JHARKHAND Rai University RANCHI

PRACTICE SET
End Semester Examination, December, 2025

Program: B. Tech
Branch: Mining Engineering
Semester: III
Subject: Engineering Mechanics
Subject Code: 8ESC201

Course Outcome:
After the completion of the course, student will be able to:

Course Outcomes	Description
CO1	To understand the basic concepts of force systems & its various force analysis.
CO2	Understand the static equilibrium of particles and rigid bodies both in two dimensions and three dimensions.
CO3	Analyze the properties of surfaces & solids in relation to moment of inertia.
CO4	Illustrate the laws of motion, kinematics of motion and their interrelationship.
CO5	Understand Kinetics of Rigid Bodies & Free and forced vibrations.

UNIT I
Section A (5 marks)

1. Define the term 'Force'. What is principle of transmissibility? CO1 **Remember**
2. Explain System of Forces with diagram.CO1 **Understand**
3. State Lami's theorem and Varignon's theorem.CO1 **Remember**
4. State triangle law of forces and polygon law of forces.CO1 **Understand**
5. State the characteristics of force. Distinguish between concurrent force system & non-current force system.CO1 **Understand**
6. The greatest and least resultant of two forces acting on a body are 40 kN and 10 kN respectively. Determine the magnitude of the forces. What would be the angle between these forces if the magnitude of the resultant is 35 kN ? CO 1 **Evaluate**
7. Find the magnitude of the two forces, such that if they act at right angles, their resultant is √(30) N but if they act at 30°, their resultant is √(45) N. CO1 **Evaluate**

Section B (10 marks)

8. State and prove parallelogram law of forces. A triangle ABC has its side AB = 40 mm along positive x-axis and side BC = 30 mm along positive y-axis. Three forces of 40 N, 50 N and 30 N act along the sides AB, BC and CA respectively. Determine magnitude of the resultant of such a system of forces.CO1 **Evaluate**
9. Determine the magnitude and direction of the resultant of the following set of forces acting on a body
   (i) 300 N inclined 30° with east towards north.
   (ii) 200 N towards the north,
   (iii) 350 N towards north west, and

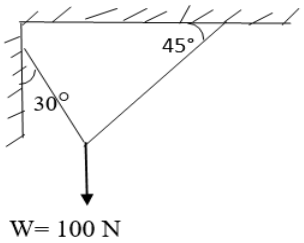
(iv) 400 N inclined at 40°. CO1 **Apply**

Section C (20 marks)

10.

a) The resultant of two forces one of which is double the other is 260 N. If the direction of the larger force is reversed and the other remains unaltered, the resultant reduces to 180 N. Determine the magnitude of the forces and the angle between them.CO1 **Evaluate**

b) A weight of 100 N hangs from a point C by means that the strings AC and BC as shown in figure below. Using Lami's theorem determine the forces in the string.CO1 **Evaluate**



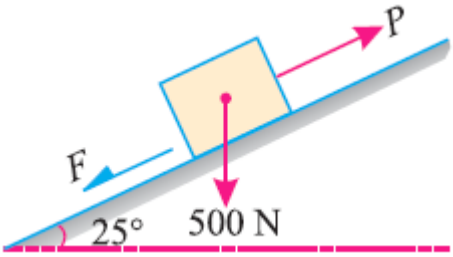
Unit II

Section A (5 marks)

11. Define Limiting friction, angle of friction, angle of repose and co-efficient of friction. CO2 **Understand**

12. Define the term friction? What are the different types of friction? CO2 **Remember**

13. A body of weight 500 N is lying on a rough plane inclined at an angle of 25° with the horizontal. It is supported by an effort (P) parallel to the plane as shown. Determine the value of P, for which the equilibrium can exist, if the co-efficient of friction between the body and the plane is 0.25.CO2 **Evaluate**



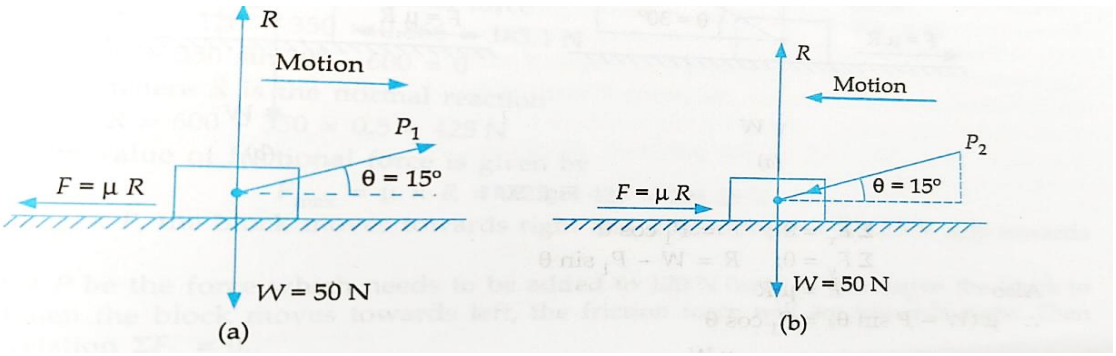
14. A body of weight 500 N is pulled up an inclined plane, by a force of 300 N. The inclination of the plane is 30° to the horizontal and the force is applied parallel to the plane. Find the coefficient of friction.CO2 **Evaluate**

Section B (10 marks)

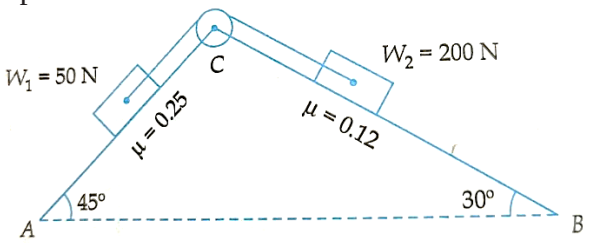
15. Derive the equation for equilibrium of a body on a rough inclined plane subjected to a force acting at an angle θ with the inclined plane.CO2 **Apply**

16. Elaborate the laws of friction. A body of weight 300 N is lying on a rough horizontal plane having a coefficient of friction as 0.3. Find the magnitude of the force, which can move the body, while acting at an angle of 25° with the horizontal.CO2 **Evaluate**

17. A wooden block of weight 60 N rests on a horizontal plane. Determine the force required to just (a) pull it, and (b) push it. Take co-efficient of friction 0.4 between the mating surfaces. Comment on the result. CO2 **Apply**



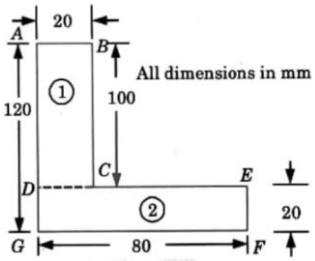
18. Two blocks of weight 50 N and 200 N and connected by a cord rest on two inclined planes as shown in figure. Determine the maximum tension in the cord when limiting friction conditions develop for both the blocks. **CO2 Evaluate**



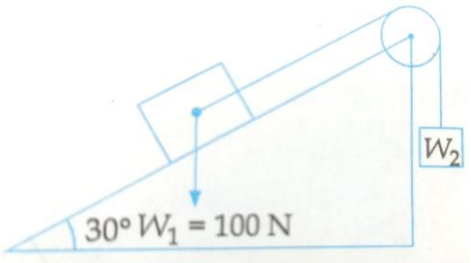
Section C (20 marks)

19. a) A screw jack has mean diameter of 70 mm and pitch of 15 mm. If the co-efficient of friction between its screw and nut is 0.15. Find the effort required at the end of 800 mm long handle to raise a load of 15 kN. Also find the effort to lower the same load.

b) Locate the centroid of L- section as shown in figure. **CO 2 Evaluate**



20. A block of weight $W_1 = 100N$ rests on an inclined plane and another weight W_2 is attached to the first weight through a string as shown in Fig. If the coefficient of friction between the block and plane is 0.3, determine the maximum and minimum values of W_2 so that equilibrium can exist. **CO 2 Evaluate**



Unit III

Section A (5 marks)

21. State parallel axis theorem and perpendicular axis theorem with diagram.CO3 **Understand**

22. What is moment of inertia and radius of gyration? CO3 **Remember**

Section B (10 marks)

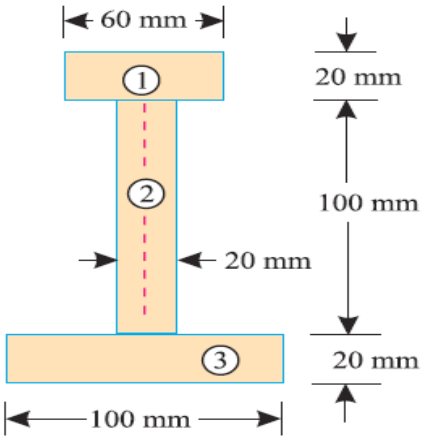
23. Derive moment of inertia of a rectangular section of width 'b' and depth 'h'. Find the moment of inertia of a hollow rectangular section about its Centre of gravity if the external dimensions are breadth 60 mm, depth 100 mm and internal dimensions are breadth 40 mm and depth 60 mm respectively.CO3 **Evaluate**

24. Derive moment of inertia of a triangular section of base 'b' and height 'h'.CO4 **Evaluate**

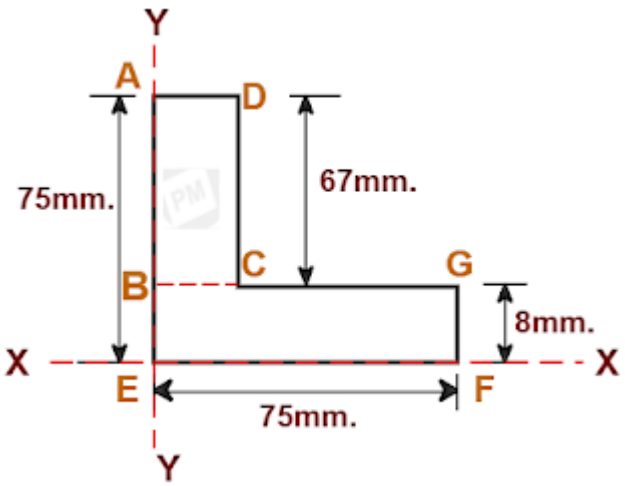
25. The moment of inertia of rectangular section beam about x-x and y-y axes passing through the centroid are 250 x 10^6 mm^4 and 40 x 10^6 mm^4 respectively. Calculate the size of the section. CO 3 **Evaluate**

Section C (20 marks)

26. An I-section is made up of three rectangles as shown in Figure. Find the moment of inertia of the section about the horizontal axis passing through the center of gravity of the section.**CO3 Evaluate**



27. A L-section is made up of two rectangles as shown in Figure. Find the moment of inertia of the section about the Horizontal axis & Vertical axis passing through the center of gravity of the section.**CO3 Evaluate**



Unit IV

Section A (5 marks)

28. Define momentum, describe impulse-momentum relation. CO 4 **Understand**

29. Define rectilinear motion and curvilinear motion with examples. CO 4 **Understand**

30. A bullet of mass 0.1 kg and travelling at a speed of 180 m/s penetrated 10 cm when fired into a wooden log. Determine the velocity with which this bullet would emerge when fired the same velocity into a similar 5 cm thick wooden plank. Also determine the force of resistance assuming it to be uniform. CO 4 **Evaluate**

31. On turning a corner, a motorist rushing at 30 m/s, finds a child on the road 40 m ahead. He instantly stops the engine and applies brakes, so as to stop the car within 10 m of the child. Calculate (i) retardation, and (ii) time required to stop the car.CO4 **Evaluate**

32. A particle, starting from rest, moves in a straight line, whose equation of motion is given by: s = t^4– $6t^3$ + 3t+2. Find the velocity and acceleration of the particle after 6 seconds.CO4 **Evaluate**

33. The motion of a particle is defined by the relations: x = t^2 + 3t and y = t^3 - $8t^2$ +3 where x and y are in meters and *t* is in seconds.

(a) Write the equations defining the motion of the particle in vectorial form.

(b) Calculate the velocity and acceleration of the particle at time *t* = 4 seconds. CO4 **Apply**

Section B (10 marks)

34. A particle moves along a straight line with an acceleration prescribed by the relation ($a = 4t^2 - 3t + 4$) where a is in m/s^2 and *t* is in seconds. The particle has a velocity of 10 m/s at t = 3 seconds, and it is located 12 m to the right of origin at t = 2 seconds. Determine the position and velocity of the particle after 5 seconds. **CO 4 Evaluate**

35. A particle moves in x-y plane and its coordinates are defined by the relations

x = 4- 3cos(t) & y = 2 – 3sin(t)

Where x and y are in meters and time *t* is in seconds:

(a) State the equation of path along which the particle moves, and

(b) Write expressions for position vector, velocity vector and acceleration vector for the particle at the instant when it starts motion. **CO 4Apply**

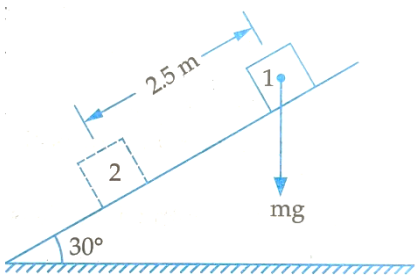
Unit V

Section A (5 marks)

36. Derive the relation which represents work-energy principle**. CO 5 Apply**

37. State D'Alembert's Principle & Newton's second law of motion. CO 5 **Understand**

38. A block of 4kg mass slides from rest at point 1 along a frictionless inclined plane that makes an angle 30˚ with the horizontal. What will be the speed of the block at point 2 which lies at a distance of 2.5 m from point 1? Obtain your solution by the principle of work and energy. CO 5 **Apply**



Section B (10 marks)

39. A block of weight 2000 N rests on a rough horizontal surface (μ = 0.2) and is pulled by a force of 800 N applied at an angle of 30˚ to the horizontal. Determine the velocity attained by the block after it has moved 20 m starting from rest. Proceed to calculate the further distance moved by the body if the pull is removed. Use work-energy relation. CO5 **Evaluate**

40. A train weighing 2.5 x 10^6 N starts from rest with an acceleration of 0.8 m/s^2 and acquires a speed of 80 km/hr. Determine the kinetic energy corresponding to final speed and the average power required.

Subsequently the power is shut off and the train is subjected to a retarding force equal to 8 % of the weight of train. Calculate the distance the train will travel before coming to rest. CO 5 **Evaluate**

Section C (20 marks)

41. Two bodies weighing 400 N and 550 N are hung to the ends of a rope passing over an ideal pulley. With what acceleration would the heavier body come down?

Obtain your solution by using

(i) The principle of impulse and momentum

(ii) The principle of work and energy

(iii) The D' Alembert's principle. **CO 5 Evaluate**

Summary Sheet

CO Wise

CO	Q. No	Marks
CO1	1,2,3,4,5,6,7,8,9,10	75
CO2	11,12,13,14,15,16,17, 18,19,20	100
CO3	21,22,23,24,25,26,27	80
CO4	28,29,30,31,32,33,34,35	50
CO5	36,37,38,39,40,41	55
Total		**360**

Unit Wise

Unit	Q. No	Marks
Unit 1	1,2,3,4,5,6,7,8,9,10	75
Unit 2	11,12,13,14,15,16,17, 18,19,20	100
Unit 3	21,22,23,24,25,26,27	80
Unit 4	28,29,30,31,32,33,34,35	50
Unit 5	36,37,38,39,40,41	55
Total		**360**

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Blooms Taxonomy Level (BTL) Wise

BTL	Q. No	Marks
LOT	1,2,3,4,5,6,7,9,12,13,14,16,18,19,20,21,22,24,25,28,29, 30,31,32,33,34,36	185
HOT	8,10,11,15,17,23,26,27,34,35,37,38,39,40,41	175
Total		**360**

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Disclaimer: - This is a Practice set. The Question in End term examination will differ from the Practice set. This Practice set is meant for practice only.