

***B.Tech. Degree I Semester Regular/Supplementary Examination in
Marine Engineering December 2024***

**19-208-0104 ENGINEERING MECHANICS
(2019 Scheme)**

Time: 3 Hours

Maximum Marks: 60

Course Outcome

On successful completion of the course, the students will be able to:

- CO1: Understand the basic principles of statics and learn general and conventional procedure to solve problems involving equilibrium of forces.
- CO2: Ascertain the physical and mathematical meaning of quantities, like centroid, moment of inertia and their applications in engineering, assimilate the principle of virtual work as a powerful tool in analysis of structures in equilibrium and analyze structures carrying two-force and multi-force members.
- CO3: Refresh and reinforce the basics of rectilinear translation and conceive the idea of the D'Alembert's principle as an ideal method to solve kinetic problems.
- CO4: Refresh and reinforce the basics of curvilinear translation and rotation of rigid bodies and familiarize their applications in engineering.
- CO5: Understand the rotational mechanics and apply them in solving engineering problems.

Bloom's Taxonomy Levels (BL): L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 – Create

PI – Programme Indicators

(Answer ALL questions)

(5 × 15 = 75)

- | | Marks | BL | CO | PI |
|---|-------|----|----|----|
| I. (a) A block P = 5 kg and block Q of mass 'm' kg are suspended through a chord which is in equilibrium as shown in Figure 1. Determine the mass of the block Q. | 10 | L3 | 1 | P1 |

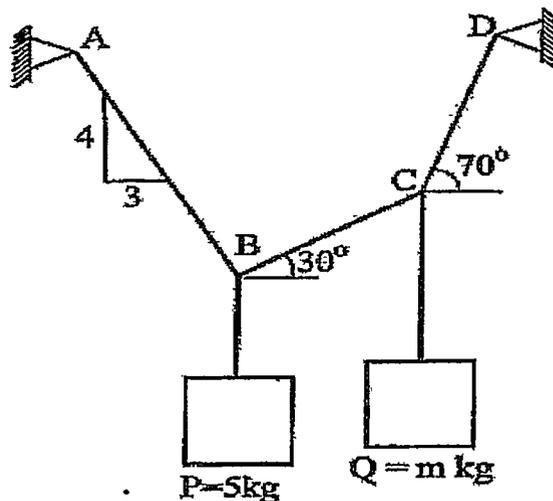


Figure 1

- | | | | | |
|--|---|----|---|---|
| (b) Explain principle of superposition and principle of transmissibility with help of simple sketches. | 5 | L2 | 1 | 1 |
|--|---|----|---|---|

OR

(P.T.O.)

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Marks	BL	CO	PI
10	L3	1	2

- II. (a) A uniform ladder 6 m long weighing 300 N, is resting against a wall with which it makes 30° as shown in Figure 2. A man weighing 750 N climbs up the ladder. At what position along the ladder from the bottom end does the ladder slips? The coefficient of friction for both the wall and the ground with the ladder is 0.2.

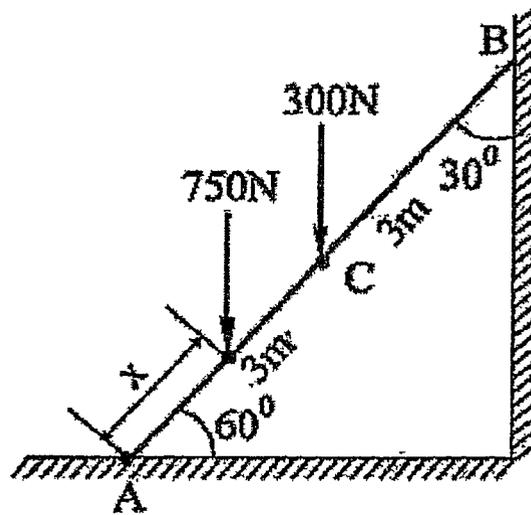


Figure 2

- (b) Explain Pappus theorems. 5 L2 1 1

- III. (a) Determine the force in the bars of the simple truss loaded and supported as shown in Figure 3. ABC is an equilateral triangle. 10 L3 2 1

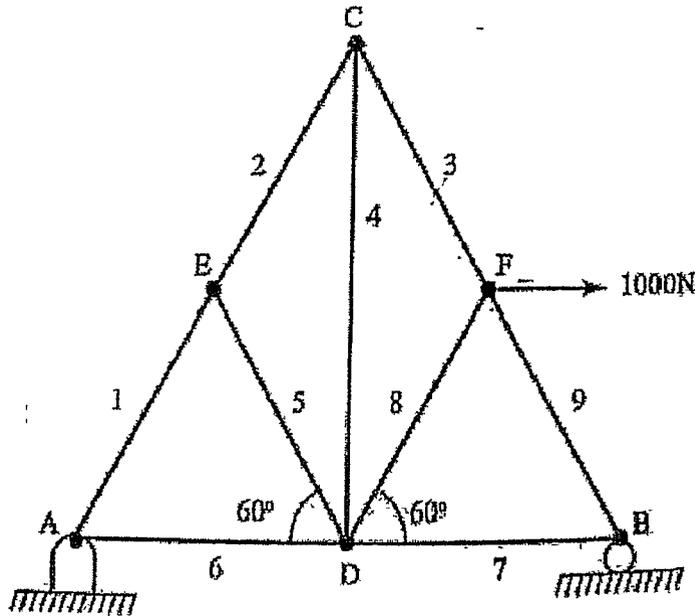


Figure 3

- (b) Explain parallel axis theorem and perpendicular axis theorem. 5 L2 2 1

OR

(Continued)

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- | | Marks | BL | CO | PI |
|---|-------|----|----|----|
| IV. (a) Using the principle of virtual work, find the reaction at D for the system shown in Figure 4, below for any position of a vertical load P on the beam AC as defined by its distance x from A. | 10 | L3 | 2 | 2 |

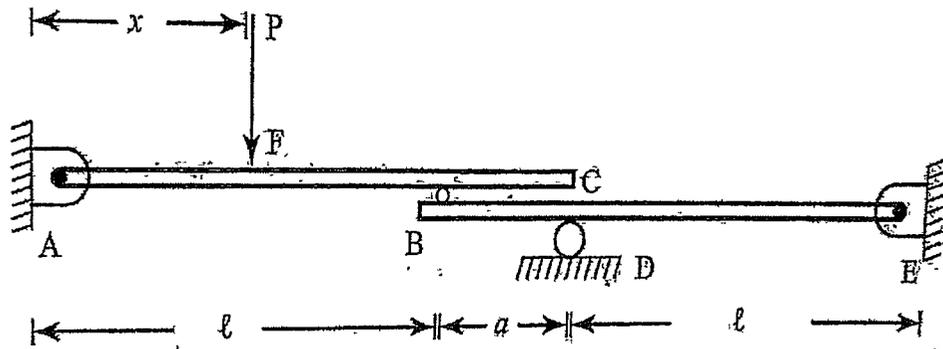


Figure 4

- | | | | | |
|---|---|----|---|---|
| (b) Find the moment of inertia of cross-section of an iron beam as shown in Figure 5 with respect to the centroidal axes. | 5 | L3 | 2 | 2 |
|---|---|----|---|---|

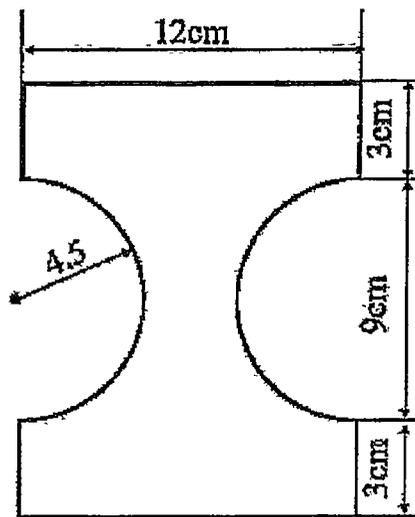


Figure 5

(P.T.O.)

V. (a) For the pile and pile driver shown in Figure 6, the following numerical data are given :

$W_1 = 8896 \text{ N}$, $W_2 = 4448 \text{ N}$, $h = 3.05 \text{ m}$ and the coefficient of restitution, $e = 0.25$. If the resistance to penetration is constant and equal to $2,66,880 \text{ N}$, how many blows of the hammer will be required to drive the pile 0.305m ?

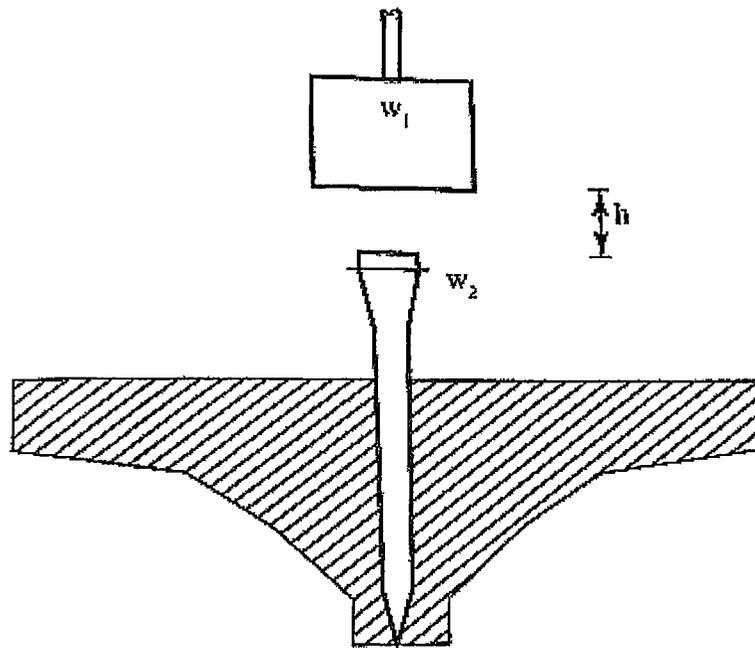


Figure 6

(b) Explain elastic impact, plastic impact and semi elastic impact.

5	L2	3	1
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OR

VI. (a) Two weights W and $2W$ are supported in a vertical plane by a string and pulleys arranged as shown in Figure 7. Find the magnitude of the additional weight Q applied on the left which will give a downward acceleration of $0.1g$ to the weight W . Neglect friction and inertia of the pulleys.

10	L3	3	2
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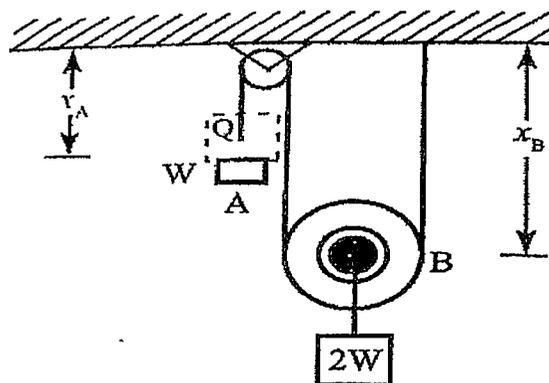


Figure 7

(b) Explain principle of impulse and momentum for a system of particles.

5	L2	3	1
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(Continued)

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Marks BL CO PI

- VII. (a) The 9 N weight of the governor can slide freely on the vertical shaft AB as shown in Figure 8. At what uniform speed about the axis AB will the 4.5 N fly balls lift the sliding weight free of its support? Neglect the weights of the bars and friction.

10

L3

4

1

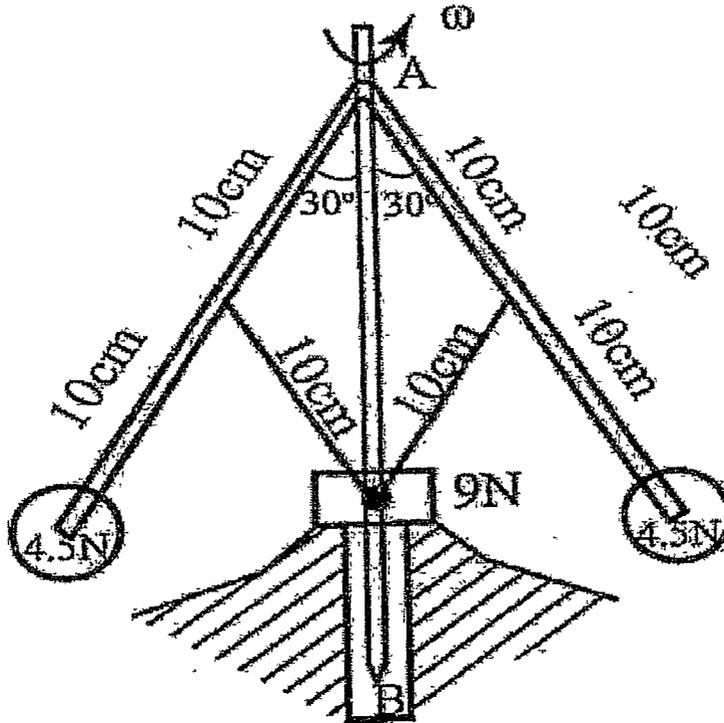


Figure 8

- (b) A mortar having muzzle velocity $V_0 = 215.6$ m/s fires for maximum range across a level plain (Figure 9). Neglecting air resistance, calculate the time of flight of the shell.

5

L3

4

1

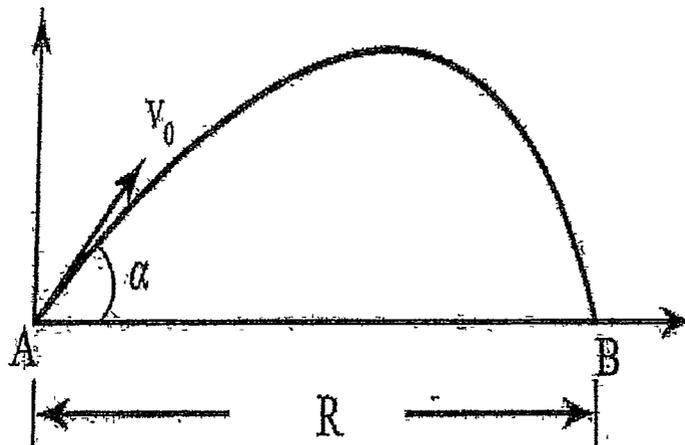


Figure 9

OR

(P.T.O.)

BT MRE-I(R/S)-12-24-3596

Marks	BL	CO	PI
10	L3	4	2

- VIII. (a) A simple pendulum is released from rest in the horizontal position OA and falls under the influence of gravity as shown in Figure 10. If it strikes a vertical wall at B and then rebounds to an angle $\theta = 41^\circ$, find the coefficient of restitution.

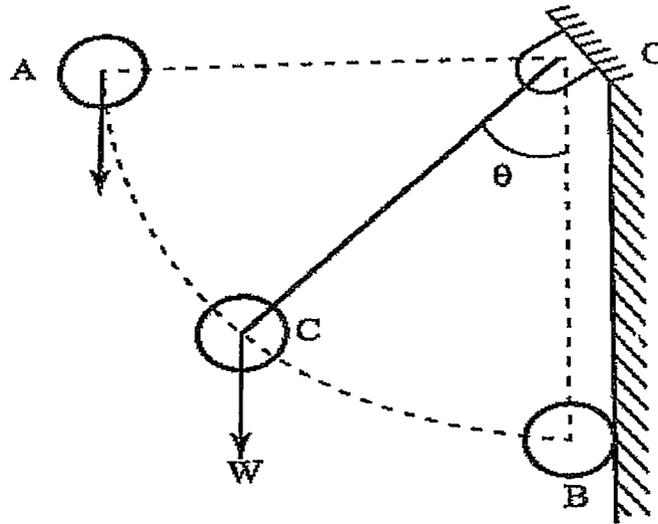


Figure 10

- (b) The pilot of a fighter plane flying horizontally with a constant speed 480 km/hr at an elevation $h = 600$ m targets to bomb a building at B (Figure 11). At what angle θ below the horizontal should he see the targets at the instant of releasing the bomb? Neglect air resistance.

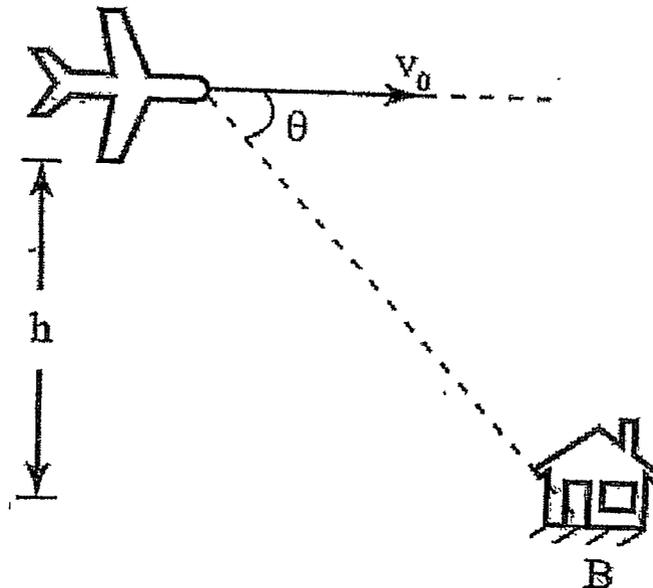


Figure 11

(Continued)

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- IX. (a) A block of weight 59 N attached to a chord which is wrapped around the periphery of a disc of weight 196 N and radius 0.2 m which has a moment of inertia 0.4 kg m^2 about the axis of rotation (Figure 12). If the block is initially moving downwards with a speed of 2 m/s, determine its speed in 3 seconds, neglecting the mass of the string.

Marks	BL	CO	PI
10	L3	5	2

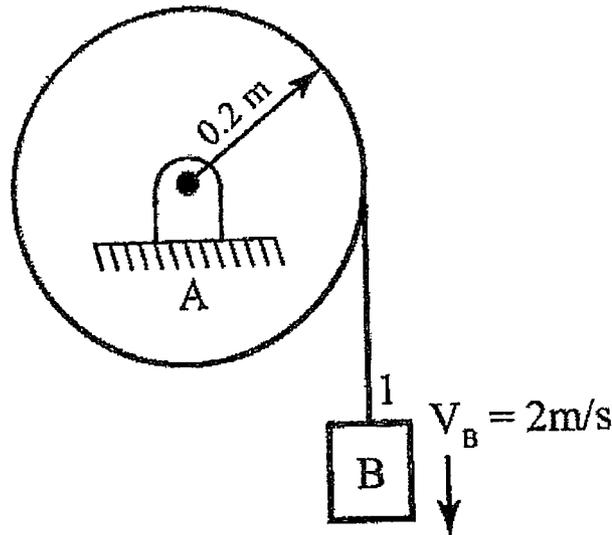


Figure 12

- (b) A homogeneous circular disc of radius r and weight W hangs in a vertical plane from a pin O at its circumference as shown in Figure 13. Find the period for small angles of swing in the plane of the disc.

5	L3	5	2
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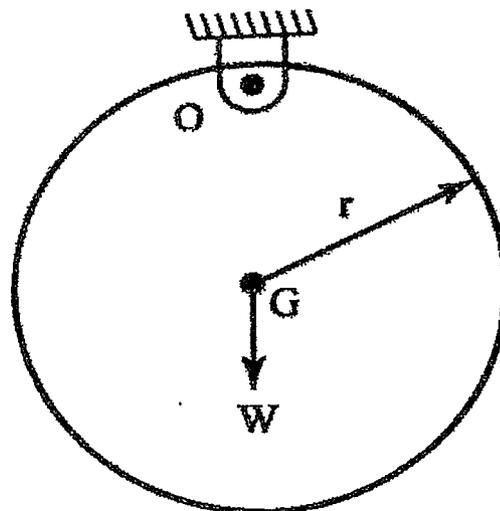


Figure 13

OR

- X. (a) Prove that the change in kinetic energy of a body rotating through an angle θ is equal to the work done by the external moment over the angular displacements θ .
- (b) The armature of an electric motor has angular speed $N = 1800 \text{ rpm}$ at the instant when the power is cut off. If it comes to rest in 6 seconds, calculate the angular deceleration ' α ' assuming it to be constant. How many complete revolutions does the armature make during this period?

10	L2	5	2
5	L3	5	2

Bloom's Taxonomy Level
L2 – 23%, L3 – 77%.