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) The moment of a couple is an example of [CO1]
(a) Fixed vector (b) Free vector
(c) Sliding vector (d) Null vector

(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) Two vectors 3i-4j+2k and 2i+xj+k are orthogonal when the value of x is [CO1]
(a) 15 (b) -14 (c) 6 (d) 2.

(iv) Self-weight of a block resting on an inclined plane will act- [CO2]
(a) vertically downward (b) horizontally
(c) along the incline (d) normal to the incline.

(v) The friction at which the body just starts to move on a real plane is called [CO3]
(a) Kinetic friction (b) Limiting friction
(c) internal friction (d) static friction.

(vi) Where the centre of gravity of a circle lies? [CO4]
(a) At its centre (b) Anywhere on its radius
(c) Anywhere on its circumference (d) Anywhere on its diameter.

(vii) Out of the following options, the property of material is [CO5]
(a) Young's modulus (b) stress
(c) strain (d) deflection.

(viii) Linear stress and linear strain are directly proportional up to the [CO5]
(a) proportional limit (b) elastic limit
(c) Upper yield point (d) lower yield point.

(ix) The equation of motion of a particle is $s = 2t^3 - t^2 - 2$, where 's' is displacement in meters and 't' is in seconds. Acceleration of the particle after 1 second will be – [CO6]
(a) 8 m/s² (b) 9m/s² (c) 10m/s² (d) 5m/s².

(x) D'Alembert's principle is useful for [CO6]
(a) determination of stresses in the truss
(b) solving kinematic problems
(c) reducing kinetics problems into equivalent statics form
(d) stability of floating body.

Group–B

2. (a) A force F acts from B (-4, -3, 0) to D (0, 2, 6) and produces a moment of 960 Nm about an axis directed from A (8, 0, 0) to E (2, -4, 6). Compute the magnitude of F. The coordinates are in 'mm'. [(CO1) (analyze/IOCQ)]
(b) Explain equivalent vector with suitable example. [(CO1) (Understand/LOCQ)]

8 + 4 = 12

3. (a) Block 'A' weighing 980 N rest over block 'B' which weighs 2000 N as shown in Figure 2. Block A is tied to a wall with a horizontal string. If the coefficient of friction between A and B is ¼ and that between B and the floor is 1/3, what value of force P is required to create impending motion if (a) P is horizontal, (b) P acts 30° upward to horizontal? [(CO2) (analyze/IOCQ)]
(b) Two smooth spheres of weight *W* and radius *r,* each are in equilibrium in a horizontal channel of A and B vertical sides as shown in Fig. 1, find the force exerted by each sphere on the other. Calculate these values, if 'r' = 150 mm, 'b' = 400 mm and 'W' = 100 N. [(CO2) (analyze/IOCQ)]

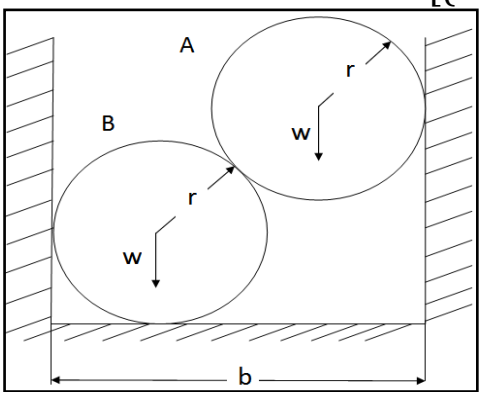

Fig.1

6 + 6 = 12

Group - C

4. (a) A smooth sphere of mass 75 kg is held in a position by means of a vertical wall and an inclined plane as shown in Fig.2. Assuming the supports are frictionless, calculate the reactions exerted by the supports. [(CO2)(Evaluate/HOCQ)]

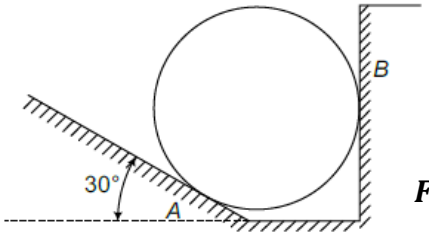

Fig. 2

(b) Two cylinders of diameter 100 mm and 50 mm, weighing 200 N and 50 N, respectively are placed in a trough as shown in Fig.3. Neglecting friction, find the reaction at contact surface 1, 2, 3 and 4. [(CO2) (Analyze /IOCQ)]

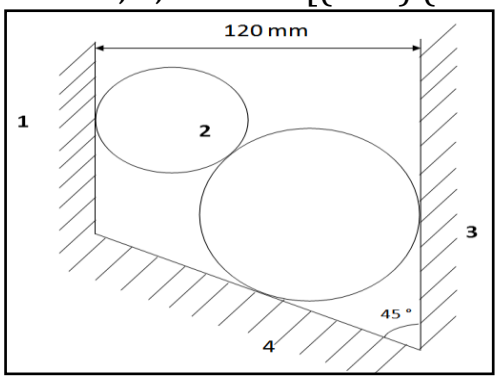

Fig.3

6 + 6 = 12

5. (a) A 100 kg block is on an inclined plane of 30° as shown in Fig.4. The coefficient of static friction between the block and the plane is 0.4. Determine the value of m for which the system will be in equilibrium. [(CO3) (Evaluate/HOCQ)]

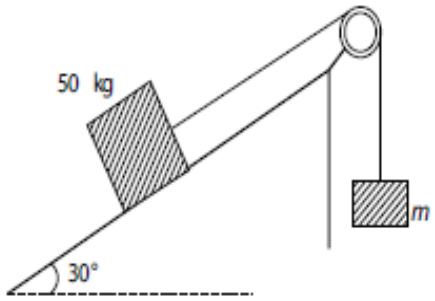

Fig.4

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

8 + 4 = 12

Group - D

6. (a) Find the centre of gravity of a channel section 100 mm x 50 mm x 15mm as shown in Fig. 5.: [(CO5) (Evaluate/HOCQ)]

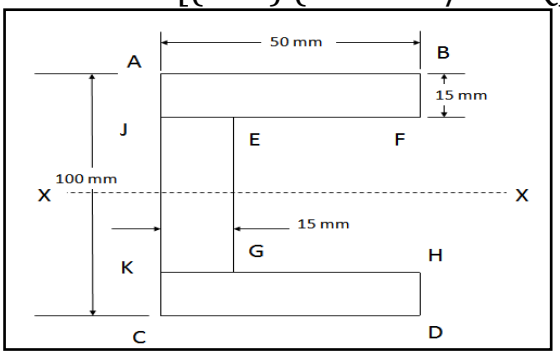

Fig.5

(b) A bar of brass 20 mm is enclosed in a steel tube of 40 mm external diameter and 20 mm internal diameter. The bar and the tubes are initially 1.2 m long and are rigidly fastened at both ends using 20 mm diameter pins. If the temperature is raised by 60 °, find the stresses induced in the bar, tube and pins

Given –

$E_s = 2.1 \times 10^5$ N/mm^2
$E_b = 1.1 \times 10^5$ N/mm^2
$\alpha_S = 11.6 \times 10^{-6}$/ °C
$\alpha_b = 18.7 \times 10^{-6}$ /°C [(CO5) (Analyze/IOCQ)]

6 + (2 + 4) = 12

7. (a) A stepped steel bar of varying cross-section (rectangular) is loaded as shown in Fig. 6. Calculate the total deformation. Take E = 2 × 10^5 N/mm2. The magnitude of different forces are P_1 = 100 kN, P_2 = 80 kN and P_3 = 50 kN. [(CO4) (Evaluate/HOCQ)]

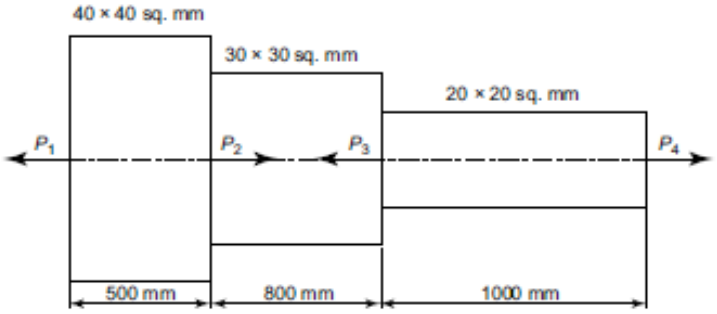

Fig.6

(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 bullet is fired at an angle of 30^0 up the horizontal with velocity 100 m/s from the top of a tower, 50 m high as shown in Fig.7. Determine: (i) The time of flight (ii) The horizontal range along the ground (iii) The maximum height the bullet can attain from the ground (iv) The velocity of the bullet after 6 sec. Assume horizontal ground at the foot of the tower. [(CO6) (Analyze/IOCQ)]]

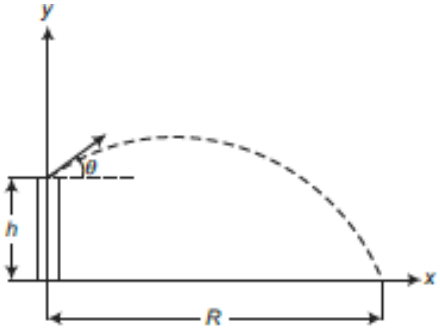

Fig.7

4 + 8 = 12

9. (a) A particle, starting from rest, moves in a straight line, whose acceleration is given by the equation : a = 10 – 0.009 s^2, where (a) is in m/s^2 and (s) in metres.

Determine (i) velocity of the particle, when it has travelled 50 metres. (ii) distance travelled by the particle, when it comes to rest.

[(CO6) (Evaluate/HOCQ)]

(b) A train weighing 54,000 kg slides down 28m along an inclined track as shown in Fig.8. When the train comes down at B and strikes a bumper-spring and stops, determine the compression of the spring. Assume the frictional resistance to be 4/987 th of the weight of the train and spring constant k = 13.6kN/mm.

[(CO6) (Evaluate/HOCQ)]

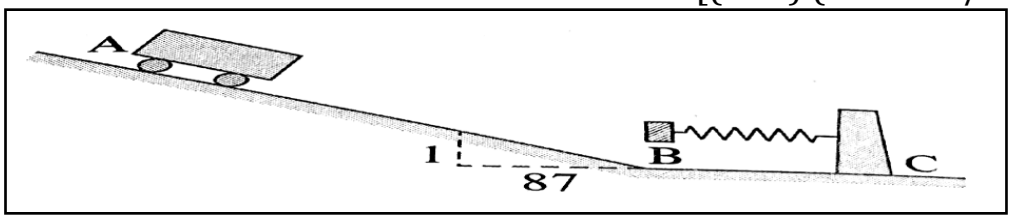

Fig.8

6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	18.75%	43.75%	37.50%

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
CHE	https://classroom.google.com/c/NDA1MzMwMTMzNjk1?cjc=satht64
EE	https://classroom.google.com/c/NDA1MzEzNDg4MDk2/a/NDYzODIyMjEzNzg4/details