ENGINEERING MECHANICS
(MECH 1101)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

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

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) Angle between the vectors (**i** + **j**) and (-**i** - **j**) is
(a) 30° (b) 45° (c) 90° (d) 180°

(ii) Moment of a Couple is a
(a) bound vector (b) free vector
(c) sliding vector (d) fixed vector.

(iii) Two forces of 100 N and 150 N are acting simultaneously at a point. What is the resultant of these two forces, if the angle between them is 45°?
(a) 212 N (b) 222 N (c) 232 N (d) 242 N

(iv) Forces are called coplanar when all of them acting on body lie in
(a) one point (b) one plane
(c) different planes (d) perpendicular planes.

(v) The ratio of limiting friction and reaction is known as
(a) coefficient of friction (b) angle of friction
(c) angle of repose (d) sliding friction

(vi) The centroidal distance $\bar{y}$ of a circular area of radius *r* from the centroidal axis is
(a) $\frac{4r}{3\pi}$ (b) $\frac{2r}{3\pi}$ (c) $\frac{3r}{2\pi}$ (d) *0*

(vii) M. I. of a rectangular area of base 'b' and height 'd' about x axis is given by
(a) $bd^3/3$ (b) $bd^3/4$ (c) $bd^3/6$ (d) $bd^3/12$.

(viii) When a body slides down an inclined surface (angle of inclination =θ), the acceleration f of the body is given by
(a) $f = g$ (b) $f = g\sin\theta$ (c) $f = g\cos\theta$ (d) $f = g/\sin\theta$

(ix) SI unit of longitudinal stress is
(a) N/m (b) N/m^2 (c) N/m^3 (d) unit less

(x) A jet engine works on the principle of conservation of
(a) energy (b) mass
(c) angular momentum (d) linear momentum.

Group – B

2. (a) Explain: (i) Equivalent vector, (ii) Position vector, (iii) Varignon's theorem

(b) Given the vectors
$\vec{A} = 6\vec{i} + 3\vec{j} + 10\vec{k}$; $\vec{B} = 2\vec{i} - 5\vec{j} + 5\vec{k}$ *and* $\vec{C} = 5\vec{i} - 2\vec{j} + 7\vec{k}$
what vector $\vec{D}$ *gives the following ?*
$\vec{D} \cdot \vec{A} = 20$; $\vec{D} \cdot \vec{B} = 5$ *and* $\vec{D} \cdot \vec{i} = 10$

(2 + 2 + 2) + 6 = 12

3. (a) Explain Law of Transmissibility.

(b) Two forces are given by (2i+3j+4k) N and (4i-2j+7k) N, Prove that two forces are not parallel.

(c) Find the perpendicular distance from the point (2, 3, 4) to the line joining the origin and the point (4, 10, 5).

3 + 3 + 6 = 12

Group – C

4. (a) A smooth circular cylinder of radius 0.5 m is lying in a rectangular groove is shown in Fig.1. Find the reactions at the surfaces of contact, if there is no friction and the cylinder weighs 500 N.

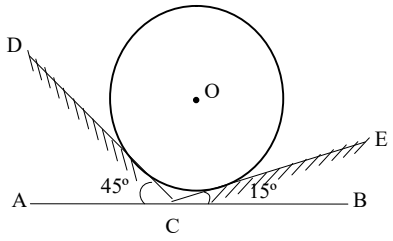

Fig.1

(b) Two equal loads of 2500 N are supported by a flexible string ABCD at points B and C as shown in Fig.2. Find the tensions in the portions AB, BC, CD of the string.

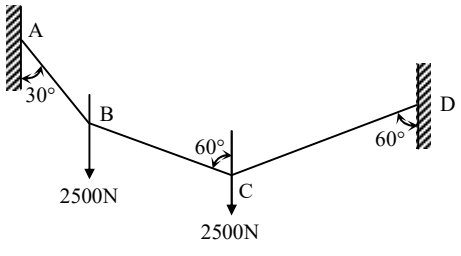

Fig.2

6 + 6 = 12

5. (a) State and proof Lami's Theorem.

(b) Two rectangular blocks of weights W_1 and W_2 are connected by a flexible cord and rest upon a horizontal and an inclined plane, respectively, with the cord passing over a pulley as shown in Fig.3. In the particular case where $W_1 = W_2$ and the coefficient of static friction μ is the same for all contiguous surfaces, then find the angle α of inclination of the inclined plane at which motion of the system will impend. Neglect friction in the pulley.

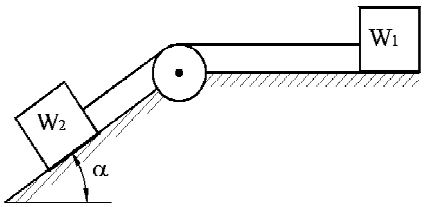

Fig.3

6 + 6 = 12

Group – D

6. (a) Calculate the location of the centroid of the L-section shown in Fig.4. (all dimensions are in mm).

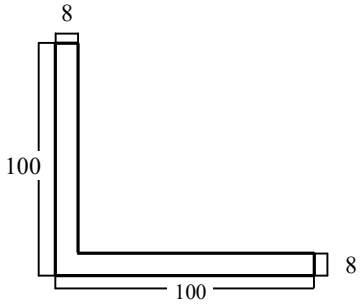

Fig.4

(b) Determine MI of the inverted T section as shown in Fig.5 about its centroidal axis parallel to the base.

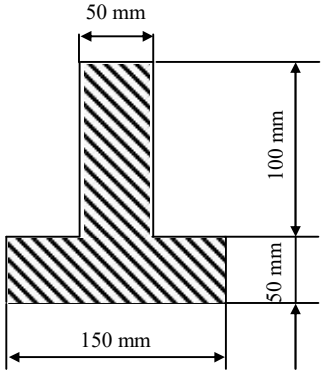

Fig.5

6 + 6 = 12

7. (a) Define: (i) malleability, (ii) toughness and (iii) elasticity.

(b) A brass bar having a cross sectional area of $1000\ mm^2$ is subjected to axial forces as shown in Fig.6. Find the total change in length of the bar. Take $E = 1.05 \times 10^5\ N/mm^2$.

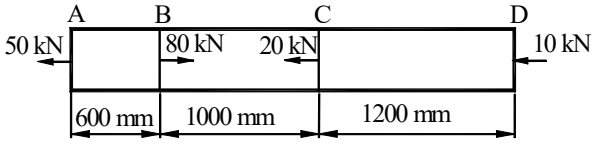

Fig.6

(3 × 2) + 6 = 12

Group – E

8. (a) A particle of mass m moves linearly along *x*-axis under the action of force $F = kx$, where k is a constant. Find the velocity as a function of displacement x if the initial conditions of motion are $v_0 = 0, x_0 = 0.$

(b) A broad jumper approaches his takeoff board A with a horizontal velocity of 10 m/s. Determine the vertical component v_y of the velocity of his centre of gravity at takeoff for him to make the jump shown in Fig.7. What is the vertical rise h of his centre of gravity?

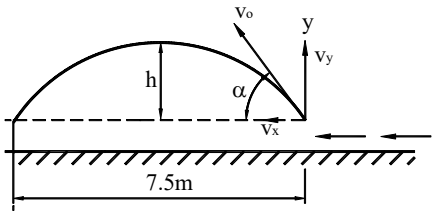

Fig.7

6 + 6 = 12

9. (a) Weight W and 2W are supported in a vertical plane by a string and pulleys arranged as shown in Fig.8. Find the magnitude of an additional weight Q applied on the left which will give a downward acceleration $a = 0.1\,g$ to the weight W. Neglect friction and inertia of pulleys. (**Using D'Alembert's principle solve the problem).**

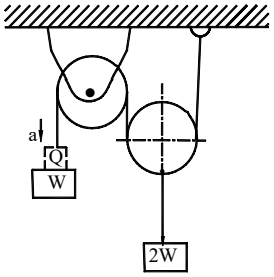

Fig.8

(b) Calculate the velocity v of the 50 kg crate when it reaches the bottom of the chute at B if it is given an initial velocity of 4 m/s down the chute at A. The coefficient of kinetic friction is 0.3.

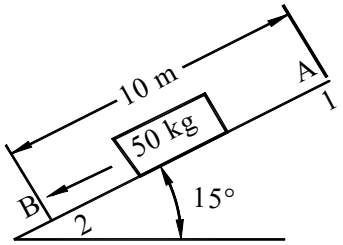

Fig.9

6 + 6 = 12

Backlog Submission link	https://forms.gle/U3d4wtAaNdT4ewnB6 Class code: 46iajup