B.Tech/ AEIE/BT/CE/CHE/CSE/ECE/EE/IT/ME/ 1st Sem/MECH-1101/2016

2016

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 x 1=10]**

i) A force vector is given as $F = 3\mathbf{i} + 4\mathbf{j} + 12\mathbf{k}$ N then

a) a unit vector along F has a magnitude 1N

b) a unit vector along F is $(3\mathbf{i} + 4\mathbf{j} + 12\mathbf{k}$ N)/13

c) a velocity vector of magnitude 13m/s along F is $3\mathbf{i} + 4\mathbf{j} + 12\mathbf{k}$ m/s

d) all are true

ii) The angle between two forces to make their resultant maximum is

a) 0° b) 45° c) 90° d) 180°

iii) Given that the vector sum of three forces acting on a rigid body is zero, then

a) the body must be in equilibrium

b) the body must be acted upon by a net couple

c) the body must not be in equilibrium

d) none of these

iv) In the absence of any external forces acting on a system of particles

a) both momentum and energy must be conserved

b) only momentum must be conserved

c) only energy must be conserved

d) none of these

v) When a body moves along a straight line with variable acceleration

a) both tangential and normal components are variable

b) only normal component is variable

c) only tangential component is variable

d) any of a), b) or c)

vi) The co-efficient of friction depends on

a) nature of surfaces b) shape of surfaces

c) strength of surfaces d) area of contact

vii) Young's Modulus is defined as

a) Longitudinal stress by Longitudinal strain

b) Lateral stress by Lateral strain

c) Longitudinal strain by Lateral strain

d) Lateral strain by Longitudinal strain

viii) The polar moment of inertia of a square are a of side '*b*' about an axis passing through its centroid is given by

a) $b^4/3$ b) $b^4/4$ c) $b^4/6$ d) $b^4/12$

ix) Percentage elongation is a measure of

a) Young's modulus b) malleability

c) ductility d) ultimate stress

x) The D' Alembert's principle

a) is based upon the presence of inertia force

b) provides advantage over Newton's Law

c) is purely a hypothetical principle

d) allows a dynamic problem to be treated as a static one

GROUP - B

2 a) Determine the couple moment (in vectorial form) associated with the pair of 400N forces applied to the T-shaped structure as shown in **Figure 1.**

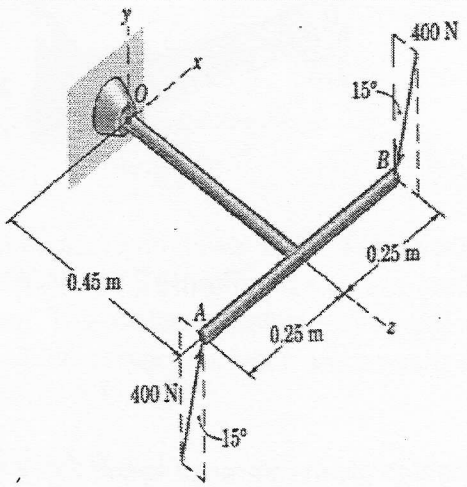

Fig.1

b) The cable exerts a tensile force, T of magnitude 2kN on the fixed bracket at A, as shown in Figure 2. Point B lies on the plane *y-z*. Write the vector expression for the tensile force **T**. Also, find the moment of the force about *z*-axis.

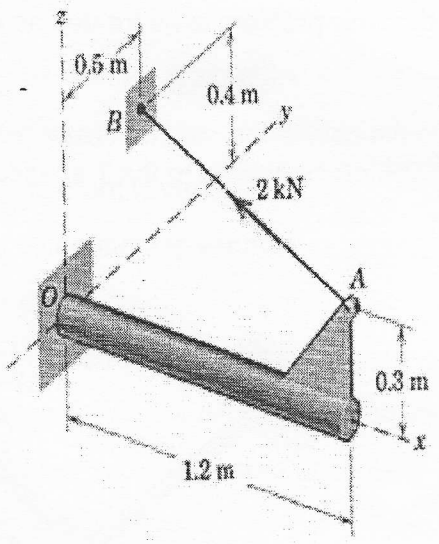

Figure 2

6+6=12

3 a) With respect to given reference system XYZ if l_A, m_A, n_A and l_B, m_B, n_B are direction cosine of two vectors *A* and *B* respectively, show that $\cos(A,B) = l_A\, l_B + m_A\, m_B + n_A\, n_B$

b) A,B,C are three points on the positive X-, Y- and Z- axes, their distances from the origin O being 12m, 4m and 3 m respectively. P is the foot of the perpendicular dropped from O on the plane ABC. Find out the vector OP.

6+6=12

GROUP - C

4 a) Two smooth cylinders as shown in the Figure 3, each of weight W = 200N and radius r = 6cm are connected by a string AB of length L = 16cm and rest upon a horizontal plane supporting a third smooth circular cylinder of weight Q = 400N and radius r = 6cm above them. Find the tension S, in the string A,B and the reaction produced by the floor at points of contact D and E.

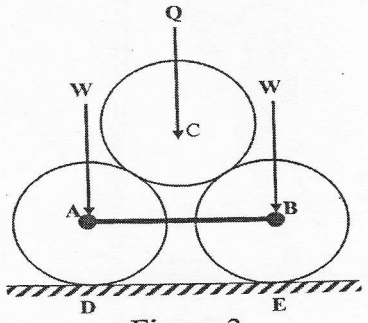

Figure 3

b) Two rollers of diameter 60mm(lower roller 1) and 30mm(upper roller 2) having weight 160N and 40N respectively are placed as shown in the Figure 4 below. The distance between the two vertical walls is 72mm. Assuming all the contact surfaces are smooth, find the reaction forces at contact points A,B and C.

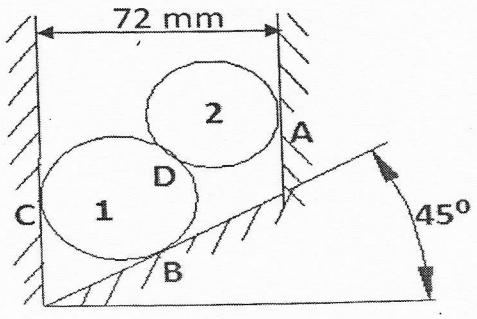

Figure 4

6+6=12

5 a) Determine the distance s to which the 90-kg painter(Figure 5) can climb without causing the 4-m ladder to slip at its lower end A. The top of the 15-kg ladder has a small roller, and at the ground the coefficient of static friction is 0.25. The mass centre of the painter is directly above the feet.

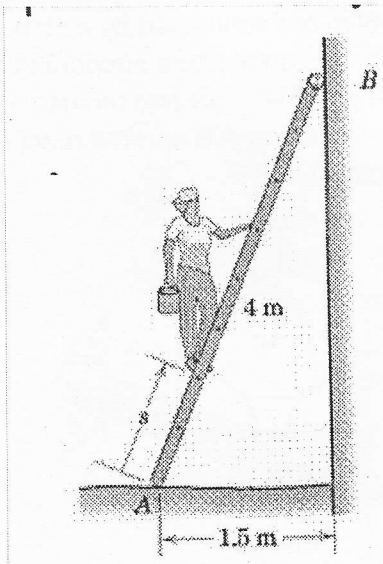

Fig.5

b) A block of weight W_1 = 900N rests on a horizontal surface and supports on top of it, another block of weight W_2 = 225 N. 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 in Figure 6 that will be necessary to cause slipping to impend. The coefficient of static friction for all contiguous surfaces is μ = 0.3.

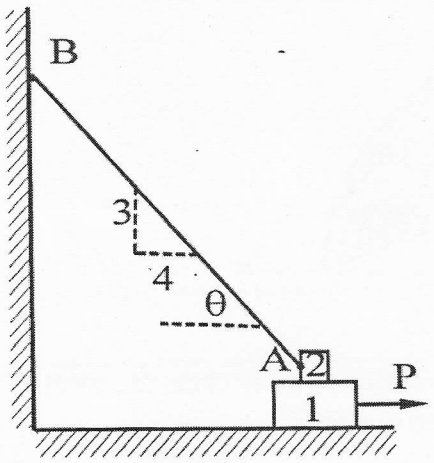

Figure 6

6+6=12

GROUP-D

6 a) Determine the centroidal x- and y-coordinates(x_c, y_c) of the shaded area bounded by a quarter circular arc of radius '***a***' and a straight line, as shown in Figure 7.

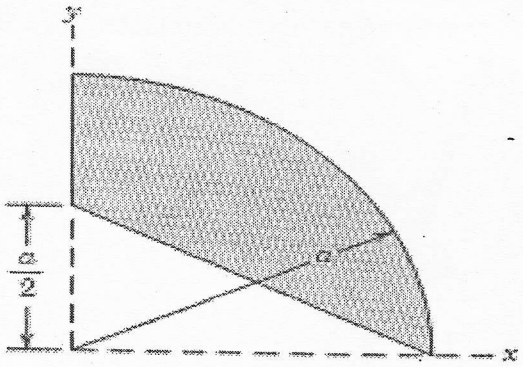

Figure 7

b) Find the area Moment of Inertia of a semi circle of radius '**R**' about an axis passing along its base diameter.

Hence, using Parallel Axes theorem, find the area Moment of Inertia of the semi circle, about its centroidal axis parallel to the base.

6+6=12

7 a) Determine the elongation of a bar of length *L*, cross-sectional area *A*, hanging vertically due to its own weight *W*. The modulus of elasticity of the material of the bar is *E*.

b) A rigid bar AB is hinged to vertical wall at A and supported horizontally by a tie-bar CD as shown in the Figure 8. The tie-bar has cross-sectional area At= 0.5cm^2 and its allowable stress in tension is σ_w = 1500kgf/cm^2 . Find the safe value of the magnitude of the load P and the corresponding vertical deflection δ_B of point B. The tie-bar has modulus of elasticity E = 2x10^6 kgf/cm^2.

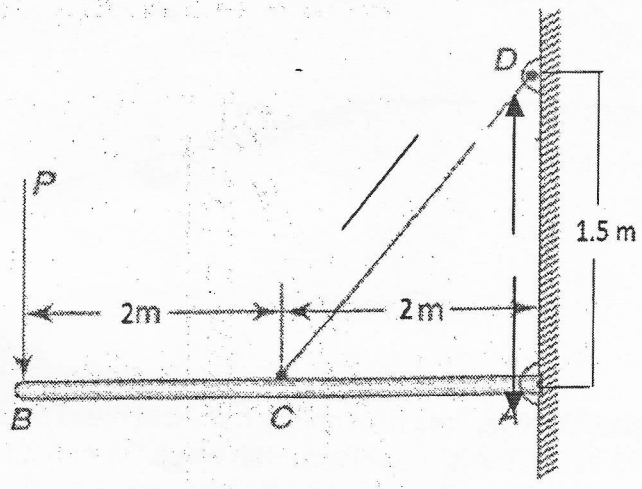

Figure 8

5+(3+4)=12

GROUP-E

8 a) The acceleration ***'a'*** of a body starting from rest at ***t***=0, is given by ***a = 12t - 6t^2*** where ***'a'*** is the acceleration in *m/s^2* and ***'t'*** is the time in *s*. Find the velocity of the body when it returns to its starting position.

b) A projectile is launched from point ***A*** with an initial velocity v_o = 120m/s at an angle 40° with horizontal, as shown in Figure 9 below. Determine the slant distance *s* which locates the point ***B*** of impact. Also calculate the time of flight *t*.

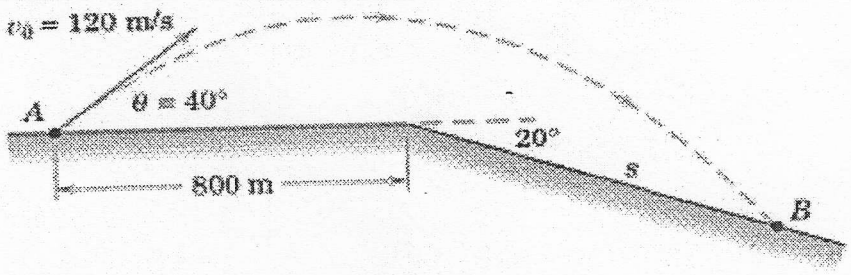

Figure 9

5+(4+3)=12

9 a) A gun of mass 3000 kg fires horizontally a shell of mass 50kg with a velocity of 300 m/s. What is the velocity with which the gun will recoil? Determine the uniform force required to stop the gun in 0.6m. In how much time will it stop? State the principles you can adopt to solve the problem.

b) An elevator of total weight 5000N starts to move upwards with a constant acceleration and acquires a speed of 2m/s after travelling a distance of 2m. Then it is uniformly decelerated to stop in next 2 seconds. Find the tensile force in the cable during the accelerated motion. Also find the reaction at the floor of the elevator felt by a man weighing 600N under his feet riding the elevator during the decelerated motion.

(4+1+1)+6=12