MECHANICS FOR ENGINEERS
(MEC2106)

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) A force is completely defined when we specify
(a) its magnitude (b) its direction
(c) point of application (d) all of the above

(ii) If two equal forces of magnitude P act at an angle q, their resultant will be
(a) $2P\ sin\frac{\theta}{2}$ (b) $2P\ cos\frac{\theta}{2}$
(c) $2P\ tan\frac{\theta}{2}$ (d) $P\ cos\frac{\theta}{2}$

(iii) A number of forces acting at a point will be in equilibrium if
(a) their total sum is zero
(b) sum of resolved parts in any two perpendicular directions are both zero
(c) all of them inclined equally
(d) two resolved parts in two directions at right angles are equa

(iv) If φ is the angle of friction, then the co-efficient of friction (μ) is
(a) sin φ (b) cos φ (c) tan φ (d) sec φ

(v) For a triangle of height h, its CG lies at a distance
(a) $\frac{h}{2}$ from the base (b) $\frac{h}{3}$ from the base
(c) $\frac{h}{4}$ from the base (d) $\frac{h}{5}$ from the base

(vi) Power is time rate of _____
(a) force (b) work (c) momentum (d) impulse

(vii) The stress produced in the members so to prevent sliding of a section over other is called
(a) nominal stress (b) bearing stress
(c) shear stress (d) none of the above

(viii) SI unit of Strain is
(a) millimetre (b) metre (c) inch (d) dimensionless

(ix) Modulus of Elasticity (E) can be found out by following relationship
(a) $E = \sigma + \varepsilon$ (b) $E = \sigma - \varepsilon$
(c) $E = \sigma \times \varepsilon$ (d) $E = {}^{\sigma}/_{\varepsilon}$

(x) The horizontal component of the velocity of a projectile
(a) increases continuously (b) decreases continuously
(c) remains constant (d) none of the above

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) Angle between the vectors (i + j) and (i – j) is _____.

(xiii) The ratio of permissible stress to ultimate strain is known as _____.

(xiv) The energy possessed by a body by the virtue of its position is called _____.

(xv) A sketch of an isolated body that shows external forces of the body and reaction forces is called _____.

Group - B

2. (a) State the parallelogram and triangle laws in relation to vector addition. *[(CO1)(Remember/LOCQ)]*

(b) A force **F** acts from B (8, -3, 0) to D (0, 0, 6) and produces a moment of 1200 Nm about an axis directed from A (12, 0, 0) to E (0, 4, -6). Compute the magnitude of F. *[(CO1)(Apply/IOCQ)]*

4 + 8 = 12

3. (a) State Varignon's Theorem. *[(CO2)(Remember/LOCQ)]*

(b) Write the moment of 600 N force about the base point O in vector format.

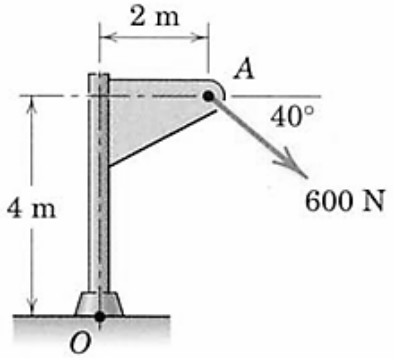

Fig. 1

[(CO1)(Apply/IOCQ)]

4 + 8 = 12

Group - C

4. (a) Prove the relation $\cos^2\alpha + \cos^2\beta + \cos^2\gamma = 1$ where α,β,γ are the direction cosines of a vector. *[(CO2)(Remember/LOCQ)]*

(b) Calculate the tension T in the cable which supports the 1000 N load with the pulley arrangement as shown in Fig. 2. Each pulley is free to rotate about its bearing, and the weights of all parts are small compared with the load. Find the

magnitude of the total force on the bearing of pulley C.

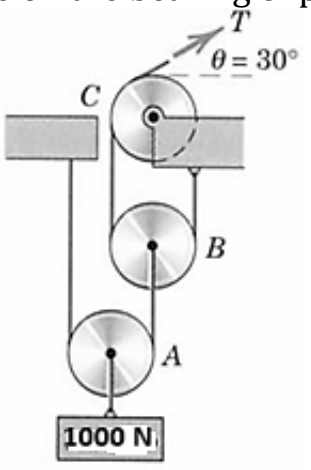

Fig. 2

[(CO2)(Apply/IOCQ)]

5 + 7 = 12

5. (a) The ladder shown in Fig. 3 is 6 m long and is supported by a horizontal floor and vertical wall. The coefficient of friction between the floor and the ladder is 0.25 and between wall and ladder is 0.4. The weight of ladder is 600 N and may be considered as concentrated at G. The ladder also supports a vertical load of 1200 N at C which is at a distance of 1 m from B. Determine the least value of α at which the ladder may be placed without slipping. Determine the reaction at that stage.

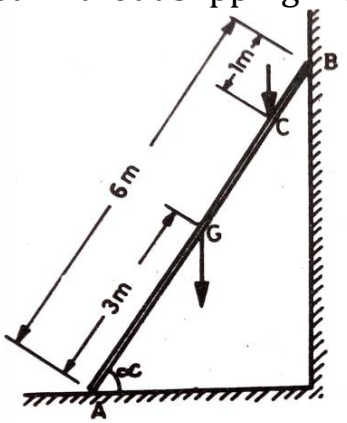

Fig. 3

[(CO3)(Apply/HOCQ)]

(b) Explain the terms (i) angle of friction, (ii) limiting friction. *[(CO3)(Remember/LOCQ)]*

7 + 5 = 12

Group - D

6. (a) Determine the coordinate y_c of the shaded area as shown in Fig. 4 below. The following dimensions are provided: a = 150 mm, b = 25 mm and c = 50 mm.

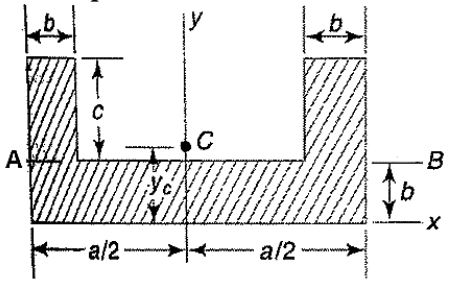

Fig. 4

[(CO4)(Apply/IOCQ)]

(b) A stone is dropped from the top of a tower 100 m high. Another stone is projected upward at the same time from the foot of the tower and meets the first stone at a

high of 40 m. Find the velocity with which the second stone is projected upwards. *[(CO5)(Analyse/IOCQ)]*

6 + 6 = 12

7. (a) The velocity of a particle which moves along the s-axis is given by $v = 2 - 4t + 5t^{\frac{3}{2}}$, where t is in seconds and v is in meters per second. Evaluate the position s, velocity v and acceleration a when t = 3 seconds. The particle is at the position s_0 = 3 m when t = 0. *[(CO5)(Analyse/IOCQ)]*

   (b) A particle of mass m moves linearly along x axis under the action of force F = k_x, where k is a constant. Find the velocity v as a function of displacement x if the initial conditions of motion are $\dot{x}_0 = 0$ and $\ddot{x}_0 = v_0$. *[(CO5)(Analyse/IOCQ)]*

6 + 6 = 12

Group - E

8. (a) Define proof resilience and modulus of resilience. *[(CO6)(Remember/LOCQ)]*

   (b) A steel rod ABCD of stepped section is loaded as shown in Fig. 5. The loads are assumed to act along the centre line of the rod. Estimate the displacement of D relative to A. Assume E = 2 x 10^5 N/mm^2.

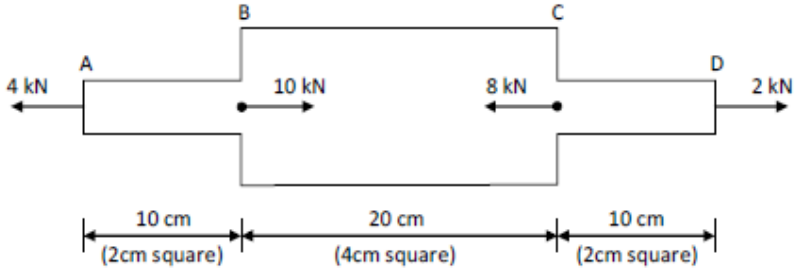

Fig. 5

[(CO6)(Apply/IOCQ)]

(2 + 2) + 8 = 12

9. (a) Draw the stress-strain diagram for a brittle material. *[(CO6)(Remember/LOCQ)]*

   (b) While carrying out experiment (tensile test) in the laboratory; following observations were made. Diameter of the specimen is 12.5 mm, length of the specimen (gauge length) is 50 mm, load at proportional limit is 3000 kg, load at yield point is 3100 kg, maximum load is 5250 kg, strain at proportional limit is 0.11%, final length is 64 mm. diameter over neck is measured as 9.72 mm. Calculate the following:

   (i) Modulus of elasticity E. (ii) Proportional limit (iii) Ultimate stress
   (iv) % elongation (v) % reduction in area
   (vi) Allowable stress based on yield point, considering factor of safety as 1.75.

[(CO6)(Analyse/IOCQ)]

4 + 8 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	27.1	65.6	7.3