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) Three forces $\sqrt{3}$p, p and 2p acting on a particle are in equilibrium. If the angle between first and second be 90^0, the angle between second and third will be. [CO1]
(a) 300 (b)1200 (c)600 (d)1500

(ii) A force 2 kN acts along the +ve Y axis. The vector component of the force (in kN) along the vector (i+j) is given by. [CO1]
(a) $(i + j)/\sqrt{2}$ (b) $\sqrt{2}$ (i + j)
(c) i + j (d) i - j

(iii) According to the principle of transmissibility of forces, the effect of a force upon a body is . [CO1]
(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

(iv) Two vectors 4**i**+2**j**-6**k** and -5i+xj-8**k** are orthogonal when the value of x is. [CO2]
(a) 15 (b) -14 (c) 6 (d) 0

(v) Lami's theorem is applicable when. [CO3]
(a) three concurrent and coplanar forces are present in a rigid body
(b) three concurrent and coplanar forces are present in a rigid body which is in static equilibrium
(c) six concurrent and coplanar forces are present in a rigid body
(d) six concurrent and coplanar forces are present in a rigid body which is in static equilibrium

(vi) The centre of gravity of solid hemisphere of radius R from its base is. [CO4]
(a) 3R/8 (b) R/2 (c) 3R/4 (d) 2R

(vii) The value of kinetic friction is normally. [CO5
(a) greater than static friction (b) less than static friction
(c) equal to static friction (d) equal to zero

(viii) 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. [CO5]
(a) 165 MPa (b) 200 MPa (c) 660 MPa (d) 180 MPa

(ix) The area under the acceleration- displacement (a-s)curve represents the. [CO6]
(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.

(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. [CO6]
(a) 2 km (b) 3 km (c) 4 km (d) 6 km

Group - B

2. (a) A force F acts from B (8, -3, 0) to D (0, 0, 6) and produces a moment of 840 Nm about an axis directed from A (12, 0, 0) to E (0, 4, -6). Compute the magnitude of F. The coordinates are in 'mm'. [(CO1) (analyze/IOCQ)]
(b) State and proof Varignon's theorem. [(CO1) (analyze/LOCQ)]

8 + 4 = 12

3. (a) A force is specified by the vector F = 145i + 60j -110k N. Calculate the angles made by F with the positive x, y and z axes. [(CO1) (analyze/IOCQ)]
(b) A force given by F = -3i + 5j – 6k N is applied at the point P (1m, -1m, 2m). Find the moment of the force F about the point O (2m, -1m, 3m).
[(CO1) (analyze/IOCQ)]

6 + 6 = 12

Group - C

4. (a) Two identical rollers, each of weights 210 N are supported by an inclined plane and a vertical wall as shown in Fig. 1. Assuming smooth surfaces, find the reactions induced at the points of supports A, B, C and D.

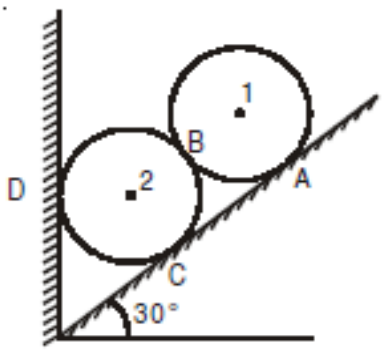

Fig. 1. [(CO2) (Evaluate/HOCQ)]

(b) Three bars are hinged at A, D and pinned at B,C as shown in Fig.2 of a four link mechanics. Find out the value of P so that there is no movement in mechanism.

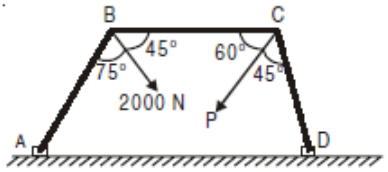

Fig. 2 [(CO2) (Evaluate/HOCQ)]

6 + 6 = 12

5. (a) Determine the magnitude and direction of the friction force acting on the 100-kg block shown in Fig. 3.If, first, P = 500 N and, second, 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.

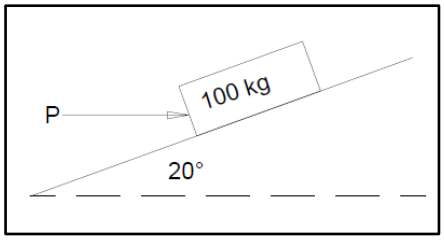

Fig. 3. [(CO3) (Evaluate/HOCQ)]

(b) Explain angle of friction with a neat sketch for dry friction. [(CO3) (Understand/LOCQ)]

8 + 4 = 12

Group - D

6 (a) Find out the centroid of the area shown in Fig.4 with respect to the given axes.

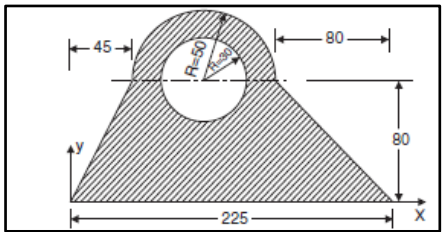

Fig. 4. [(CO5) (Analyze/IOCQ)]

(b) Discuss the concept of centre of gravity. Find out its expression from the concept of principle of moment theory. [(CO5) (Analyze/IOCQ)]

6 + (2 + 4) = 12

7. (a) The bar shown in Fig. 5 is tested in universal testing machine. It is observed that at a load of 40 kN, the total extension of the bar shown is 0.280 mm. Determine the Young's modulus ofthe material.

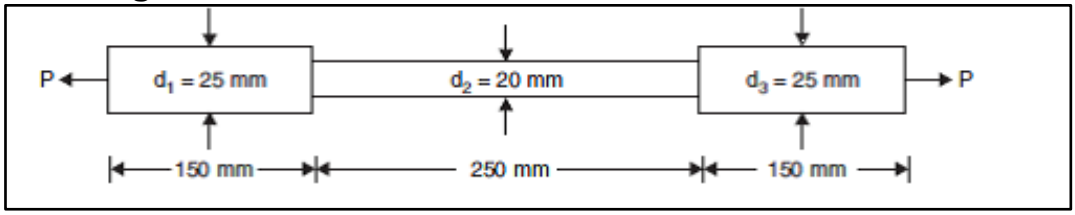

Fig. 5 [(CO4) (Evaluate/HOCQ)]

(b) Write down Hooke's law for stress and strain. Explain Poisson's ratio with expression. [(CO4) (Understand/LOCQ)]

7 + (2 + 3) = 12

Group - E

8. (a) The acceleration of a particle at any point A is expressed by the relation a = 200 x (1 + kx^2), where a and x are expressed in m/s^2 and metres respectively and k is a constant. If the velocity of the particle at A is v_A = 2.5 m/s when x = 0 and v_A = 5 m/s when x = 0.15 m, find the value of k. [(CO6) (Analyze/IOCQ)]

(b) A long-range artillery rifle at A is aimed at angle of 45° with the horizontal, and its shell is just able to clear the mountain peak at the top of its trajectory as shown in Fig. 6. Determine the magnitude u of the muzzle velocity, the height H of the mountain above sea level, and the range R to the sea.

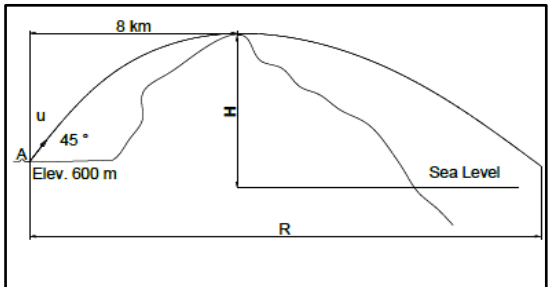

Fig. 6 [(CO6) (Analyze/IOCQ)]]

4 + 8 = 12

9. (a) 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. 7. Determine the cart speed as it passes point B.

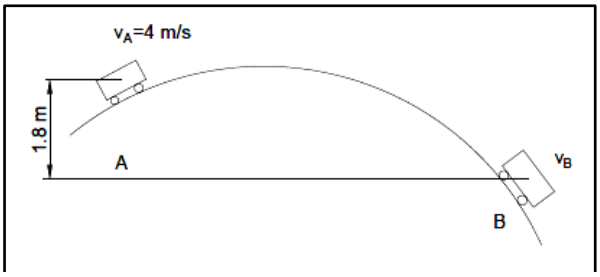

Fig. 7 [(CO6) (Evaluate/HOCQ)]

(b) Write down the work energy principle and explain all the terms. [(CO6) (Understand/LOCQ)]

8 + 4 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	25%	43.75%	31.25%

Course Outcome (CO):

After the completion of the course students will be able to

CO1: Understand basic concepts of vector algebra as applied to engineering mechanics.

CO2:Draw free body diagram of a system under equilibrium.
CO3:Understand friction phenomenon and calculate friction loss.
CO4:Understand and quantify elastic behavior of deformable bodies.
CO5:Know how to calculate the CG location required for design of structures.
CO6:Apply the principles of work-energy for analysis of dynamic systems.

Department & Section	Submission Link
Backlog	Submission link: https://classroom.google.com/c/NDA1MzEzNDg4MDk2/a/NDc1MTQ0NzQyNTg3/details Classroom link: https://classroom.google.com/c/NDA1MzEzNDg4MDk2?cjc=4u73hbh