. The point on a beam where the bending moment changes its sign is called:
(a) Neutral axis
(b) Point of contraflexure
(c) Centroid
(d) Shear center
Ans. b | Sol. : The point of contraflexure is the location where the bending moment changes from positive to negative or vice versa.

Q104. For a simply supported beam subjected to a uniformly distributed load over the entire span, the shear force diagram is:
(a) Rectangular
(b) Triangular
(c) Parabolic
(d) Circular
Ans. b | Sol. : Under a uniformly distributed load, shear force varies linearly along the beam, producing a triangular shear force diagram.

Q105. The slope of the bending moment diagram at any section of a beam is equal to:
(a) Load intensity
(b) Deflection
(c) Shear force
(d) Reaction force
Ans. c | Sol. : The fundamental relation dM/dx = V states that the rate of change of bending moment with distance equals the shear force.

Q106. The slope of the shear force diagram at a section is equal to:
(a) Bending moment
(b) Load intensity
(c) Deflection
(d) Flexural rigidity
Ans. b | Sol. : The relation dV/dx = –w indicates that the slope of the shear force diagram equals the negative of the load intensity.

Q107. A cantilever beam carrying a point load at its free end has maximum bending moment at:
(a) Free end
(b) Midspan
(c) Fixed end
(d) One-third length from the fixed end
Ans. c | Sol. : The fixed end resists the entire loading effect and therefore experiences the maximum bending moment equal to WL.

Q108. For a rotating rigid body, the normal acceleration of a point at radius r is:
(a) rα
(b) rω
(c) $r\omega^2$
(d) $r^2\omega$
Ans. c | Sol. : Normal or centripetal acceleration is given by $a_n = r\omega^2$, directed toward the axis of rotation.
Q109. The SI unit of bending moment is:
(a) N
(b) N/m
(c) N·m
(d) N/m^2
Ans. c | Sol. : Bending moment is the product of force and perpendicular distance, so its SI unit is newton-metre (N·m).
Q110. The resultant of a uniformly distributed load acts at:
(a) One-fourth of the loaded length
(b) Midpoint of the loaded length
(c) One-third of the loaded length
(d) Free end of the beam
Ans. b | Sol. : The equivalent concentrated load of a UDL acts through the centroid of the distribution, which is at its midpoint.
Q111. Kinematics is primarily concerned with the study of:
(a) Forces causing motion
(b) Motion without considering forces
(c) Energy transformations
(d) Material properties
Ans. b | Sol. : Kinematics describes displacement, velocity, and acceleration without reference to the forces producing the motion.
Q112. The time rate of change of angular displacement is called:
(a) Angular acceleration
(b) Linear velocity
(c) Angular velocity
(d) Torque
Ans. c | Sol. : Angular velocity is defined as ω = dθ/dt, representing the rate of change of angular displacement.
Q113. A simply supported beam subjected to equal and opposite moments at its ends experiences:
(a) Constant shear force
(b) Constant bending moment
(c) Zero bending moment
(d) Parabolic bending moment
Ans. b | Sol. : Pure bending exists when only end couples act, producing a constant bending moment throughout the beam.
Q114. For a rigid body undergoing pure rotation about a fixed axis, the linear velocity of a point at distance r from the axis is:
(a) v = r/ω
(b) v = ω/r
(c) v = rω
(d) $v = r\omega^2$
Ans. c | Sol. : The tangential velocity of a point in rotational motion is given by v = rω.
Q115. The relation between angular acceleration α and tangential acceleration at is:
(a) at = α/r
(b) at = rα
(c) at = $r^2\alpha$
(d) at = $\alpha^2 r$
Ans. b | Sol. : Tangential acceleration is directly proportional to the radius and angular acceleration, expressed as at = rα.
Q116. The centripetal acceleration of a rotating particle is:
(a) rω
(b) $r\omega^2$
(c) ω/r
(d) $r^2\omega$
Ans. b | Sol. : Centripetal acceleration acts toward the center of rotation and is given by ac = $r\omega^2$.
Q117. A rigid body undergoes general plane motion. The motion can always be represented as:
(a) Pure translation only
(b) Pure rotation only
(c) Translation combined with rotation
(d) Oscillatory motion only
Ans. c | Sol. : General plane motion is equivalent to translation of a reference point combined with rotation about that point.
Q118. The kinetic energy of a rotating rigid body is:
(a) Iω
(b) $I\omega^2$
(c) ½Iω
(d) $\frac{1}{2}I\omega^2$
Ans. d | Sol. : Rotational kinetic energy is expressed as KE = $\frac{1}{2}I\omega^2$.
Q119. A wheel of radius 0.5 m rolls without slipping at 4 m/s. Its angular velocity is:
(a) 4 rad/s
(b) 6 rad/s
(c) 8 rad/s
(d) 10 rad/s
Ans. c | Sol. : For pure rolling, $v = r\omega$. Thus, $\omega = 4/0.5 = 8$rad/s.
Q120. The SI unit of mass moment of inertia is:
(a) kg·m
(b) kg/m^2
(c) $kg\cdot m^2$
(d) $N\cdot m^2$
Ans. c | Sol. : Mass moment of inertia is the product of mass and the square of distance from the axis, giving the unit $kg\cdot m^2$.
Q121. For rolling without slipping, the relationship between linear velocity v and angular velocity ω is:
(a) v = r/ω
(b) v = ω/r
(c) v = rω

(d) $v = r^2\omega$

Ans. c | Sol. : In pure rolling motion, the translational velocity of the center equals the product of angular velocity and radius.

Q122. The angular momentum of a rigid body rotating about a fixed axis is given by:

(a) $H = I\omega$

(b) $H = I\alpha$

(c) $H = m\omega$

(d) $H = mr^2$

Ans. a | Sol. : Angular momentum about a fixed axis equals the product of moment of inertia and angular velocity.

Q123. The theorem stating that the moment of inertia about any axis equals the moment of inertia about a parallel centroidal axis plus Md^2 is known as:

(a) Varignon's theorem

(b) Lami's theorem

(c) Parallel axis theorem

(d) Perpendicular axis theorem

Ans. c | Sol. : The parallel axis theorem is expressed as $I = I_G + Md^2$, where d is the distance between the two parallel axes.

Q124. If the shear force diagram of a beam crosses the zero axis, the bending moment at that section is:

(a) Always zero

(b) Always maximum or minimum

(c) Always constant

(d) Undefined

Ans. b | Sol. : Since the slope of the bending moment diagram equals shear force, zero shear indicates an extremum in bending moment.

Q125. For a simply supported beam with span L carrying a uniformly distributed load w over the entire span, the maximum bending moment is:

(a) $wL^2/4$

(b) $wL^2/8$

(c) $wL^2/12$

(d) $wL^2/16$

Ans. b | Sol. : The maximum bending moment occurs at the center of the beam and is equal to $wL^2/8$ for a full-span uniformly distributed load.

Q126. A simply supported beam of span Lcarries a uniformly distributed load over its entire length. The maximum bending moment occurs at:

(a) One-fourth of the span from the left support

(b) Mid-span

(c) At the left support

(d) At both supports

Ans. b | Sol. : For a simply supported beam subjected to a uniformly distributed load over the entire span, the shear force becomes zero at the center, and hence the maximum bending moment occurs at mid-span.

Q127. A point of contraflexure in a beam is the point where:

(a) Shear force is maximum

(b) Load intensity is zero

(c) Bending moment changes sign

(d) Slope becomes zero

Ans. c | Sol. : A point of contraflexure is a location on the beam where the bending moment changes from positive to negative or vice versa, indicating a reversal in the curvature of the beam.

Q128. The area under the shear force diagram between two sections of a beam represents the:

(a) Load intensity

(b) Slope of the beam

(c) Change in bending moment

(d) Deflection of the beam

Ans. c | Sol. : The change in bending moment between two sections is equal to the area under the shear force diagram over that interval.

Q129. For a cantilever beam carrying a point load at its free end, the maximum bending moment occurs at:

(a) Free end

(b) Mid-span

(c) Fixed end

(d) One-third span from the fixed end

Ans. c | Sol. : In a cantilever beam, the bending moment increases from zero at the free end to its maximum value at the fixed support.

Q130. If the shear force at a section of a beam is zero, then the bending moment at that section is generally:

(a) Minimum

(b) Maximum or minimum

(c) Zero

(d) Constant throughout the beam

Ans. b | Sol. : The condition $dM/dx=V=0$indicates that the bending moment is at an extreme value, which may be either a maximum or a minimum.

Q131. A rigid body differs from a deformable body because:

(a) It has zero mass

(b) It possesses infinite strength

(c) The distance between any two points remains constant

(d) It cannot rotate

Ans. c | Sol. : In rigid body mechanics, deformation is neglected, and the relative positions of all particles within the body remain unchanged.

Q132. The angular velocity of a rotating body is directed along:

(a) Tangential direction

(b) Radial direction

(c) Axis of rotation according to the right-hand rule

(d) Direction of linear acceleration

Ans. c | Sol. : Angular velocity is a vector quantity whose direction is determined by the right-hand thumb rule along the axis of rotation.

Q133. For pure rolling motion of a wheel, the relationship between linear velocity vand angular velocity ωis:

(a) $v=\omega/r$

(b) $v=r/\omega$

(c) v=rω
(d) $v = r\omega^2$
Ans. c | Sol. : In pure rolling without slipping, the translational velocity of the center equals the product of radius and angular velocity.
Q134. The moment of inertia of a rigid body depends upon:
(a) Only its mass
(b) Only its shape
(c) Distribution of mass about the axis of rotation
(d) Gravitational acceleration
Ans. c | Sol. : Moment of inertia is determined by how the mass of the body is distributed relative to the chosen axis.
Q135. According to Newton's second law for rotational motion:
(a) Torque equals force multiplied by velocity
(b) Torque equals angular momentum
(c) Torque equals moment of inertia multiplied by angular acceleration
(d) Torque equals mass multiplied by acceleration
Ans. c | Sol. : The rotational form of Newton's second law is given by τ=Iα, where Iis moment of inertia and αis angular acceleration.
Q136. The radius of gyration of a body is defined as:
(a) Distance from centroid to support
(b) Equivalent distance at which entire mass may be assumed concentrated without changing moment of inertia
(c) Distance between two parallel axes
(d) Maximum dimension of the body
Ans. b | Sol. : Radius of gyration represents the distance from the axis at which the total mass can be imagined to be concentrated while preserving the same moment of inertia.
Q137. A particle moves in a circular path with constant speed. Its acceleration is:
(a) Zero
(b) Tangential only
(c) Radial inward only
(d) Radial outward only
Ans. c | Sol. : Even at constant speed, the direction of velocity changes continuously, producing a centripetal acceleration directed toward the center.
Q138. The unit of angular acceleration in SI system is:
(a) rad/s
(b) rad/s^2
(c) m/s^2
(d) N·m
Ans. b | Sol. : Angular acceleration is the rate of change of angular velocity with respect to time and is measured in radians per second squared.
Q139. The centroidal axis theorem is commonly used to determine:
(a) Linear velocity
(b) Shear stress
(c) Moment of inertia about parallel axes
(d) Friction coefficient
Ans. c | Sol. : The parallel-axis theorem enables calculation of moment of inertia about any axis parallel to the centroidal axis.
Q140. For a simply supported beam with a central point load W, the maximum bending moment is:
(a) WL/2
(b) WL/4
(c) WL/8
(d) WL
Ans. b | Sol. : The reactions at both supports are W/2, giving the maximum moment at mid-span as (W/2)(L/2)=WL/4.
Q141. The slope of the bending moment diagram at any section is equal to:
(a) Load intensity
(b) Shear force
(c) Deflection
(d) Bending stress
Ans. b | Sol. : Mathematically, dM/dx=V, indicating that the slope of the bending moment diagram equals the shear force.
Q142. If a beam is subjected to no external load between two points, the shear force diagram in that region is:
(a) Parabolic
(b) Inclined straight line
(c) Horizontal straight line
(d) Vertical line
Ans. c | Sol. : In the absence of loading, shear force remains constant, resulting in a horizontal line on the shear force diagram.
Q143. The instantaneous center of rotation of a rigid body in plane motion is the point:
(a) Having maximum acceleration
(b) Having zero velocity at that instant
(c) Located at the center of mass
(d) Having zero angular velocity
Ans. b | Sol. : At the instantaneous center, the velocity is momentarily zero, and the body may be considered to rotate about that point.
Q144. The kinetic energy of a rotating rigid body is given by:
(a) $\frac{1}{2}mv^2$
(b) $I\omega$
(c) $\frac{1}{2}I\omega^2$
(d) mgh
Ans. c | Sol. : Rotational kinetic energy depends on the body's moment of inertia and the square of its angular velocity.
Q145. For a body undergoing general plane motion, the motion consists of:
(a) Translation only
(b) Rotation only
(c) Translation and rotation simultaneously
(d) Oscillation only

Ans. c | Sol. : General plane motion is a combination of translational motion of one reference point and rotational motion about that point.

Q146. The shear force just to the left and right of a concentrated load on a beam:

(a) Remains unchanged
(b) Changes suddenly by the magnitude of the load
(c) Becomes zero
(d) Changes linearly

Ans. b | Sol. : A point load causes an abrupt jump in the shear force diagram equal to the magnitude of that load.

Q147. The angular momentum of a rotating rigid body about a fixed axis is:

(a) mω
(b) Iω
(c) Iα
(d) mrω

Ans. b | Sol. : Angular momentum about a fixed axis is the product of moment of inertia and angular velocity.

Q148. For pure rotational motion about a fixed axis, all particles of the body have the same:

(a) Linear velocity
(b) Tangential acceleration
(c) Angular velocity
(d) Centripetal acceleration

Ans. c | Sol. : Every particle in a rigid body rotating about a fixed axis shares the same angular velocity, though their linear velocities differ according to radius.

Q149. A uniformly distributed load acting on a beam produces a bending moment diagram that is:

(a) Linear
(b) Rectangular
(c) Parabolic
(d) Circular

Ans. c | Sol. : Since the shear force varies linearly under a uniformly distributed load, the bending moment, being its integral, follows a parabolic variation.

Q150. For efficient structural performance, long slender members in a truss are preferably designed to carry:

(a) Compression loads
(b) Torsional loads
(c) Bending loads
(d) Tensile loads

Ans. d | Sol. : Slender members are less susceptible to failure in tension, whereas compression members may fail by buckling.

Q151. A simply supported beam of span 6 m carries a uniformly distributed load of 4 kN/m over the entire span. The maximum bending moment developed at the center of the beam is:

(a) 12 kN·m
(b) 18 kN·m
(c) 24 kN·m
(d) 36 kN·m

Ans. b | Sol. : For a simply supported beam carrying a UDL over the entire span, $M_{max} = wL^2/8$. Thus, $M_{max} = 4 \times 6^2/8 = 18\text{kN·m}$.

Q152. A simply supported beam of length 8 m carries a point load of 20 kN at its mid-span. The shear force immediately to the left of the load is:

(a) 0 kN
(b) 10 kN
(c) 20 kN
(d) –10 kN

Ans. b | Sol. : The reactions at both supports are equal to 10 kN. Therefore, the shear force just to the left of the central load is +10 kN.

Q153. A cantilever beam of length 3 m carries a concentrated load of 15 kN at the free end. The bending moment at the fixed end is:

(a) 15 kN·m
(b) 30 kN·m
(c) 45 kN·m
(d) 60 kN·m

Ans. c | Sol. : For a cantilever with an end load, the fixed-end moment is M=PL=15×3=45kN·m.

Q154. A section of a beam experiences a positive shear force. The corresponding bending moment diagram in that region will:

(a) Remain constant
(b) Decrease linearly
(c) Increase linearly
(d) Become parabolic

Ans. c | Sol. : Shear force is the rate of change of bending moment. A positive constant shear force causes the bending moment to increase linearly.

Q155. A simply supported beam carries a uniformly distributed load throughout its span. The shear force diagram is:

(a) Rectangular
(b) Triangular
(c) Parabolic
(d) Circular

Ans. b | Sol. : Under a UDL, shear force changes linearly along the span, producing a triangular shear force diagram.

Q156. A rigid body rotates about a fixed axis with constant angular acceleration of 2 rad/s². If the initial angular velocity is 4 rad/s, its angular velocity after 5 s is:

(a) 10 rad/s
(b) 12 rad/s
(c) 14 rad/s
(d) 16 rad/s

Ans. c | Sol. : Using $\omega = \omega_0 + \alpha t$, $\omega = 4 + 2 \times 5 = 14\text{rad/s}$.

Q157. A wheel rotating at 600 rpm is brought to rest uniformly in 20 s. The angular deceleration is:

(a) 1.57 rad/s²
(b) 2.14 rad/s²
(c) 3.14 rad/s²

(d) 4.71 rad/s²
Ans. c | Sol. : Initial angular velocity =600×2π/60=20πrad/s. Hence, α=(0-20π)/20=-π≈-3.14rad/s².

Q158. A particle moving in a circular path of radius 2 m has a speed of 6 m/s. The centripetal acceleration is:
(a) 9 m/s²
(b) 12 m/s²
(c) 18 m/s²
(d) 24 m/s²
Ans. c | Sol. : Centripetal acceleration $a_c = v^2/r = 6^2/2 = 18$m/s².

Q159. A flywheel increases its angular speed from 10 rad/s to 30 rad/s while rotating through 80 radians. The angular acceleration is:
(a) 4 rad/s²
(b) 5 rad/s²
(c) 6 rad/s²
(d) 8 rad/s²
Ans. b | Sol. : Using $\omega^2 = \omega_0^2 + 2\alpha\theta$, $30^2 = 10^2 + 2\alpha(80)$, giving $\alpha = 5$rad/s².

Q160. The moment of inertia of a rigid body determines its resistance to:
(a) Linear motion
(b) Translational acceleration
(c) Angular acceleration
(d) Gravitational force
Ans. c | Sol. : Moment of inertia is the rotational analogue of mass and measures resistance to changes in angular motion.

Q161. A disc of mass 5 kg and radius 0.4 m rotates about its central axis. Its mass moment of inertia is:
(a) 0.2 kg·m²
(b) 0.4 kg·m²
(c) 0.6 kg·m²
(d) 0.8 kg·m²
Ans. b | Sol. : For a solid disc, $I = \frac{1}{2}mr^2 = \frac{1}{2} \times 5 \times 0.4^2 = 0.4$kg·m².

Q162. A beam section where the shear force changes sign corresponds to:
(a) Point of contraflexure
(b) Maximum bending moment
(c) Zero slope
(d) Fixed support
Ans. b | Sol. : The bending moment becomes maximum or minimum at sections where the shear force passes through zero.

Q163. A cantilever carrying a uniformly distributed load over its entire length exhibits a bending moment diagram that is:
(a) Linear
(b) Rectangular
(c) Parabolic
(d) Triangular
Ans. c | Sol. : Since the load is uniform, shear varies linearly and bending moment varies parabolically.

Q164. A rigid body in plane motion simultaneously translating and rotating is said to undergo:
(a) Pure translation
(b) Pure rotation
(c) General plane motion
(d) Helical motion
Ans. c | Sol. : General plane motion consists of a combination of translation and rotation within the same plane.

Q165. A rotating machine component experiences angular displacement θ under constant angular acceleration α from rest. The final angular velocity is given by:
(a) ω=αt
(b) $\omega^2 = 2\alpha\theta$
(c) $\omega = \sqrt{\alpha\theta}$
(d) $\omega^2 = \alpha\theta$
Ans. b | Sol. : The rotational kinematic equation for constant acceleration and zero initial velocity is $\omega^2 = 2\alpha\theta$.

Q166. A rigid body has an angular acceleration of 3 rad/s² and moment of inertia of 4 kg·m². The applied torque is:
(a) 6 N·m
(b) 9 N·m
(c) 12 N·m
(d) 15 N·m
Ans. c | Sol. : Newton's second law for rotation gives T=Iα=4×3=12N·m.

Q167. The kinetic energy of a rotating body depends on:
(a) Only mass
(b) Only radius
(c) Moment of inertia and angular velocity
(d) Linear momentum
Ans. c | Sol. : Rotational kinetic energy is $KE = \frac{1}{2}I\omega^2$involving both inertia and angular speed.

Q168. A simply supported beam of span 4 m carries two equal point loads symmetrically placed. The maximum bending moment occurs:
(a) At the supports
(b) At the midpoint between the loads
(c) Under the left load only
(d) Under the right load only
Ans. b | Sol. : For symmetric loading, the region between the loads experiences constant maximum bending moment.

Q169. The area under the shear force diagram between two sections of a beam represents:
(a) Slope of the beam
(b) Deflection of the beam
(c) Change in bending moment
(d) Strain energy
Ans. c | Sol. : The integral of shear force with respect to distance gives the change in bending moment.

Q170. A body of mass 8 kg moving at 5 m/s rotates with no angular motion. Its kinetic energy is:
(a) 50 J
(b) 80 J
(c) 100 J
(d) 120 J
Ans. c | Sol. : Translational kinetic energy $= \frac{1}{2}mv^2 = \frac{1}{2} \times 8 \times 25 = 100\text{J}$.
Q171. A rotating shaft completes 1200 revolutions in one minute. Its angular velocity is:
(a) 40π rad/s
(b) 20π rad/s
(c) 60π rad/s
(d) 80π rad/s
Ans. a | Sol. : Angular velocity $= 1200 \times 2\pi/60 = 40\pi\text{rad/s}$.
Q172. A point on the rim of a rotating wheel experiences both tangential and normal acceleration. If angular velocity is constant, the tangential acceleration is:
(a) Maximum
(b) Equal to normal acceleration
(c) Zero
(d) Infinite
Ans. c | Sol. : Tangential acceleration depends on angular acceleration. With constant angular velocity, angular acceleration is zero.
Q173. The point in a beam where bending moment changes sign is called:
(a) Neutral axis
(b) Point of contraflexure
(c) Centroid
(d) Shear center
Ans. b | Sol. : The point of contraflexure is where the bending moment passes through zero and changes from positive to negative or vice versa.
Q174. A rod of length 2 m rotates about one end with angular velocity 5 rad/s. The linear velocity of the free end is:
(a) 5 m/s
(b) 8 m/s
(c) 10 m/s
(d) 12 m/s
Ans. c | Sol. : Linear velocity is $v = r\omega = 2 \times 5 = 10\text{m/s}$.
Q175. For a rigid body under rotational equilibrium, the necessary condition is:
(a) $\Sigma F = 0$ only
(b) $\Sigma M = 0$ only
(c) $\Sigma F \neq 0$ and $\Sigma M = 0$
(d) $\Sigma F = 0$ and $\Sigma M = 0$
Ans. d | Sol. : A rigid body is in complete equilibrium only when both the resultant force and the resultant moment acting on it are zero.
Q176. A simply supported beam of span 6 m carries a uniformly distributed load of 20 kN/m over the entire span. If a concentrated load of 30 kN acts at mid-span, the maximum bending moment is:
(a) 90 kN·m
(b) 105 kN·m
(c) 120 kN·m
(d) 135 kN·m
Ans. d | Sol. : The UDL produces a maximum moment of $wL^2/8 = 20 \times 6^2/8 = 90\text{kN·m}$. The central point load produces $PL/4 = 30 \times 6/4 = 45\text{kN·m}$. Hence, the total maximum bending moment is 90 + 45 = 135 kN·m.
Q177. For a simply supported beam subjected to a uniformly distributed load throughout the span, the shear force diagram is:
(a) Rectangular
(b) Triangular
(c) Parabolic
(d) Circular
Ans. b | Sol. : Under a constant distributed load, shear force varies linearly along the beam length, producing a triangular shear force diagram.
Q178. A cantilever beam of length L carries a point load W at its free end. The bending moment at a section located at distance x from the free end is:
(a) Wx
(b) W(L − x)
(c) WL
(d) $Wx^2/2$
Ans. a | Sol. : Considering the free-end segment, the moment at a section x from the free end equals W × x, giving a linear bending moment variation.
Q179. The point of contraflexure in a beam is the location where:
(a) Shear force is maximum
(b) Deflection is maximum
(c) Bending moment changes sign
(d) Slope becomes zero
Ans. c | Sol. : A point of contraflexure exists where the bending moment passes through zero and changes from sagging to hogging or vice versa.
Q180. A simply supported beam experiences zero shear force at a section. Which statement is most appropriate?
(a) Bending moment must also be zero
(b) Bending moment is likely to be maximum or minimum
(c) Deflection must be zero
(d) Slope must be infinite
Ans. b | Sol. : Since $dM/dx = V$, a zero shear force indicates an extremum of the bending moment diagram.
Q181. A rigid body rotates with constant angular acceleration α. If its initial angular velocity is ω_0, the angular velocity after time t is:
(a) $\omega = \omega_0 + \alpha t$
(b) $\omega = \omega_0 t + \alpha$
(c) $\omega = \alpha t^2$
(d) $\omega = \omega_0 - \alpha t^2$

Ans. a | Sol. : Rotational kinematics directly gives the relation $\omega = \omega_0 + \alpha t$ for uniform angular acceleration.

Q182. A wheel accelerates from rest at 2 rad/s². The angular displacement after 5 s is:
(a) 10 rad
(b) 20 rad
(c) 25 rad
(d) 30 rad
Ans. c | Sol. : Using $\theta = \omega_0 t + \frac{1}{2}\alpha t^2$, with $\omega_0 = 0$, we obtain $\theta = 0.5 \times 2 \times 25 = 25\text{rad}$.

Q183. For a rigid body in pure rolling motion, the velocity of the point in contact with the ground is:
(a) Maximum
(b) Equal to translational velocity
(c) Zero
(d) Twice the translational velocity
Ans. c | Sol. : In pure rolling, translational velocity and rotational velocity cancel at the contact point, making its instantaneous velocity zero.

Q184. A disc rotates with angular velocity ω. The tangential acceleration of a point at radius r is zero when:
(a) ω = 0
(b) α = 0
(c) r = 0
(d) ω = α
Ans. b | Sol. : Tangential acceleration is given by $a_t = r\alpha$. It becomes zero when angular acceleration α is zero.

Q185. The centripetal acceleration of a point on a rotating rigid body is directed:
(a) Tangentially to the path
(b) Away from the center
(c) Toward the center of rotation
(d) Vertically upward
Ans. c | Sol. : Centripetal acceleration always acts radially inward and maintains circular motion.

Q186. A flywheel increases its speed from 100 rpm to 300 rpm in 20 s. Assuming uniform acceleration, the angular acceleration is approximately:
(a) 0.52 rad/s²
(b) 1.05 rad/s²
(c) 2.09 rad/s²
(d) 3.14 rad/s²
Ans. b | Sol. : Converting rpm to rad/s gives $\omega_1 = 10.47$ rad/s and $\omega_2 = 31.42$ rad/s. Therefore, $\alpha = (31.42 - 10.47)/20 = 1.05\text{rad/s}^2$.

Q187. For a rigid body rotating about a fixed axis, the kinetic energy is proportional to:
(a) ω
(b) Iω
(c) Iω²
(d) I²ω
Ans. c | Sol. : Rotational kinetic energy is $KE = \frac{1}{2}I\omega^2$, showing proportionality to Iω².

Q188. A body of mass m moves in a circle of radius r with angular velocity ω. Its kinetic energy can be expressed as:
(a) mrω
(b) $\frac{1}{2}mr^2\omega^2$
(c)) $mr^2\omega$
(d)) $\frac{1}{2}m\omega^2$
Ans. b | Sol. : Since linear velocity v = rω, kinetic energy becomes $KE = \frac{1}{2}m(r\omega)^2 = \frac{1}{2}mr^2\omega^2$.

Q189. A beam carries a triangular load increasing uniformly from zero at one end to w at the other. The shear force diagram will be:
(a) Linear
(b) Parabolic
(c) Cubic
(d) Constant
Ans. b | Sol. : Since load intensity varies linearly, integrating it produces a parabolic variation of shear force.

Q190. The bending moment diagram corresponding to a uniformly distributed load on a simply supported beam is:
(a) Linear
(b) Rectangular
(c) Parabolic
(d) Cubic
Ans. c | Sol. : A constant load produces linear shear variation, and integration of linear shear gives a parabolic bending moment diagram.

Q191. A beam segment has a constant positive shear force. The bending moment variation over that segment is:
(a) Constant
(b) Linear increasing
(c) Parabolic increasing
(d) Exponential
Ans. b | Sol. : Since $dM/dx = V$, a constant positive shear force produces a linearly increasing bending moment.