

B. TECH
(SEM IV) THEORY EXAMINATION 2022-23
ENGINEERING MECHANICS

Time: 3 Hours

Total Marks: 100

Note: Attempt all Sections. If require any missing data; then choose suitably.

SECTION A

1. Attempt all questions in brief.

2 x 10 = 20

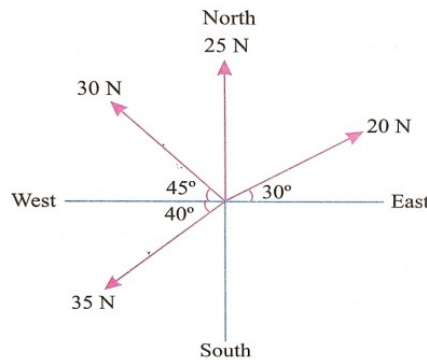
- (a) State and explain the principle of transmissibility of forces.
- (b) Explain the following terms.
 - (i) Coefficient of friction.
 - (ii) Angle of repose.
- (c) Define and explain the term: perfect, deficient and redundant frame.
- (d) Define point of contraflexure.
- (e) Define radius of gyration.
- (f) Define polar moment of inertia.
- (g) State and explain D'Alembert's principle.
- (h) Explain rectilinear motion.
- (i) State Hook's Law.
- (j) Define the term: strain energy and resilience.

SECTION B

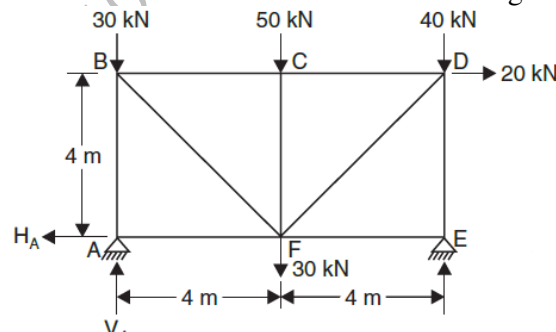
2. Attempt any three of the following:

10 x 3 = 30

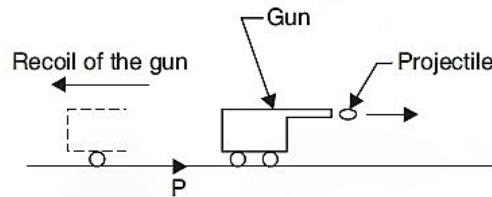
- (a) The following forces act at a point as shown in figure, find out the magnitude and direction of resultant force.



- (b) Determine the forces in the members of truss shown in the figure below.



- (c) State and prove the following theorems of moment of inertia:
 (i) Perpendicular axis theorem.
 (ii) Parallel axis theorem.
- (d) A gun of mass 3×10^4 kg fires projectile of mass 456 kg with a velocity of 305 m/s as shown in below figure. Determine (i) with what initial velocity will the gun recoil; (ii) if the recoil is overcome by an average force of 60 kN, how far will the gun travel and how long will it take.



- (e) Define pure torsion? List the assumptions made in torsion theory. Derive the torsion equation.

$$\frac{T}{I_p} = \frac{\tau}{R} = \frac{C\theta}{l}$$

where,

T = Maximum twisted torque.

R = Radius of shaft.

I_p = Polar moment of inertia.

τ = Shear stress.

C = Modulus of rigidity.

θ = The angle of twist (radians), and

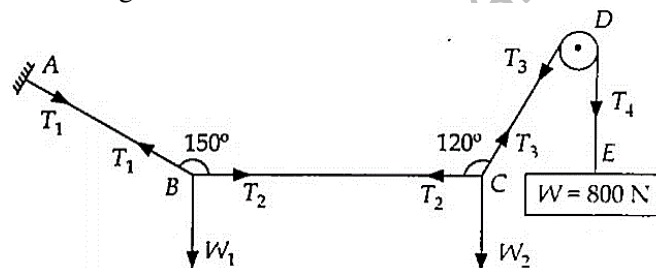
l = Length of shaft.

SECTION C

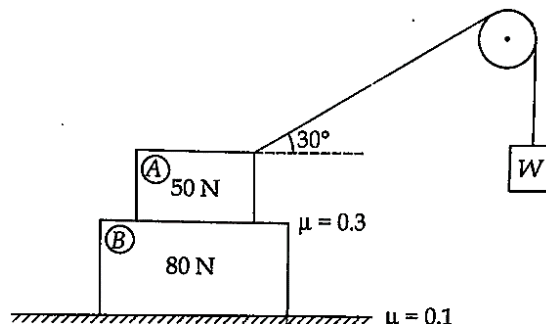
3. Attempt any *one* part of the following:

10 x 1 = 10

- (a) A string ABCDE whose extremity A is fixed has weights W_1 and W_2 attached to it at B and C, and passes round a smooth peg at D carrying a weight of 800 N at the free end E as shown in below figure. If in a state of equilibrium, BC is horizontal and AB and CD makes angle of 150° and 120° respectively with BC, make calculations for:
- (i) The tensions in portions AB, BC, CD and DE of the string.
 (ii) The values of weights W_1 and W_2 .



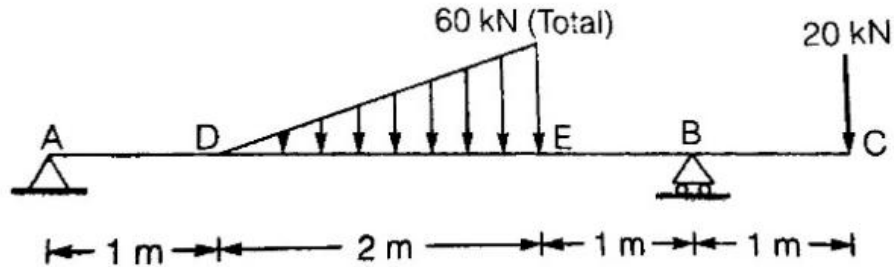
- (b) Two block A and B weighting 50 N and 80 N respectively are positioned as shown in below figure. The coefficient of friction between ground and block B is 0.1 and that between block B and block A is 0.28. State whether B is stationary with respect to ground and A moves or B is stationary with respect to A. Proceed to determine the minimum value of weight W in the pan so that motion starts.



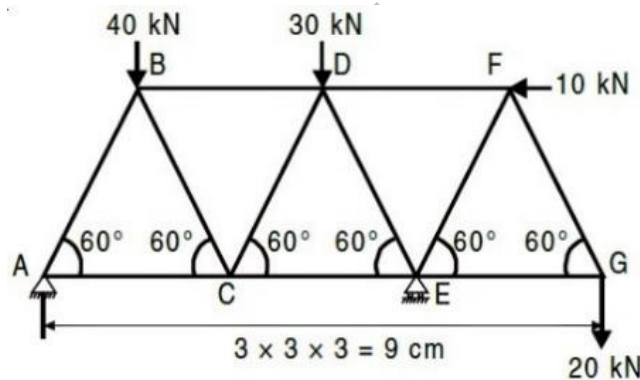
4. Attempt any *one* part of the following:

10 x 1 = 10

- (a) Draw the bending moment and shear force diagram for overhanging beam shown in the figure below.



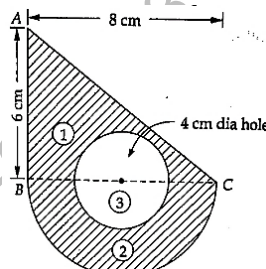
- (b) Analyze the forces in each member of truss shown in figure below. All the members are of 3 m length.



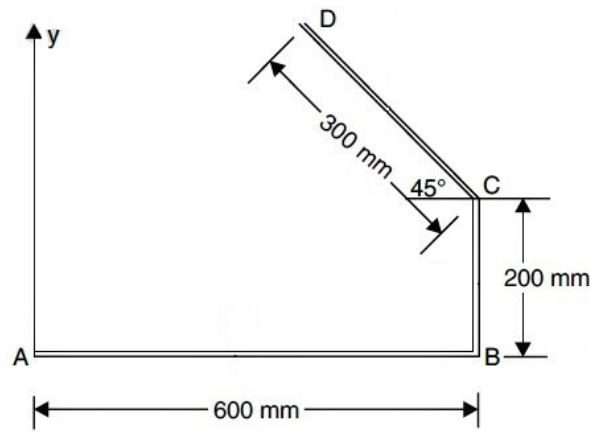
5. Attempt any *one* part of the following:

10 x 1 = 10

- (a) Find the moment of inertia about the centroid horizontal axis of the area shown shaded in the below figure. The section consists of triangle ABC, semi-circle on BC as diameter, and a circular hole of diameter 4 cm with its center on BC.



- (b) Determine the centroid of the wire shown in below figure.



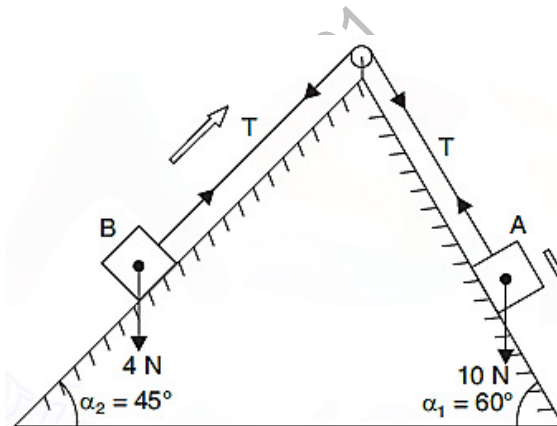
6. Attempt any *one* part of the following:

10 x 1 = 10

- (a) At a certain instant a body of mass 10 kg falling freely under the force of gravity, was found to be falling at the rate of 20 m/s. what force will stop the body in

- i) 2 seconds and
- ii) 2 meters

- (b) Blocks A and B weighing 10 N and 4 N respectively are connected by a weightless rope passing over a frictionless pulley and are placed on smooth inclined planes making 60° and 45° with the horizontal as shown in figure below. Determine: (i) The tension in the string and (ii) Velocity of the system 3 seconds after starting from rest.



7. Attempt any *one* part of the following:

10x1=10

- (a) Define pure bending? List the assumptions made in bending theory. Derive the bending equation.

$$\frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R}$$

where,

M = Moment of resistance,

I = Moment of inertia of the section about neutral axis.

E = Young's modulus of elasticity.

R = Radius of curvature of neutral axis, and

σ = Bending stress.

- (b) Illustrate the stress and strain diagram for ductile and brittle material. Also derive the relation for strain energy.