

MECHANICS FOR ENGINEERS
(MECH 2106)

Time Allotted : 2½ hrs

Full Marks : 60

Figures out of the right margin indicate full marks.

*Candidates are required to answer Group A and
any 4 (four) from Group B to E, taking one from each group.*

Candidates are required to give answer in their own words as far as practicable.

Group - A

1. Answer any twelve:

12 × 1 = 12

Choose the correct alternative for the following

- (i) According to Lami's theorem
(a) there must be three forces only
(c) forces must be co-planner and concurrent
(b) forces must be in equilibrium
(d) all of these.
- (ii) Two like parallel forces are acting at a distance of 24 mm apart and their resultant is 20 N. If the line of action of the resultant is 6 mm from any given force, the two forces are
(a) 15N and 5 N
(c) 15N and 15 N
(b) 20 N and 5 N
(d) none of these.
- (iii) The centre of gravity of a semi-circular plane lies at a distance from its base measured along vertical radius
(a) $3r/8$
(c) $8r/3$
(b) $4r/3\pi$
(d) $3r/4\pi$.
- (iv) A couple produces
(a) translatory motion
(c) combined translatory and rotational motion
(b) rotational motion
(d) none of the above.
- (v) The minimum forces required to slide a body of weight W on a rough horizontal plane is
(a) $W \sin\theta$
(c) $W \tan\theta$
(b) $W \cos\theta$
(d) none of these.
- (vi) A ladder is resting on a rough ground and leaning against a smooth vertical wall. The friction force will act
(a) perpendicular to the wall at its upper end
(c) upward at its upper end
(b) downward at its upper end
(d) upward at its lower end
- (vii) An object which is symmetrical about y axis, its
(a) $x_c = 0$
(c) $z_c = 0$
(b) $y_c = 0$
(d) all of these.
- (viii) Rate of doing work is known as
(a) potential energy
(c) power
(b) kinetic energy
(d) none of these.
- (ix) Time of flight of a projectile on downward inclined plane depends upon
(a) angle of projection
(c) both (a) and (b)
(b) angle of inclination of the plane
(d) none of these.
- (x) Modulus of Elasticity (E) can be found out by following relationship (where the symbols have their usual meanings)
(a) $E = \sigma + \epsilon$
(c) $E = \sigma \times \epsilon$
(b) $E = \sigma - \epsilon$
(d) $E = \frac{\sigma}{\epsilon}$.

Fill in the blanks with the correct word

- (xi) If two equal forces of magnitude P act at an angle θ , their resultant will be _____.
- (xii) The energy possessed by a body by the virtue of its position is called _____.
- (xiii) A member which does not regain its original shape after removal of the load producing deformation is said _____.
- (xiv) The unit of power in S.I. system is _____.
- (xv) In [MLT] system, the dimension of stress is _____.

Group - B

2. (a) Differentiate between equal and equivalent vector with suitable examples.

[[CO1](Remember/LOCQ)]

- (b) Determine the magnitude of the resultant force vector F_1 and F_2 as shown in Fig.1 and its direction, measured counter-clockwise from the positive x axis. Also find out the resultant in vector expression.

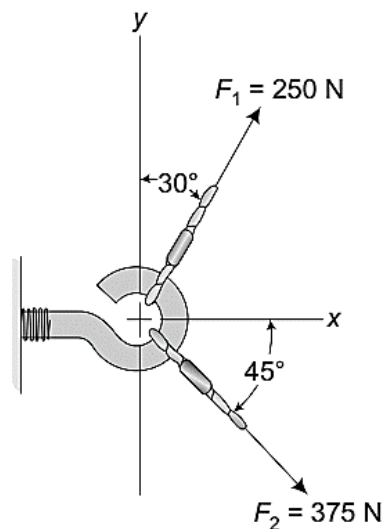


Fig.1

[[CO1](Apply/IOCQ)]

- (c) Replace the 800 N force acting at point A by a force-couple system at point O as shown in Fig.2.

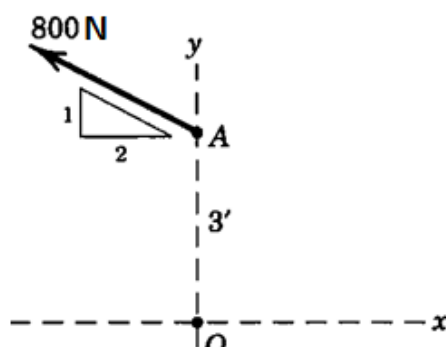


Fig.2

[[CO1](Analyze/HOCQ)]

2 + 5 + 5 = 12

3. (a) State the Varignon's theorem for a system of concurrent forces. [[CO1](Remember/LOCQ)]
 (b) Determine the moment of the 500 N force which acts from point D to point E about points A and B as shown in the Fig.3.

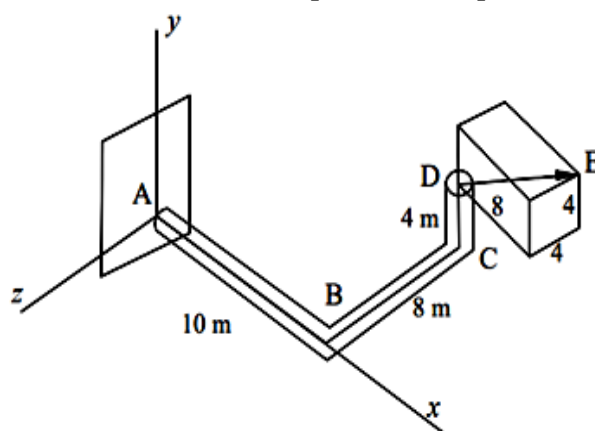


Fig.3

[[CO1](Apply/IOCQ)]

- (c) If $\mathbf{P} = 5\mathbf{i} - \mathbf{j} - 2\mathbf{k}$ and $\mathbf{Q} = 2\mathbf{i} + 3\mathbf{j} - \mathbf{k}$, find $\sin\theta$ where, θ is the smaller angle between \mathbf{P} and \mathbf{Q} .

[[CO1](Apply/IOCQ)]

2 + 6 + 4 = 12

Group - C

4. (a) What is free body diagram? Explain with suitable examples. [[CO2](Understand / LOCQ)]
 (b) Draw the free body diagram of the two identical rollers supported by an inclined plane and a vertical wall as shown in Fig.4.

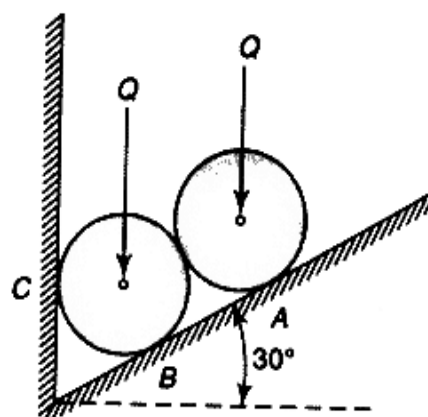


Fig.4

[[CO2](Apply/IOCQ)]

- (c) A smooth sphere of mass 75 kg is held in a position by means of a vertical wall and an inclined plane as shown in Fig.5. Assuming the supports are frictionless, calculate the reactions exerted by the supports.

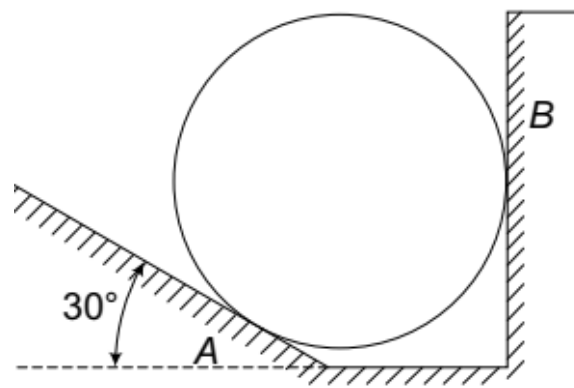


Fig. 5

[[CO2](Apply/IOCQ)]

2 + 5 + 5 = 12

5. (a) Draw the applied load vs friction force plot and mention all the salient points.
 (b) Determine the magnitude of mass m as shown in Fig.6 so that the system remains equilibrium.

[[CO3](Remember/LOCQ)]

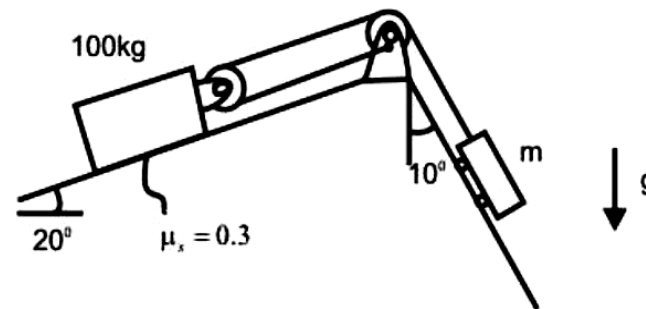


Fig. 6

[[CO2](Evaluate/HOCQ)]

5 + 7 = 12

Group - D

6. (a) Explain Stress and Strain.
 (b) Find out the CG of the hatched area formed by eliminating the square with 40 mm sides from that of a quarter of a circle with an 80 mm radius as shown in Fig.7.

[[CO5](Remember/LOCQ)]

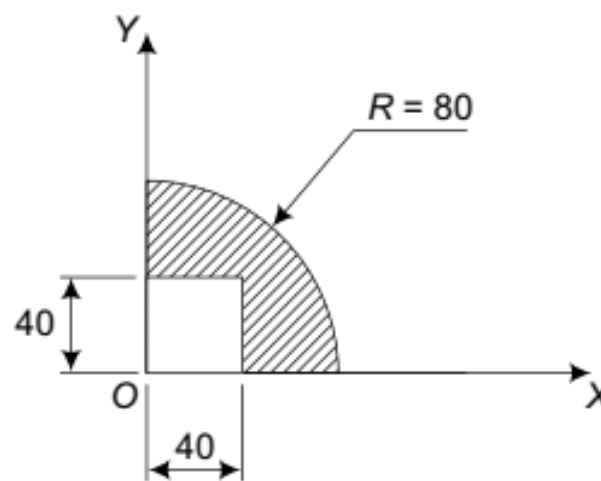


Fig.7

[[CO4](Apply/IOCQ)]

- (c) Draw a stress-strain diagram of a mild steel specimen for tensile test, clearly stating the implications of important points
 [[CO5](Remember/LOCQ)]
 2 + 5 + 5 = 12

7. (a) Explain the properties of materials: Malleability, and Toughness.
 (b) A steel rod ABCD of stepped section is loaded as shown in Fig.8. The loads assumed to act along the centre line of the rod. Estimate the displacement of D relative to A. Assume $E = 2 \times 10^5 \text{ N/mm}^2$.

[[CO5](Remember/LOCQ)]

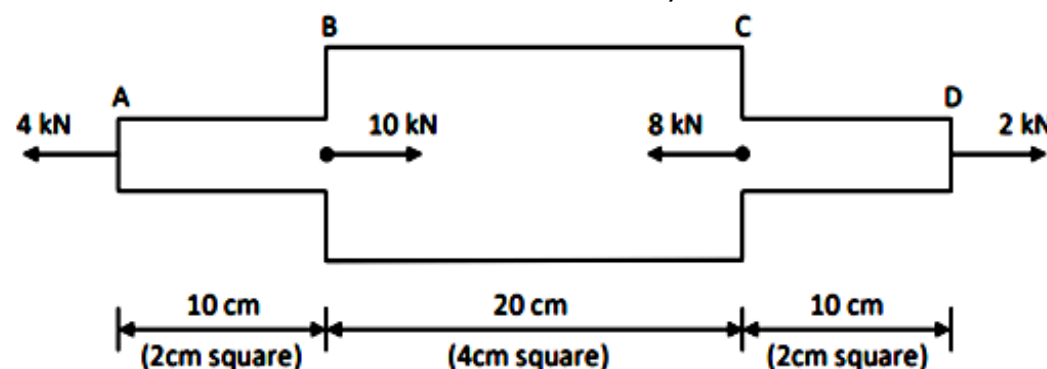


Fig.8

[[CO4](Evaluate/HOCQ)]

5 + 7 = 12

Group - E

8. (a) The acceleration of a particle is given by $a = 2t - 10$, where a is in meters per second squared and t is in seconds. Determine the velocity and displacement as functions of time. The initial displacement at $t = 0$ is $S_0 = -4 \text{ m}$, and the initial velocity is $V_0 = 3 \text{ m/s}$.

[[CO6](Apply/IOCQ)]

- (b) The pilot of an aircraft flying horizontally at a speed of 480 km/hr at an elevation of 600 metre above ground wants to hit the target on the ground as shown in Fig.9. At what angle θ below the horizontal should the pilot see the target at the instant of releasing the bomb in order to hit the same?

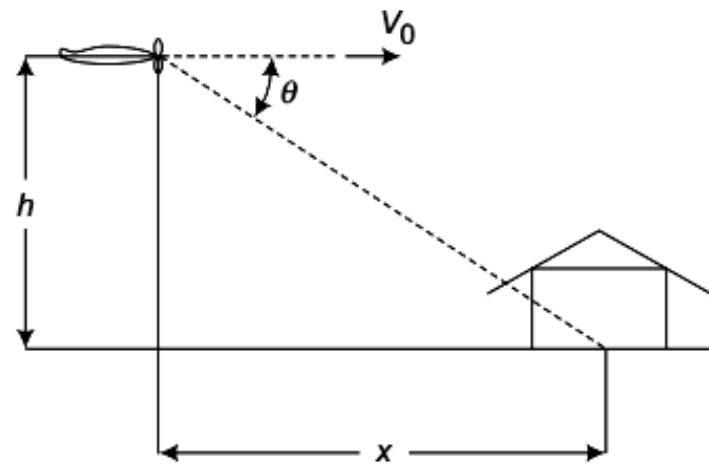


Fig.9

[[CO6](Apply/IOCQ)]

6 + 6 = 12

9. (a) The 125 Kg concrete block A is released from rest in the position shown in Fig.10 and pulls the 200 Kg log up the 30° ramp. If the coefficient of kinetic friction between the log and the ramp is 0.5. Calculate the velocity of the block A as it hits the ground at B.

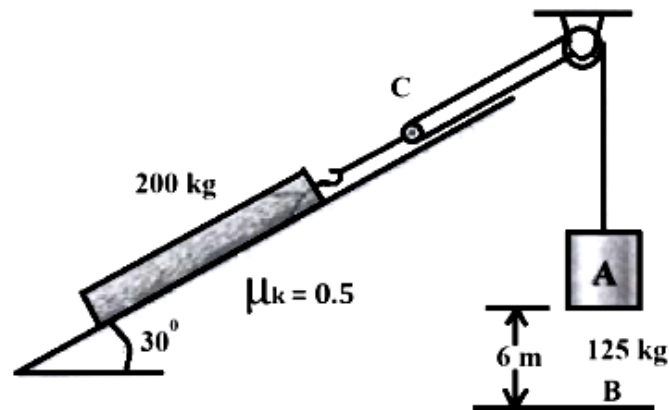


Fig.10

[[CO6](Apply/IOCQ)]

- (b) A block of wood of weight 800 N is placed on a rough inclined plane which makes an angle of 30° with the horizontal. If the co-efficient of friction between the block and plane is 0.3, find the work done in pulling the block up for a length of 5 m.

[[CO6](Analyze/HOCQ)]

7 + 5 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	24	51	25

Course Outcome (CO):

After the completion of the course students will be able to

- CO1: Determine the components of force and moment of forces in rectangular co-ordinate.
- CO2: Compute the equilibrium of rigid bodies in 2D using principles / laws of mechanics.
- CO3: Understand friction phenomenon and solve friction related problems.
- CO4: Calculate the Centroid required for design calculations.
- CO5: Determine and assess the elastic behavior of deformable bodies.
- CO6: Apply the principles of work-energy for analysis of dynamic systems.

*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question.