

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) If two forces each equal to P in magnitude act at right angles, their effect may be neutralized by a third force acting along their bisector in opposite direction whose magnitude is equal to
(a) 2P (b) $\sqrt{2}P$ (c) $\frac{P}{\sqrt{2}}$ (d) $\frac{P}{2}$
- (ii) Two couples will balance one another when they are in the same plane and have
(a) equal moments and their direction of rotation is same
(b) unequal moments and their direction of rotation is opposite
(c) equal moments and their direction of rotation is opposite
(d) none of the above.
- (iii) The algebraic sum of moments of the forces forming couple about any point in their plane is
(a) constant (b) equal to the moment of the couple
(c) both of these (d) none of these.
- (iv) Dynamic friction is always
(a) more than static friction (b) more than limiting friction
(c) less than limiting friction (d) none of these.
- (v) For a semi-circular arc of radius r, centre of mass lies at a distance
(a) $\frac{r}{\pi}$ from its centre (b) $\frac{2r}{\pi}$ from its centre
(c) $\frac{3r}{2\pi}$ from its centre (d) $\frac{4r}{3\pi}$ from its centre.
- (vi) The path of a projectile in vacuum is
(a) straight line (b) circular (c) parabolic (d) none of the above.
- (vii) The range of a projectile is maximum when its angle of projection is
(a) 30° (b) 45° (c) 60° (d) 70°
- (viii) The ratio of lateral strain and longitudinal strain
(a) stress (b) strain (c) Poisson's ratio (d) modulus of elasticity
- (ix) The maximum value Poisson's ratio is
(a) 0.25 (b) 0.50 (c) 0.75 (d) 1.0.
- (x) According to the Hooke's law
(a) stress is directly proportional to strain (b) stress is inversely proportional to strain
(c) stress is square root of strain (d) none of the above.

Fill in the blanks with the correct word

- (xi) Work done on motion between any two points is equal to change in _____ energy.
- (xii) Angle of friction is the ratio of _____.
- (xiii) In [MLT] system, the dimension of stress is _____.
- (xiv) A member which does not regain its original shape after removal of the load producing deformation is said _____.
- (xv) The unit of power in S.I. system is _____.

Group - B

2. (a) State and explain the principle of transmissibility of vector. Does it affect its behavior? [[CO1](Remember/LOCQ)]
- (b) Distinguish the following system of forces with a suitable sketch. (i) Collinear and (ii) concurrent. [[CO2](Remember/LOCQ)]
- (c) Two like parallel forces of 50 N and 100 N act at the ends of a rod 360 mm long as shown in Fig.1. Find the magnitude (R) of the resultant force and the point where it acts. [[CO2](Apply/IOCQ)]

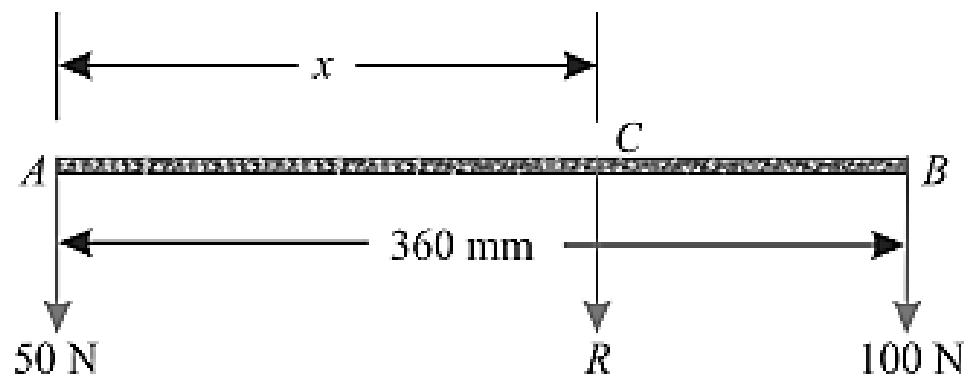


Fig. 1

4 + 4 + 4 = 12

3. (a) Prove that moment of a couple does not depend on the location of the moment center.
 (b) The 4 kN force F is applied at a point A shown in Fig. 2. Compute the moment of F about point O.

[[CO2](Understand/LOCQ)]

[[CO2](Apply/IOCQ)]

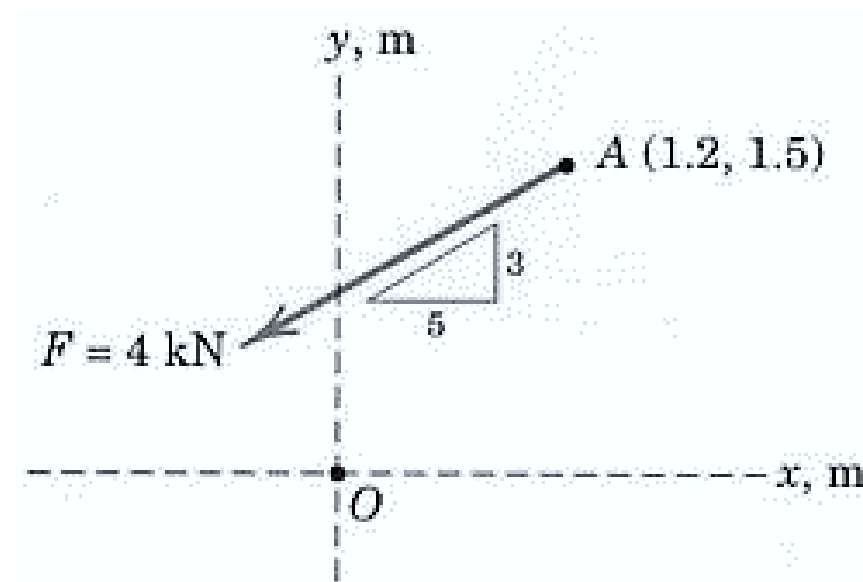


Fig. 2

6 + 6 = 12

Group - C

4. (a) What is a free-body diagram? Draw the free-body diagram of a ball of weight W , placed on a smooth horizontal surface.
 (b) A body of weight 500 N is lying on a rough plane inclined at an angle of 25° with the horizontal. It is supported by an effort (P) parallel to the plane as shown in Fig. 3. Determine the minimum values of P , for which the equilibrium can exist, if the angle of friction is 20° .

[[CO2](Understand/LOCQ)]

[[CO3](Evaluate/HOCQ)]

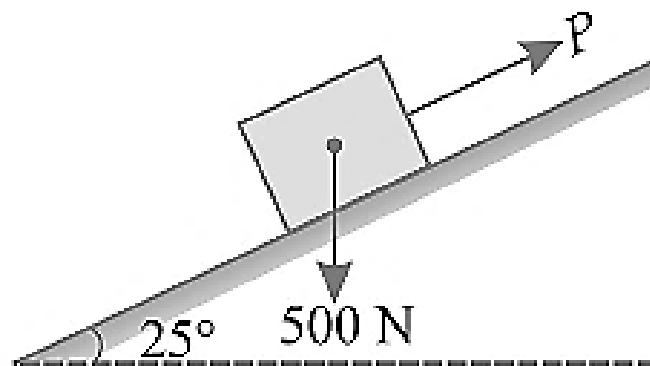


Fig. 3

5 + 7 = 12

5. (a) Explain the terms: (i) angle of friction, (ii) limiting friction.
 (b) A 100 kg block is on an inclined plane of 30° as shown in Fig. 4. The coefficient of static friction between the block and the plane is 0.4. Determine the range of m for which the system will be in equilibrium.

[[CO3](Remember/LOCQ)]

[[CO3](Evaluate/HOCQ)]

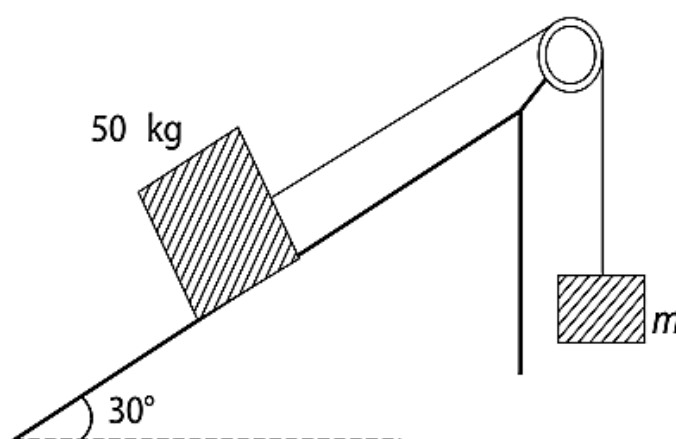


Fig. 4

4 + 8 = 12

Group - D

6. (a) What is centre of gravity? Does it differ from centre of mass? If yes, under what condition?
 (b) Briefly outline the method of calculation of centre of gravity of composites.
 (c) Locate the centroid of a composite as shown in Fig. 5.

[[CO4](Remember/LOCQ)]

[[CO4](Remember/LOCQ)]

[[CO4](Apply/IOCQ)]

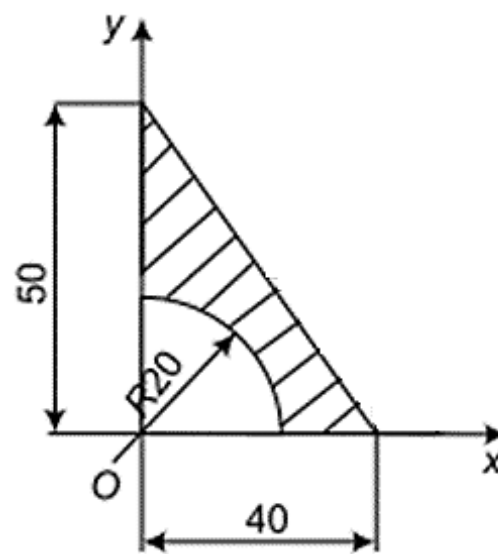


Fig. 5

3 + 3 + 6 = 12

7. (a) A car starts from rest to attain a speed V with a constant acceleration f_1 . It maintains the same speed V for some time and then comes to rest following a constant deceleration f_2 . If the total distance covered is S , find the total time t required to cover this distance.
 (b) A person throws a stone so as to clear a wall of height 3.685 m located at a distance 5.25 m from the origin. The stone touches the ground at a distance of 3.58 m from the wall – away from the origin. Find the least initial velocity at which the stone to be thrown along with its direction.

[[CO5](Analyse/IOCQ)]

[[CO5](Analyse/IOCQ)]

6 + 6 = 12

Group - E

8. (a) Explain the following properties of materials: Malleability, Brittleness, and Toughness.
 (b) A lever is attached to a spindle by means of a square key 6 mm x 6 mm x 2.5 cm long as shown in Fig. 6. If the average shear stress in the key is not to exceed 700 kg/cm², what is the safe value of the load P applied at the free end of the lever?

[[CO6](Remember/LOCQ)]

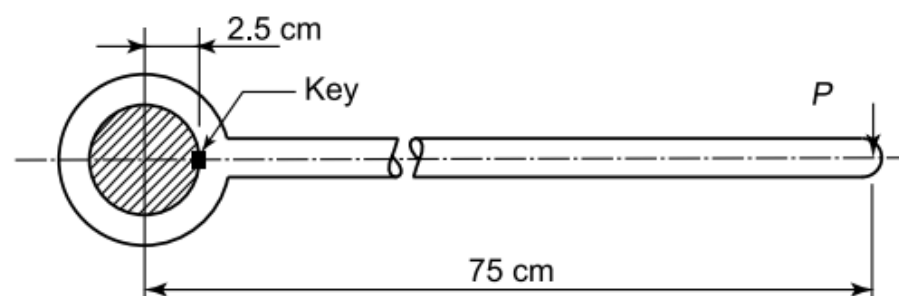


Fig. 6

[[CO6](Analyse/IOCQ)]

6 + 6 = 12

9. (a) A rigid bar AB of length 9 m is suspended by two vertical rods at its ends and hangs in a horizontal position under its own weight as shown in Fig. 7. The rod at A is made of brass having 3 m length and cross-section area 10 cm². Take modulus of elasticity $E_{Br} = 10 \times 10^5$ kg/cm². The rod at B is steel having a length of 5 m, cross-section area 4.45 cm², modulus of elasticity $E_{st} = 2 \times 10^6$ kg/cm². At what distance x from A may a vertical load P be applied if the bar is to remain horizontal after the load is applied?

[[CO6](Analyse/IOCQ)]

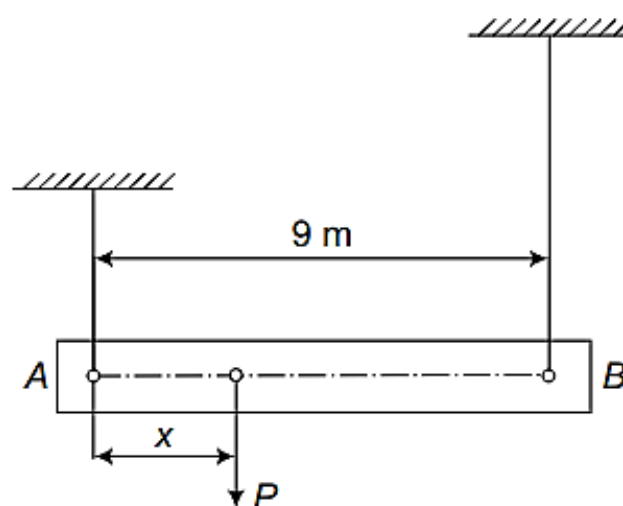


Fig. 7

- (b) A composite rod is 1000 mm long as shown in Fig. 8, its two ends are 40 mm² and 30 mm² in area and length are 300 mm and 200 mm respectively. The middle portion of the rod is 20 mm² in area and 500 mm long. If the rod is subjected to an axial tensile load of 1000 N, find its total elongation. (E = 200 GPa).

[[CO6](Analyse/IOCQ)]

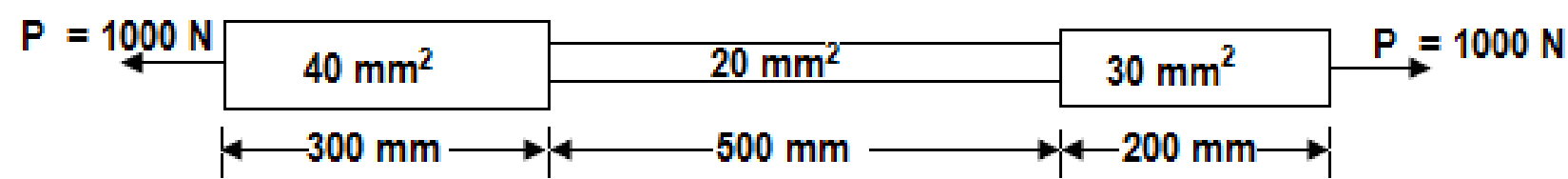


Fig. 8

5 + 7 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	36.5	47.9	15.6