Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.TECH(NEW)/SEM-1/ME-101/2011-12

2011
ENGINEERING MECHANICS

Time Allotted : 3 Hours *Full Marks :* 70

The figures in the margin indicate full marks.

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

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following : $10 \times 1 = 10$

   i) Coloumn friction is between

      a) solids and liquids

      b) dry surfaces

      c) between bodies having relative motion

      d) none of these.

   ii) The velocity of a simple wheel and axle, with D and d as the diameters of effort respectively is

      a) $(D + d)$ b) $(D - d)$

      c) $\frac{d}{D}$ d) $\frac{D}{d}$

iii) For stable equilibrium the potential energy will be

a) maximum

b) minimum

c) zero

d) equal to kinetic energy.

iv) The centroid 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 .

v) Materials having same elastic properties in all directions are called

a) Isotropic b) Orthotropic

c) Composite d) Elastic.

vi) The work done against any conservative force is stored in the body in the form of

a) energy b) potential energy

c) elastic energy d) strain energy.

vii) A pair of a force and a couple in the same plane upon a rigid body

a) balance each other

b) cannot modify each other

c) produce a moment

d) none of these .

viii) A particle inside a hollow sphere of radius r, having co-efficient of friction $\frac{1}{\sqrt{3}}$, can be in rest up to a height of

a) $\frac{r}{2}$ b) $\frac{r}{4}$

c) $\frac{3r}{8}$ d) none of these.

ix) Hooke's law is valid up to

a) yield point b) elastic limit

c) proportional limit d) ultimate stress.

x) A jet engine works on he principle of conservation of

a) energy

b) angular momentum

c) linear momentum

d) none of these.

xi) Moment of inertia of a triangle of base b and height h about the centroidal axis parallel to base is

a) $bh\frac{3}{36}$ b) $\frac{bh^3}{12}$

c) $bh\frac{3}{3}$ d) none of these.

xii) Couple is a

a) bound vector b) free vector

c) sliding vector d) none of these.

xiii) Angle between the vectors $(i + j)$ and $(i - j)$ *is*

a) 90° b) 45°

c) 0° d) none of these.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following.

$3 \times 5 = 15$

2. a) Define moment.

   b) In the given figure 1 weight of the block is 1600N and $\mu=0.2$. Find the value of P for impending motion. 2 + 3

Figure 1

3. 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 m and t is in sec.

   Determine,

   a) the time required for the particle to reach a velocity of 72 m/s from its initial condition at t = 0.

   b) the acceleration of the particle when v = 30 m/s.

   c) the net displacement of the particle during the interval from t =1 sec to t = 4 sec.

4. Define (i) Malleability (ii) Resilience (iii) Toughness (iv) Ductility and (v) Proof Resilience.

5. A force $F = 3i - 4j + 12k$ acts at a point A whose co-ordinates are (1, – 2, 3). Compute,

   a) moment of force about origin,

   b) moment of force about point (2,1,2)

6. a) State & Prove Lame's theorem.

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

2 + 3

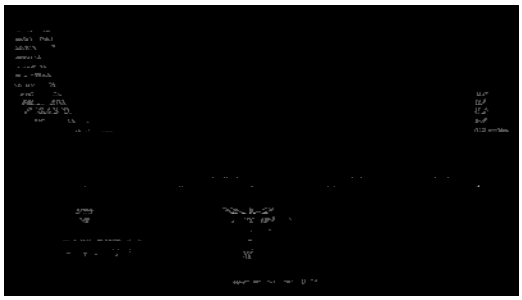

Figure 2

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. 3 × 15 = 45

7. a) A block of weight $W_1 = 200$ kgf rests on a horizontal surface and supports on top of it another block of weight $W_2 = 50$ kgf. The block W_2 is attached to a vertical wall by the inclined string *AB*. Find the magnitude of the horizontal force *P* applied to the lower block as shown, that will be necessary to cause slipping to impend. The coefficient of static friction for all contiguous surfaces is $\mu = 0.3$ 7

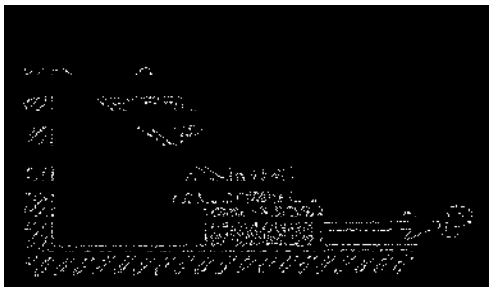

Figure 3

b) A shot is fired with a bullet with an initial velocity of 40m/s from a point 20m in front of a vertical wall 10m high. Find the angle of projection with horizontal to enable the shot to just clear the wall. 8

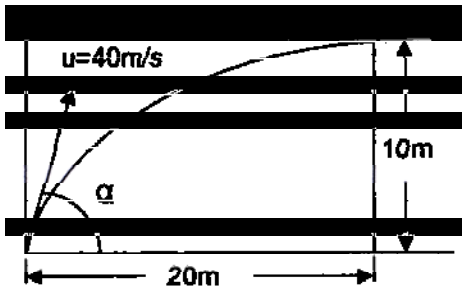

Figure 4

8. a) The bar shown in fig. 5 is subjected to a tensile load 152kN. Find the diameter of the middle portion if the stress there is to be limited to 140 N/Mm^2. Find also the length of the middle portion of the total elongation of the bar is to be 0.16mm. Take $E = 2 \times 2 \times 10^5 mm^2$. 10

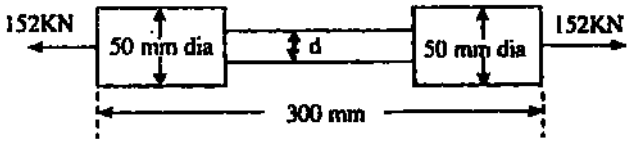

Figure 5

b) Determine the co-ordinate of the centroid with respect to the given axis of the shaded area as shown in figure 6. 5

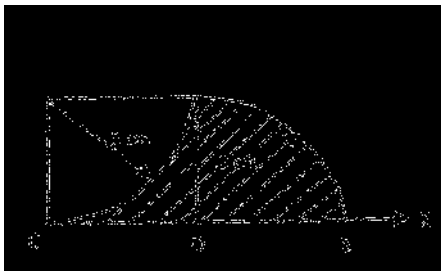

Figure 6

9. a) State principle of transmissibility.

b) Given a force $F = 10i + 5j +$ A kN. If this force is to have a rectangular component of 8N along a line having unit vector $r = 0.6i + 0.8\ k$, what should be the value of A ? What is the angle between F and r ?

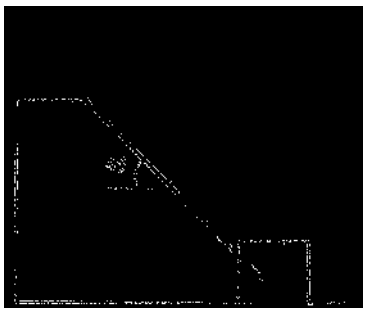

Figure 7

c) Two identical blocks A and B each having weight W are connected by rigid link and supported by a vertical wall and a horizontal plane having same co-efficient of friction (μ) as shown in figure. If sliding impends for $\theta = 45^0$, calculate μ. 2 + 5 + 8

10. a) If the string AN is horizontal, find the angle that the string AC makes with the horizontal when the ball is in a position of equilibrium. Also find the pressure R between the ball and the plane.

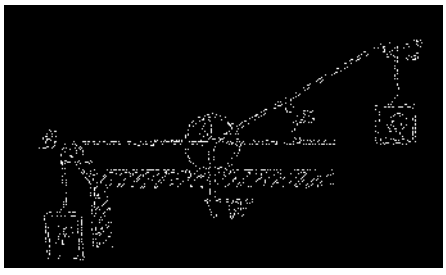

Figure 8

b) A roller of radius r = 12 cm and Q = 500 kgf is to be rolled over a curb of height h = 6 cm by a horizontal force P applied to the end of a string wound around the circumference of the roller. Find the magnitude of P required to start the roller over the curb. There is sufficient friction between the roller surface and the edge of the curb to prevent slip at A.

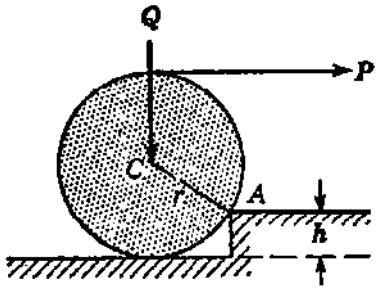

Figure 9

7 + 8

11. a) State parallel axis and perpendicular axis theorem for moment of inertia.

b) Define radius of gyration. How is it related to mass moment of inertia ?

c) Determine the centre of a quarter circular arc of radius 'r'. (2 + 2) + (2 + 1) + 8