MECHANICS FOR ENGINEERS
(MECH 2106)

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) According to the principle of transmissibility of forces, the effect of a force upon a body is
(a) maximum when it acts at the centre of gravity of the body
(b) different at different points in its line of action
(c) the same at every point in its line of action
(d) minimum when it acts at the centre of gravity of the body.

(ii) Two vectors $4\boldsymbol{i}+2\boldsymbol{j}-6\boldsymbol{k}$ and $-5\boldsymbol{i}+x\boldsymbol{j}-8\boldsymbol{k}$ are orthogonal when the value of x is
(a) 15 (b) -14 (c) 6 (d) 0.

(iii) Self weight of a block resting on an inclined plane will act-
(a) vertically downward (b) horizontally
(c) along the incline (d) normal to the incline.

(iv) The value of kinetic friction is normally
(a) greater than static friction (b) less than static friction
(c) equal to static friction (d) equal to zero.

(v) During design of a component, factor of safety is taken as 4. If the material of the component is brittle and have an ultimate strength 660 MPa. The working stress is
(a) 165 MPa (b) 200 MPa (c) 660 MPa (d) 180 MPa.

(vi) Which point on the stress strain curve of the ductile material occurs after the ultimate point?
(a) Last point (b) Breaking point
(c) Elastic limit (d) Material limit.

(vii) Which of the following is found out by calculating the area under the stress strain graph?
(a) Toughness (b) Hardness (c) Endurance (d) Strength.

(viii) The area under the acceleration-displacement curve represents the
(a) velocity of a particle
(b) acceleration of the particle
(c) change in kinetic energy of the particle considering unit mass
(d) displacement of the particle.

(ix) Centre of gravity of a thin hollow cone lies on the axis of symmetry at a height of
(a) One-half of the total height above base
(b) One-third of the total height above base
(c) One-fourth of the total height above base
(d) One-eight of the total height above base.

(x) A particle is projected at a particular velocity with a projected angle of 24^0. The range on horizontal plane is measured as 2 km. The particle with same velocity and same point is projected again at an angle 66^0. The new range is
(a) 2 km (b) 3 km (c) 4 km (d) 6 km.

Group – B

2. (a) Find the magnitude and direction of the resultant of the concurrent forces of 15 N, 16 N, 19 N and 28 N making angles of 30°, 70°, 120° and 155° respectively with a fixed horizontal line.

(b) A uniform circular wheel of 900 mm diameter, weighing 5 kN rests against a rigid rectangular block of 150 mm height as shown in Fig.1. Find the least pull, through the centre of the wheel, required just to turn the wheel over the corner A of the block. Also find the reaction on the block. Take all the surfaces to be smooth.

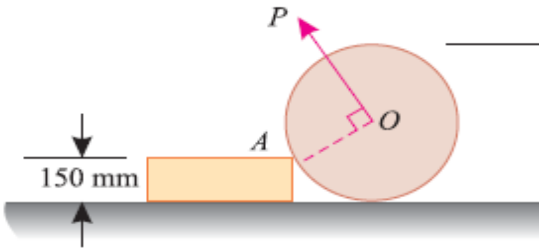

Fig.1

(3 + 3) + 6 = 12

3. (a) A force is specified by the vector $\boldsymbol{F} = 145\boldsymbol{i} + 60\boldsymbol{j} - 110\boldsymbol{k}$ N. Calculate the angles made by F with the positive x, y and z axes.

(b) A force given by $\boldsymbol{F} = -3\boldsymbol{i} + 5\boldsymbol{j} - 6\boldsymbol{k}$ N is applied at the point P (1m, -1m, 2m). Find the moment of the force F about the point O (2m, -1m, 3m).

6 + 6 = 12

Group – C

4. (a) Two blocks A and B of weights 10 kN and 20 kN respectively are in equilibrium position as shown in Fig.2. If the coefficient of friction between the two blocks as well as the block B and the floor is 0.3, find the force (P) required to move the block B.

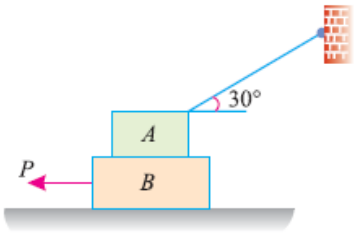

Fig.2

(b) Two identical rollers, each of weight Q = 300 N, are supported by an inclined plane and a vertical wall as shown in Fig.3. Assuming smooth surfaces, find the reactions induced at the points of support A, B and C.

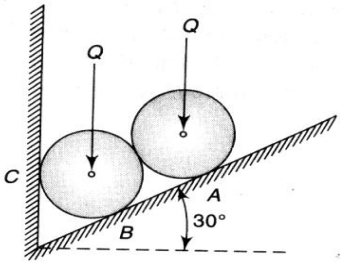

Fig.3

6 + 6 = 12

5. (a) Define angle of friction and angle of repose in the context of dry friction.

(b) Determine the magnitude and direction of the friction force acting on the 100-kg block shown in Fig. 4. For (i) P = 500 N and then (ii) P = 100 N.
The coefficient of static friction μ_s = 0.20 and the coefficient of kinetic friction μ_k = 0.17. Assume that the forces are applied with the block initially at rest.

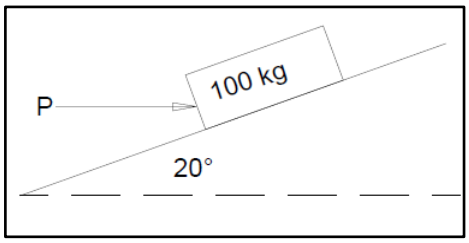

Fig.4

4 + 8 = 12

Group – D

6. (a) Find out the centroid of the area shown in Fig.5 with respect to the given axes.

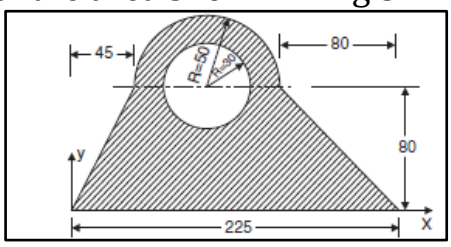

Fig. 5

(b) The bar shown in Fig. 6 is tested in universal testing machine. It is observed that at a load of 40 kN, the total extension of the bar is 0.280 mm. Determine the Young's modulus ofthe material.

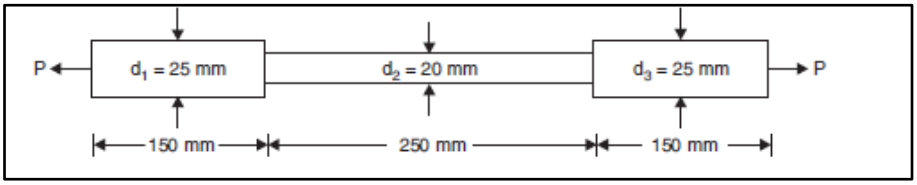

Fig.6

6 + 6 = 12

7. (a) Find the centroid of a T-section given in Fig.7 below.

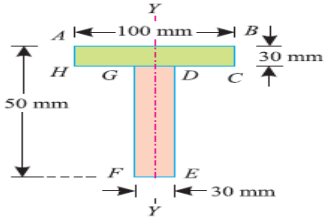

Fig.7

(b) (i) Draw stress strain diagram for mild steel and show all the significant points of the curve.
(ii) Define ductility as a property of material.

6 + (4 + 2) = 12

Group – E

8. (a) A car moves along a straight line whose equation of motion is given by $s = 6t + 4t^2 - 2t^3$, where (s) is in metres and (t) is in seconds. Calculate (i) velocity and acceleration at start, and (ii) acceleration, when the velocity is zero.

(b) Two masses are interconnected with an inextensible cord as shown in Fig.8 below. Considering coefficient of friction in the contiguous surfaces $\mu = 1/4$, determine the acceleration and the tension of the string. Take $m_1 = 12$kg and $m_2 = 6$kg.

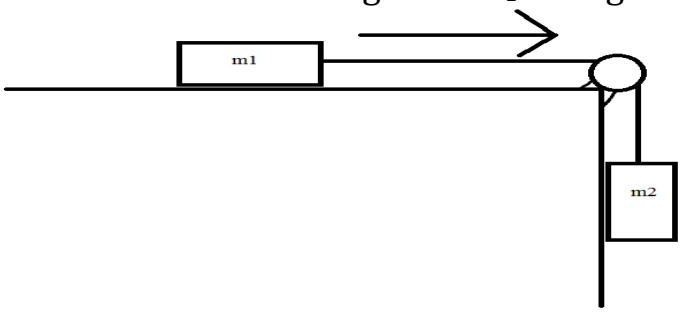

Fig.8

(2 + 2) + 8 = 12

9. (a) Determine the tension P in the cable Shown in Fig.9 which will provide the 50-kg block a steady acceleration of 2 m/s² up the incline.

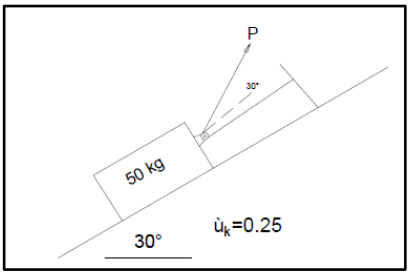

Fig.9

(b) The small cart has a speed $v_A = 4$ m/s as it passes point A. It moves without appreciable friction and passes over the top hump of the track as shown in Fig. 10. Determine the cart speed as it passes point B.

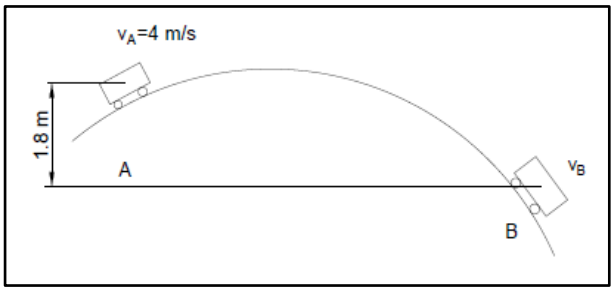

Fig.10

7 + 5 = 12

Department & Section	Submission Link
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EE	https://classroom.google.com/c/MTIyNDY0NzI1ODk4/a/Mjc0MDUzNDEwOTc5/details