ENGINEERING MECHANICS
(MECH 2101)

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 resultant of forces $\boldsymbol{P} = -2\boldsymbol{i} - 3\boldsymbol{j}$ and $\boldsymbol{Q} = 3\boldsymbol{i} - 4\boldsymbol{j}$ will lie in _____ quadrant (quadrant to be reckoned anticlockwise) (CO1)
(a) first (b) second (c) third (d) forth.

(ii) If the resultant of two equal forces have the same magnitude as either of the forces, then the angle between the two forces is (CO1)
(a) 60° (b) 30° (c) 90° (d) 120°

(iii) Three forces $\sqrt{3}p, p$ and $2p$ on a particle are in equilibrium. If the angle between first and second be 90°, the angle between second and third will be (CO2)
(a) 30° (b) 60° (c) 120° (d) 150°.

(iv) Limiting friction depends on (CO3)
(a) materials of the body in contact
(b) weight of the body to be moved
(c) roughness of surface contact of two bodies
(d) all of the above.

(v) The ratio of limiting friction and reaction is known as (CO3)
(a) coefficient of friction (b) angle of friction
(c) angle of repose (d) sliding friction

(vi) Moment of inertia is always the least with respect to (CO5)
(a) bottom most axis (b) radius of gyration
(c) top most axis (d) centroidal axis.

(vii) When a body slides down an inclined surface (angle of inclination = θ), the acceleration f of the body is given by (CO4)
(a) $f = g$ (b) $f = g \sin\theta$
(c) $f = g \cos\theta$ (d) $f = g / \sin\theta$

(viii) The unit of energy is (CO6)
(a) Joule (b) Watt (c) Joule/sec (d) Watt/sec.

(ix) A jet engine works on the principle of conservation of (CO6)
(a) energy (b) mass
(c) angular momentum (d) linear momentum.

(x) The ratio of the moment of inertia of a circular plane about its x-axis to that about the y-axis is (CO5)
(a) 0.5 (b) 1.0 (c) 1.5 (d) 2.0.

Group–B

2. (a) State Varignon's theorem. [(CO1) (Remember/LOCQ)]
(b) A force is specified by the vector $\boldsymbol{F} = 80\boldsymbol{i} - 40\boldsymbol{j} + 60\boldsymbol{k}$lb. calculate the angles made by $\boldsymbol{F}$ with the x, y, z-axes. [(CO1) (Analyze/IOCQ)]
(c) A force vector $\boldsymbol{F} = 10\boldsymbol{i} + 25\boldsymbol{j} + 35\boldsymbol{k}$ passes through a point (2, 5, 7). Prove that the force is also passing through the origin. [(CO1)(Evaluate/HOCQ)]

2 + 5 + 5 = 12

3. (a) Define displacement vector. [(CO1)(Understand/LOCQ)]
(b) Determine the moment of the 200 N force which acts from point D to point E, about point B as shown in the Fig.1 below. [(CO1)(Analyse/IOCQ)]

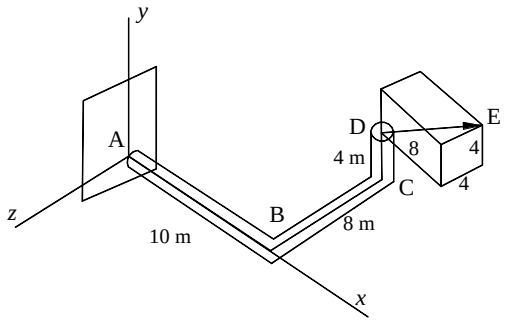

Fig.1

(c) Two equal loads of 2500 N are supported by a flexible string ABCD at points B and C as shown in Fig.2. Find the tensions in the portions AB, BC, CD of the string. [(CO2)(Evaluate/HOCQ)]

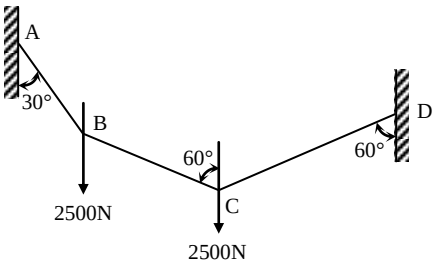

Fig.2

2 + 5 + 5 = 12

Group - C

4. (a) Two identical rollers, each of weight Q = 100 kgf, are supported by an inclined plane and a vertical wall a shown in Fig 3. Assuming smooth surfaces, find the reactions induced at the points of support A, B and C. [(CO2) (Analyze/IOCQ)]

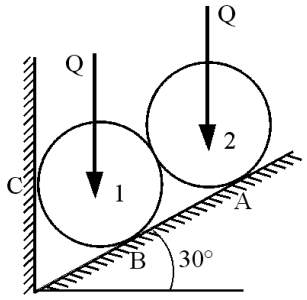

Fig.3

(b) A 150 kg man stands on the mid-point of a 50 kg ladder as shown in Fig.4. Assuming that floor and the wall are perfectly smooth, find the reactions at points *A* and *B*. [(CO2) (Analyze/IOCQ)]

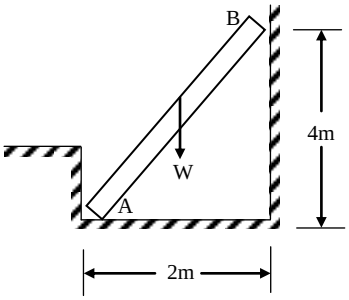

Fig. 4

6 + 6 = 12

5. (a) A nail has to be removed from the ground by the nail diver as shown in Fig 5. If the applied force at *A* is *F* = 25 N, calculate the force *(R_c)* applied on the nail. [(CO2)(Analyze/IOCQ)]

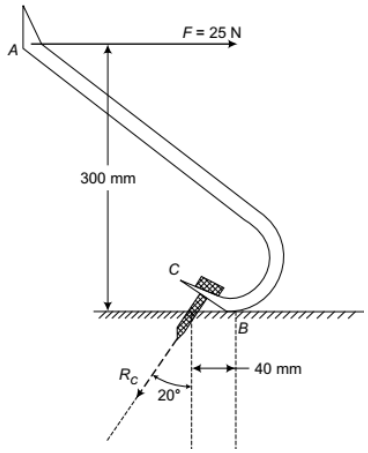

Fig.5

(b) Determine the magnitude and direction of the friction force acting on the 100-kg block shown in Fig. 6 when (i) P = 500 N and, (ii) P = 100 N. The coefficient of static friction is 0.20, and the coefficient of kinetic friction is 0.17. The forces are applied with the block initially at rest. [(CO3) (Analyze/IOCQ)]

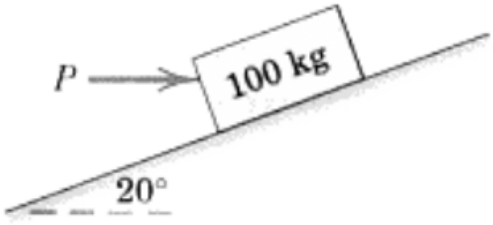

Fig.6

6 + 6 = 12

Group - D

6. (a) Define angle of repose. [(CO3) (Remember/LOCQ)]

(b) Refer to the Fig.7, determine the range of values of mass m_0 so that the 100 kg block will neither move up nor slip down the inclined plane. The coefficient of static friction for the surfaces in contact is 0.3. [(CO3) (Analyze/IOCQ)]

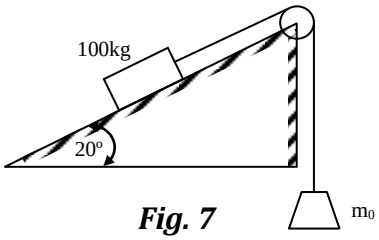

Fig. 7

(c) Two rectangular blocks of weights W_1 and W_2 are connected by a flexible cord and rest upon a horizontal and an inclined plane, respectively, with the cord passing over a pulley as shown in the next Fig.8. In the particular case where $W_1 = W_2$ and the coefficient of static friction μ is the same for all contiguous surfaces, then find the angle α of inclination of the inclined plane at which motion of the system will impend. Neglect friction in the pulley. [(CO3)(Evaluate/HOCQ)]

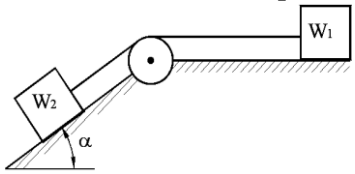

Fig. 8

2 + 5 + 5 = 12

7. (a) Compare and contrast moment and second moment about an axis. [(CO5)(Remember/LOCQ)]

(b) Determine the moment of inertia of the shaded area with respect to the *x-axis* passing through the point *O* as shown in Fig. 9. [(CO5)(Analyze/IOCQ)]

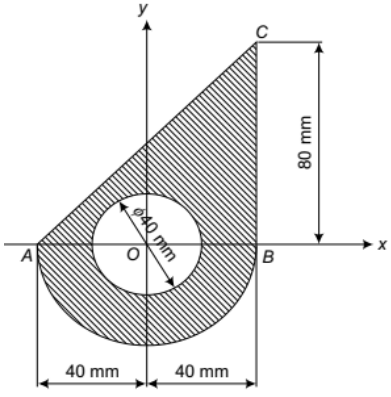

Fig. 9

(c) A block of weight W_1 = 400 N rests on the horizontal surface and supports on top of it, another block of weight W_2 = 100 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 Fig. 10, which will be necessary to cause slipping to impend. Take coefficient of static friction for all contiguous surfaces is μ= 0.3. [(CO3)(Evaluate/HOCQ)]

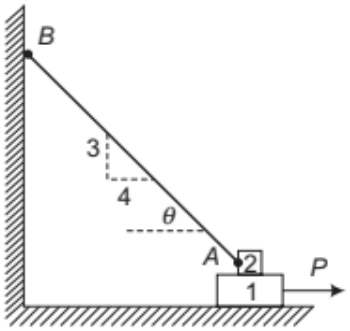

Fig. 10

2 + 5 + 5 = 12

Group – E

8. (a) A bullet is fired from a rifle with an initial velocity of 50 m/s so as to just clear a vertical wall of 20 m high and located at a distance of 30 m measured horizontally from the point of projection. Estimate the **two angles of projection** with horizontal. [(CO4) (Evaluate/HOCQ)]

   (b) A bullet loses 1/20th of its velocity in passing through a wooden plank. Determine how many such uniform planks it would pass through before coming to rest. Assume that the resistance offered by the planks is uniform. [(CO6) (Analyze/IOCQ)]

6 + 6 = 12

9. (a) Two blocks of weights *P* and *Q* are connected by a flexible but inextensible cord and supported as shown in Fig. 11. If the co-efficient of friction between the block *P* and the horizontal surface is μ (mu) and all other friction is negligible, find (a) the acceleration of the system and (b) the tensile force *S* in the cord. The following numerical data are given *P* = 53.4N; *Q* = 26.7N, $\mu = \frac{1}{3}$.

[(CO6) (Evaluate/HOCQ)]

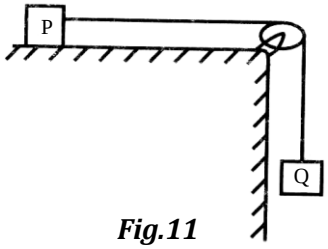

Fig.11

(b) A 50N block is released from rest on an inclined plane which is making an angle of 35° to the horizontal (Fig.12). The block starts from 'A' slides down a distance of 1.2 m and strikes a spring with a stiffness of 8 kN/m. The co-efficient of friction between the inclined plane and the block is 0.25. Determine (i) the amount the spring gets compressed and (ii) distance of the block will rebound up the plane from the compressed position. [(CO4)(Analyze/IOCQ)]

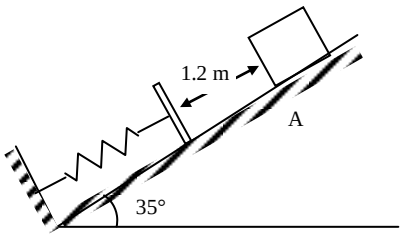

Fig. 12

6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	20%	55%	25%

Course Outcome (CO):

After the completion of the course, students will be able to

1. Describe basic concepts of vector algebra as applied to engineering mechanics.
2. Construct a free body diagram of a system under equilibrium.
3. Interpret the friction phenomenon and calculate friction force.
4. Execute dynamics of members/links in a mechanism and inertia force with the help of D'Alembert's principle.
5. Develop the steps to calculate the centroid and MI values required for designingstructures.
6. Implement the principles of work-energy and impulse-momentum for analysis of dynamic systems.

*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question

Department & Section	Submission Link
ME - A	https://classroom.google.com/c/NDAzODI4NjgwMDc0/a/NDc1MDY5MzY0MDMw/details
ME - B	https://classroom.google.com/c/NDAzODY2MDkzMzMy/a/NDY4MjcwNjc3MjQ4/details