(b) With neat sketch, explain stress-strain diagram for a ductile material.

7 + 5 = 12

Group – E

8. (a) The position co-ordinate of a particle which is confined to move in a straight line is given by $S = 2t^3 - 24t + 6$, where, S is in meters and t is in sec. Determine
   (i) the time required for the particle to reach a velocity of 72 m/s from its initial condition at $t = 0$
   (ii) the acceleration of the particle when $v = 30$ m/s
   (iii) the net displacement of the particle during the interval from $t = 1$ sec to $t = 4$ secs.

   (b) A projectile is launched with an initial speed of 200 m/s at an angle of $60°$ with respect to the horizontal as shown in Fig.7. Compute the range R as measured up the incline.

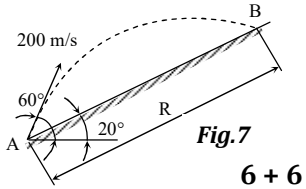

Fig.7

6 + 6 = 12

9. (a) Explain D'Alembert's principle.

   (b) Determine the tension in the strings and accelerations of two blocks of masses 150 kg and 50 kg connected by a string and a frictionless, weightless pulley as shown in Fig.8.

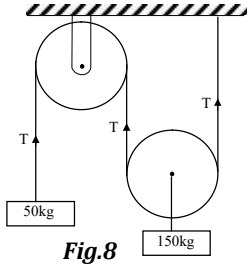

Fig.8

3 + 9 = 12

B.TECH/AEIE/BT/CE/CHE/CSE/ECE/EE/IT/ME/1ST SEM/MECH 1101 (BACKLOG)/2019

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) The angle between $(\hat{i} + \hat{j})$ *and* $(-\hat{j} + \hat{i})$ is
   (a) 180° (b) zero (c) 270° (d) 90°.

   (ii) Given $\vec{F}_1 = -2\hat{j} + 3\hat{k}$ and $\vec{F}_2 = 3\hat{i} - 5\hat{k}$. The magnitude of the scalar product of these vectors is
   (a) -15 (b) -9 (c) 13 (d) 15.

   (iii) To solve equilibrium problem, if the total unknowns are 3 then at least how many equations or conditions are required?
   (a) 4 (b) 1 (c) 2 (d) 3.

   (iv) A force 50 kN is acting along a direction 30° inclined with positive x axis. The magnitude of y component of the force is
   (a) 25 (b) 50 N (c) 25 kN (d) $100\sqrt{3}$ kN.

   (v) The general relation between coefficient of static friction (μ_s) and coefficient of kinetic friction (μ_k) is
   (a) $\mu_s = \mu_k$ (b) $\mu_s > \mu_k$ (c) $\mu_s < \mu_k$ (d) all of these.

   (vi) The centroidal distance of a semicircular area of radius *r* from the base is
   (a) $\frac{4r}{3\pi}$ (b) $\frac{2r}{3\pi}$ (c) $\frac{3r}{2\pi}$ (d) *r*.

   (vii) Moment of inertia of a rectangle of base *b* and height *h* about the centroidal axis parallel to base is
   (a) $\frac{bh^3}{36}$ (b) $\frac{bh^3}{12}$ (c) $\frac{bh^3}{3}$ (d) $\frac{bh^3}{4}$.

(viii) Hooke's law for ductile materials is valid within
(a) proportional limit (b) elastic limit
(c) ultimate strength (d) breaking point.

(ix) Equation of motion of a particle is $s = t^3 - t^2 - 500$, where, *s* is displacement in meters and t is time in seconds. Acceleration of the particle after 1 second will be
(a) 4 m/s^2 (b) 9 m/s^2 (c) 10 m/s^2 (d) 5 m/s^2.

(x) A projectile is fired at an angle θ to the vertical. Its horizontal range will be maximum when θ is
(a) 0° (b) 30° (c) 45° (d) 60°.

Group – B

2. (a) State and prove Varignon's theorem for concurrent forces.

(b) A moment vector of magnitude 200 Nm acts through the points (-3, 0, 0) and (0, -4, 5). Find the vector expression for the moment.

6 + 6 = 12

3. (a) Explain following vectors:
(i) Equal vector (ii) Equivalent vector and (iii) Position vector.

(b) A force $\vec{F} = (15\vec{i} - 2\vec{j} + 5\vec{k})N$ acts at a point A whose coordinates are (1, –2, -3). Co-ordinate distances are in meters. Compute moment of force about origin.

(3 × 2) + 6 = 12

Group – C

4. (a) Determine the tension in the tie rod AC = 150 mm when a circular roller of weight Q = 450 N and radius r = 75 mm is resting against a smooth vertical wall at B as shown in Fig.1.

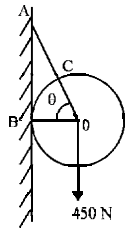

Fig.1

(b) An electric-light fixture of weight Q = 178 N is supported as shown in Fig.2. Determine the tensile forces S_1 and S_2 in the wires BA and BC if their angles of inclination are as shown.

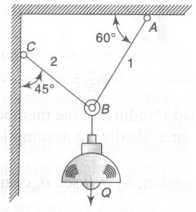

Fig.2

6 + 6 = 12

5. (a) State and prove Lami's theorem.

(b) Two blocks of weights W_1 and W_2 rest on a rough inclined plane and are connected by a short piece of string as shown in Fig.3. If the coefficients of friction are μ_1 = 0.2 and μ_2 = 0.3, respectively, find the angle of inclination of the plane for which sliding will impend. Assume $W_1 = W_2$ = 22.25 N.

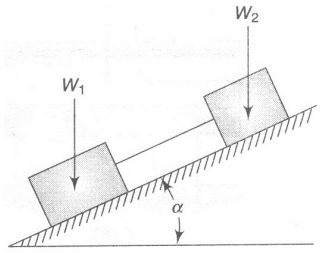

Fig.3

5 + 7 = 12

Group – D

6. (a) Locate the centroid of the L section as shown in Fig.4.

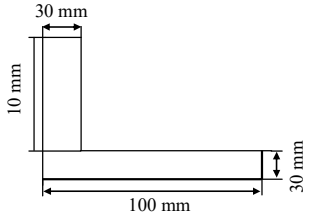

Fig.4

(b) Determine the moment of inertia of the shaded area with respect to the x axis as shown in Fig.5.

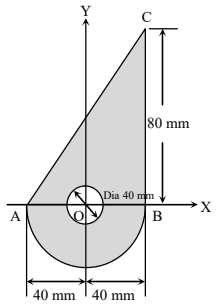

Fig.5

6 + 6 = 12

7. (a) A bar of variable cross-sectional areas as shown in Fig.6 is subjected to different forces. Find the total elongation of the bar. Take E = 2×10^5 N/mm^2:

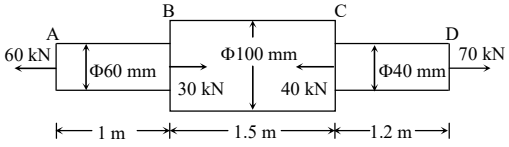

Fig.6