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DEPARTMENT OF MECHANICAL ENGINEERING ENGINEERING

QUESTION BANK

PROGRAMME	:	B.E. - MECH
ACADEMIC YEAR	:	2024-2025
SEMESTER	:	III (ODD)
REGULATION	:	2021
COURSE CODE	:	ME3351
COURSE NAME	:	ENGINEERING MECHANICS
COURSE COMPONENT	:	CORE
NAME OF THE COURSE IN-CHARGE	:	Mr.S.KRISHNAMOORTHI

UNIT I STATICS OF PARTICLES

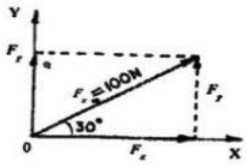
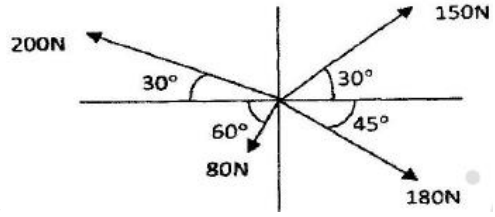
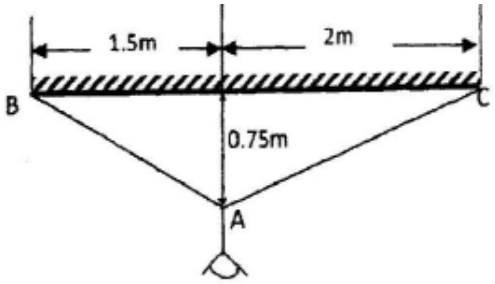
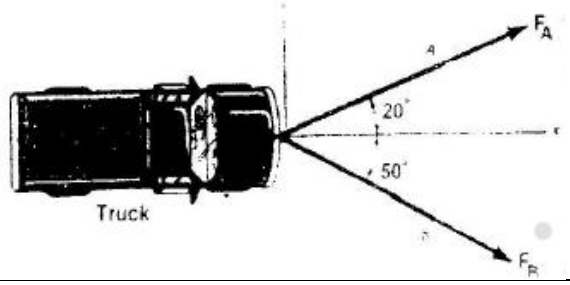
Fundamental Concepts and Principles, Systems of Units, Method of Problem Solutions, Statics of Particles - Forces in a Plane, Resultant of Forces, Resolution of a Force into Components, Rectangular Components of a Force, Unit Vectors. Equilibrium of a Particle- Newton's First Law of Motion, Space and Free-Body Diagrams, Forces in Space, Equilibrium of a Particle in Space.

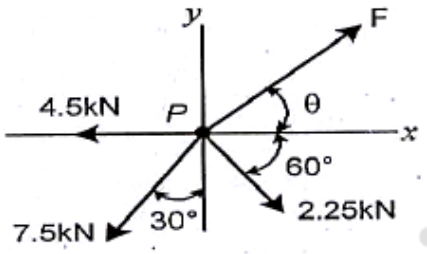
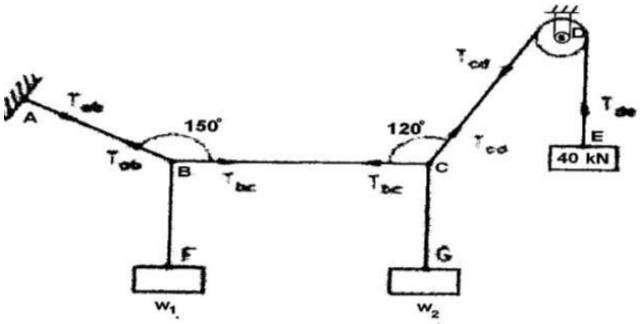
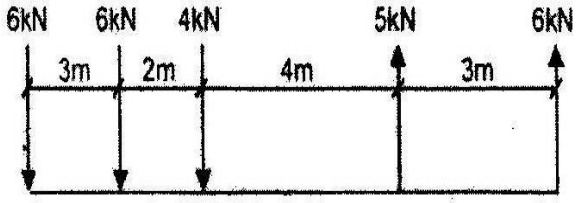
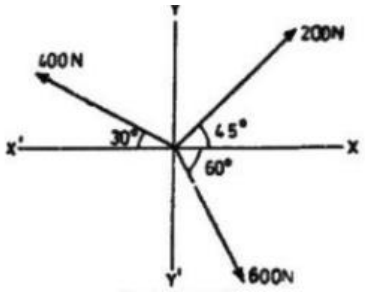
Assessment Questions for UNIT I

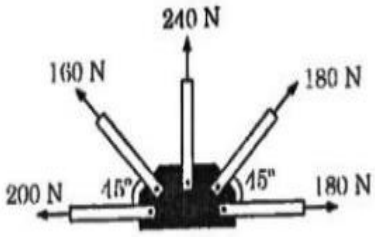
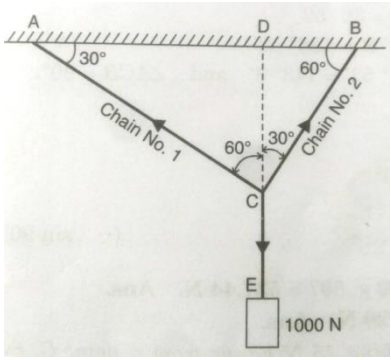
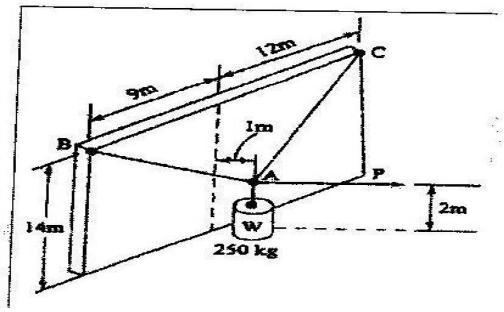
Bloom's Taxonomy Levels: L1- Remember, L2- Understand, L3- Apply, L4 - Analyze, L5- Evaluate, L6- Create.

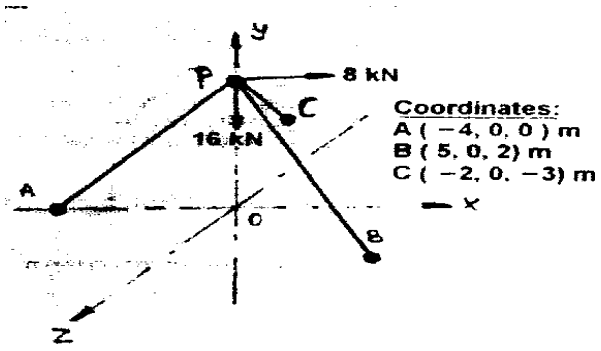
Thinking Skills: L1, L2, and L3 & L4.

Sl. No.	Questions	Marks	CO	BL	PI Code
	PART A				
1	Define Coplanar & concurrent forces	2	CO1	L1	1.6.1
2	What is the different between a resultant force and equilibrant force?	2	CO1	L1	1.6.1
3	State the necessary and sufficient conditions for static equilibrium of a particle in two dimensions	2	CO1	L1	1.6.2
4	What is unit vector?	2	CO1	L1	1.6.1
5	State Lame's theorem	2	CO1	L3	1.6.1
6	A force F = 9i + 6j – 15k acts through the origin. What is the magnitude of the force and the angle it makes with X, Y and Z axis?	2	CO1	L3	1.6.1
7	State Varignon's Theorem?	2	CO1	L3	1.6.2
8	Find the magnitude of the resultant of the two concurrent forces of magnitude 60 kN and 40 kN with an included angle of 70^o between them.	2	CO1	L3	1.6.1
9	A force of magnitude 500N is passing through the origin and a point A (0.2, 1, 0) m. write the couple form of the force.	2	CO1	L3	1.6.2
10	State the principal of transmissibility of forces with simple sketch.	2	CO1	L3	1.6.1

11	Define Resultant Force.	2	CO1	L1	1.6.1
12	A force of 100 N is acting at a point making an angle of 30^0 with the horizontal as shown in fig. determine the components of this force along X and Y directions. 	2	CO1	L3	1.6.1
	PART B				
1	Determine the resultant of the concurrent force system shown in the following Figure 	13	CO1	L3	2.6.2
2	The following figure shows a 10 kg lamp supported by two cables AB and AC. Find the tension in each cable. 	13	CO1	L3	2.6.2
3	The truck is to be towed using two ropes. Determine the magnitudes of forces FA and FB acting on each rope in order to develop a resultant force of 950N directed along the positive X-axis. 	13	CO1	L3	2.6.2
4	Determine the magnitude and angle and F so that particle shown in figure, is in Equilibrium.	13	CO1	L3	2.6.1

					
5	ABCDE is a light string whose end A is fixed. The weights W_1 and W_2 are attached to the string at B & C and the string passes round a small smooth wheel at D carrying a weight 40KN at the free end E. In the position of equilibrium, BC is horizontal and AB and CD make angles 150° and 120° with horizontal. 	13	CO1	L3	2.6.2
6	Find the magnitude and position of the resultant of the system of forces shown in Figure below. 	13	CO1	L3	2.6.1
7	Three coplanar force are acting at a point Q as shown in fig. determine the magnitude and the direction of the resultant force. 	13	CO1	L3	2.6.2
8	A guess plate of roof truss is subjected to forces as shown in fig. determine the magnitude of the resultant force and its orientation	13	CO1	L3	2.6.2

	measured counter clockwise from the positive x-axis. 				
9	A weight of 1000 N is supported by two chains as shown in fig. Determine the tension in each chain. 	13	CO1	L3	2.6.2
	PART C				
1	A horizontal force P normal to the wall holds the cylinder in the position shown in figure below. Determine the magnitude of P and the tension in each cable. 	15	CO1	L3	2.6.2
2	Figure below shows three cables AB, AC, AD that are used to support the end of asign which exerts a force of $F = \{250i + 450j - 450k\}N$ at A. Determine the force develop in each cable.	15	CO1	L3	2.6.2
3	Two forces act upon a tripod at 'P' as shown in figure. The force 8 kN is parallel to x- axis and the force 16kN is parallel to y – axis.	15	CO1	L3	2.6.2

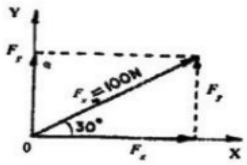
UNIT II **EQUILIBRIUM OF RIGID BODIES**

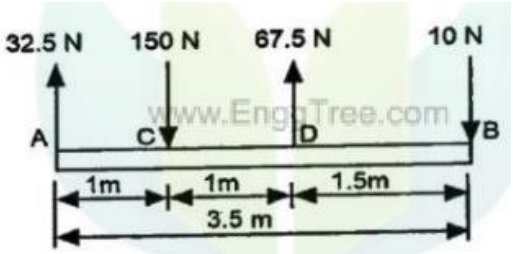
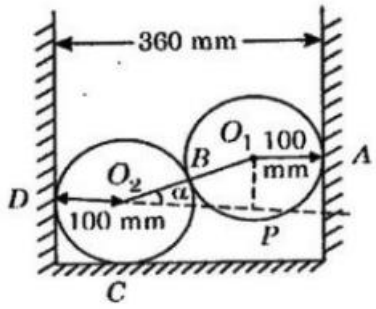
Principle of Transmissibility, Equivalent Forces, Vector Product of Two Vectors, Moment of a Force about a Point, Varignon's Theorem, Rectangular Components of the Moment of a Force, Scalar Product of Two Vectors, Mixed Triple Product of Three Vectors, Moment of a Force about an Axis, Couple - Moment of a Couple, Equivalent Couples, Addition of Couples, Resolution of a Given Force into a Force -Couple system, Further Reduction of a System of Forces, Equilibrium in Two and Three Dimensions - Reactions at Supports and Connections.

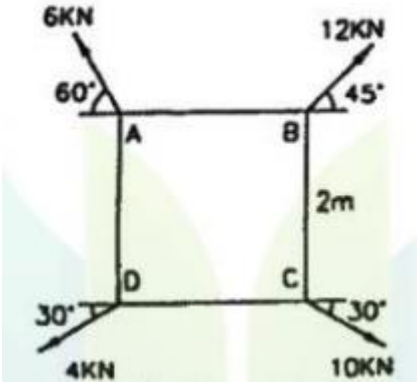
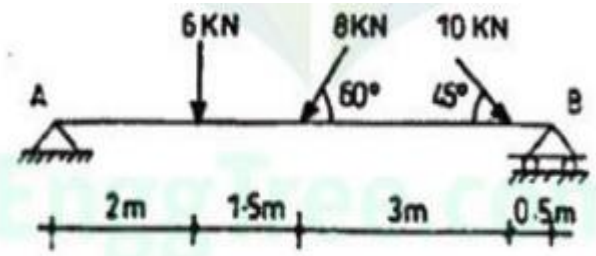
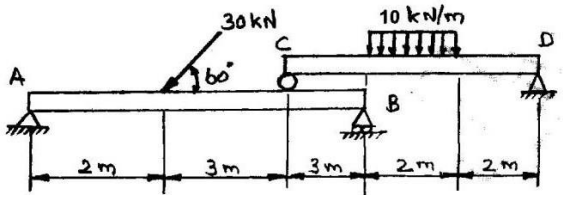
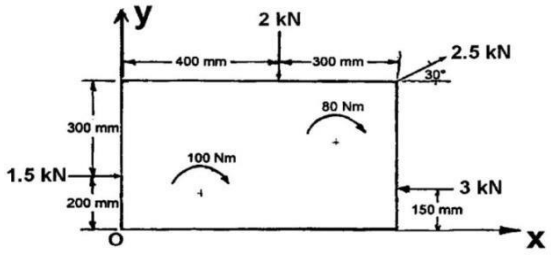
Assessment Questions for UNIT II

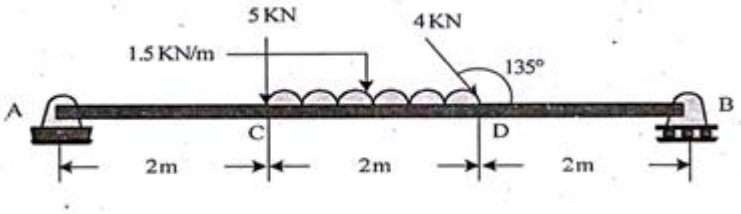
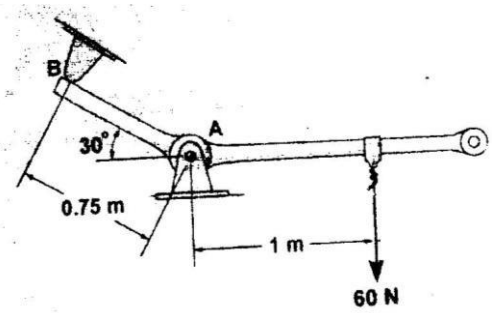
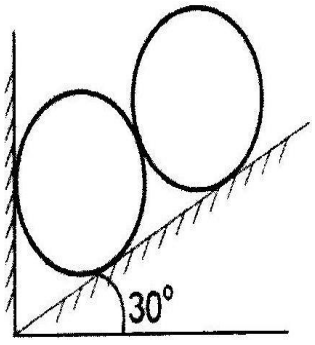
Bloom's Taxonomy Levels: L1- Remember, L2- Understand, L3- Apply, L4 - Analyze, L5- Evaluate, L6- Create

Thinking Skills: L1, L2, and L3 & L4.

Sl. No.	Questions	Marks	CO	BL	PI Code
	Part A				
1	A force of 100 N is acting at a point making an angle of 30^0 with the horizontal as shown in fig. determine the components of this force along X and Y directions. 	2	CO2	L3	1.6.2
2	Write the principle of transmissibility.	2	CO2	L1	1.6.1
3	Explain free body diagram	2	CO2	L2	1.6.1
4	State Varignon's theorem	2	CO2	L1	1.6.1
5	List out the steps to be followed to draw the Free Body Diagram of a rigid body.	2	CO2	L4	1.6.1
6	State the necessary and sufficient conditions for equilibrium of rigid bodies in two dimensions.	2	CO2	L2	1.6.1
7	Write the conditions of equilibrium of a system of parallel forces acting in a plane.	2	CO2	L2	1.6.1

8	State the general condition of equilibrium of particle.	2	CO2	L1	1.6.1
9	Why the couple moment is said to be a free vector?	2	CO2	L5	1.6.1
10	Distinguish between a couple and a moment.	2	CO2	L4	1.6.1
	Part B				
1	A system of parallel forces 32.5 N, 150N, 67.5N and 10N are acting on a rigid bar as shown in fig. reduce this system to: (i) A single force. (ii) A single force and a couple at A. (iii) A single force and a couple at B. 	13	CO2	L3	1.6.2
2	Two smooth spheres each of radius 100 mm, and weight 100N, rest in a horizontal channel having vertical walls, the distance between the walls being 360 mm. find the reactions at the points of contacts A , B, C, and D as shown in fig. 	13	CO2	L3	1.6.2
3	Four forces of magnitude and direction acting on a square ABCD of side 2m are shown in fig. Calculate the resultant in magnitude and direction and also locate its point of application with respect to the sides AB and AD.	13	CO2	L3	1.6.2

					
4	Determine the support reaction of the beam shown in fig. 	13	CO2	L3	1.6.2
5	A force(10i+20j-5k)N acts at a point P(4,3,2)m. Determine the moment of this force about the point Q(2,3,4)m in the vector form, Also find the magnitude of the moment and its angles with respect to x,y,z axes.	13	CO2	L3	1.6.2
6	Two beams AB and C D are shown in figure. A and D are hinged supports. B and Care roller supports. 	13	CO2	L3	1.6.1
7	A force couple system acting on a rectangular plate is shown in figure below. i) Find the equivalent force couple system at the origin O. ii) Find the single resultant force and its location on x–axis. 	13	CO2	L3	1.6.2
8	A load of 3500 N is acting on the boom ,which is held by a cable B C as shown in figure	13	CO2	L3	1.6.2

	Sketch the free body diagram of the boom. (i) Determine the tension in cable BC. (ii) Find the magnitude and direction of the reaction at A.				
	PART C				
1	A simply supported beam AB of 6m spans loaded as shown A is a hinged.  	15	CO2	L3	1.6.1
2	A force of 60 N acts on a lever as shown in the figure. Determine their actions at A and B.  	15	CO2	L3	1.6.2
3	Four tug boats are used to bring an ocean larges hip to its pier. Each tug boat exerts a 22.5 kN force in the direction. (i) Determine the equivalent force-couple system at O. (ii) Determine a single equivalent force and its location along the longitudinal axis of the ship.	15	CO2	L3	1.6.2
4	Two identical rollers, each of weight 500N, are supported by an inclined plane making an angle of 30°tothehorizontalandaverticalwallasshownin the figure.  	15	CO2	L3	1.6.2

UNIT III DISTRIBUTED FORCES

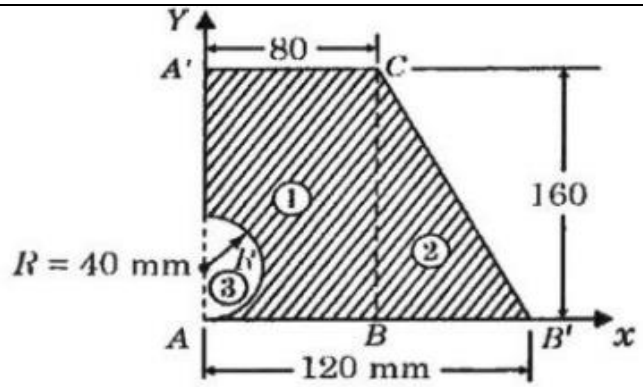
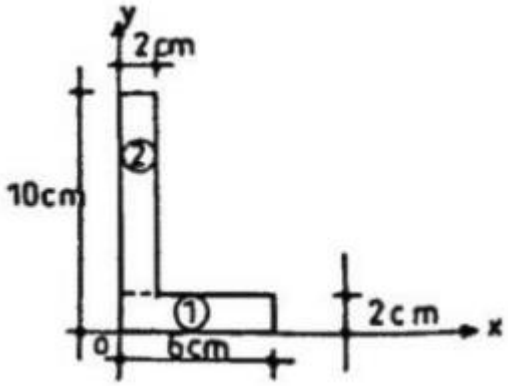
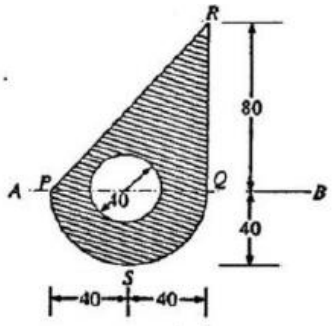
Centroids of lines and areas – symmetrical and unsymmetrical shapes, Determination of Centroids by Integration, Theorems of Pappus-Guldinus, Distributed Loads on Beams, Centre of Gravity of a Three-Dimensional Body, Centroid of a Volume, Composite Bodies, Determination of Centroids of Volumes by Integration. Moments of Inertia of Areas and Mass - Determination of the Moment of Inertia of an Area by Integration, Polar Moment of Inertia, Radius of Gyration of an Area, Parallel-Axis Theorem, Moments of Inertia of Composite Areas, Moments of Inertia of a Mass - Moments of Inertia of Thin Plates, Determination of the Moment of Inertia of a Three-Dimensional Body by Integration.

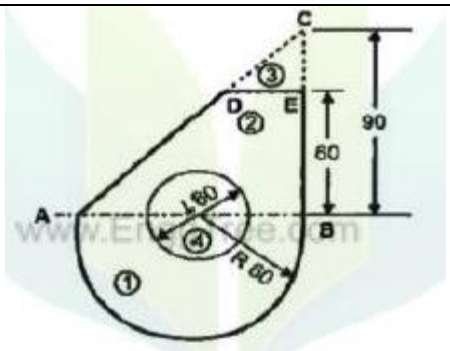
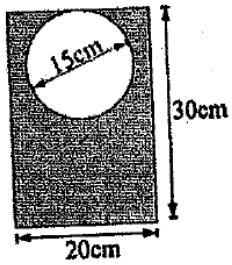
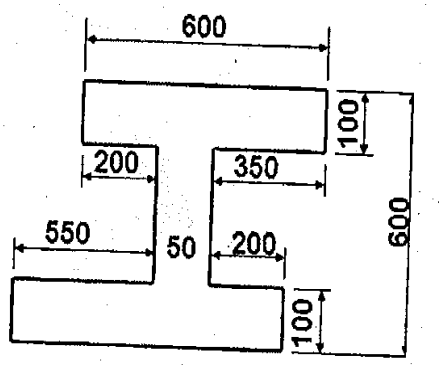
Assessment Questions for UNIT III

Bloom's Taxonomy Levels: L1- Remember, L2- Understand, L3- Apply, L4 - Analyze, L5- Evaluate, L6- Create

Thinking Skills: L1, L2, and L3 & L4.

Sl. No.	Questions	Marks	CO	BL	PI Code
	PART A				
1	Derive centroid of a semicircle.	2	CO3	L6	1.6.1
2	State parallel axis theorem	2	CO3	L1	1.6.1
3	Distinguish between centroid and centre of gravity	2	CO3	L4	1.6.1
4	State parallel axis theorem with simple sketch	2	CO3	L1	1.6.1
5	Define radius of gyration with respect to x-axis of an area.	2	CO3	L2	1.6.1
6	Define polar moment of inertia of lamina	2	CO3	L1	1.6.1
7	Write the SI units of the mass moment on inertia and of the area moment of inertia of a lamina.	2	CO3	L3	1.6.1
8	Define first moment of an area about an axis	2	CO3	L1	1.6.1
9	Define principal axes and principal moment of inertia.	2	CO3	L1	1.6.1
10	When will the product of inertia of a lamina become zero?	2	CO3	L4	1.6.1
11	State principal axes of inertia?	2	CO3	L2	1.6.1
12	What is meant by moment of inertia of the area?	2	CO3	L1	1.6.1
	PART B				
1	Find the moment of inertia for the shaded area shown in fig. the lines AA' and BB'.	13	CO3	L3	1.6.2

					
2	Calculate the moment of inertia of L section shown in fig. below about the horizontal axis passing through the C.G. 	13	CO3	L3	1.6.2
3	Find moment of inertia of the shaded area shown in fig. about axis AB 	13	CO3	L3	1.6.2
4	Find the moment of inertia of the area shown in fig. about line AB parallel to the centroidal axis.	13	CO3	L3	1.6.1

					
5	Find the moment of inertia of a hollow rectangular plane shown in fig. about x axis and y axis through the centroid. 	13	CO3	L3	1.6.2
6	Derive from first principles, the second moment of area of a circle about its diametral . Axis.	13	CO3	L3	1.6.2
7	For the section shown in figure below, locate the horizontal and vertical centroidal Axis. 	13	CO3	L3	1.6.2
8	Calculate the centroid polar moment of inertia of a rectangular section with breadth of 100 mm and height 200 mm.	13	CO3	L3	1.6.2
9	Find the moment of inertia of the shaded area shown in figure about the vertical and horizontal centroid axes. The width of the hole is 200 mm.	13	CO3	L3	1.6.2
	PART C				
1	Derive the expressions for the location of the centroid of a triangular area shown in Figure, by direct integration.	15	CO3	L3	1.6.2
2	Locate the centroid of the plane area shown in figure below.	15	CO3	L3	1.6.1
3	Figure shows a composite area.	15	CO3	L3	1.6.2
4	Derive the expression for the product of inertia of the rectangular area about x and y axes shown.	15	CO3	L3	1.6.1

UNIT IV **FRICTION** **9**

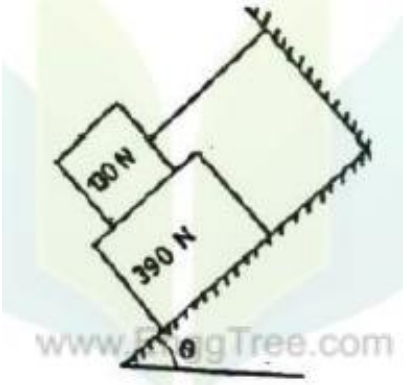
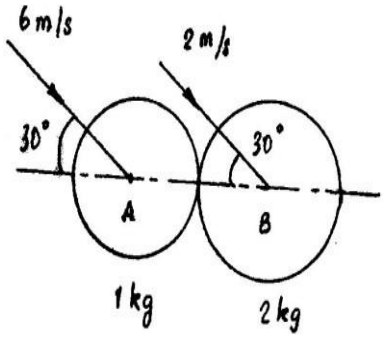
The Laws of Dry Friction, Coefficients of Friction, Angles of Friction, Wedge friction, Wheel Friction, Rolling Resistance, Ladder friction. s

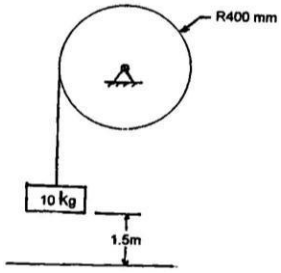
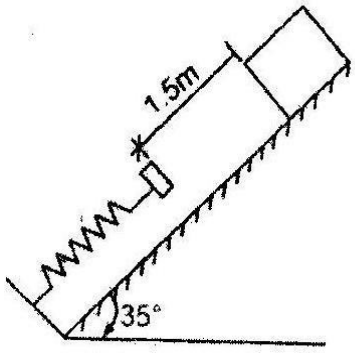
Assessment Questions for UNIT IV

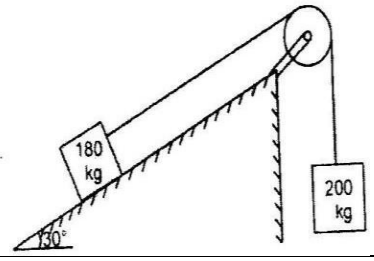
Bloom's Taxonomy Levels: L1- Remember, L2- Understand, L3- Apply, L4 - Analyze, L5- Evaluate, L6- Create

Thinking Skills: L1, L2, and L3 & L4.

Sl. No.	Questions	Marks	CO	BL	PI Code
	PART A				
1	A body of weight 100 N is placed on a rough horizontal plane, and pushed by force of 45 N, to just cause sliding over the horizontal plane. Determine the co-efficient of friction.	2	CO4	L3	1.6.1
2	A train running at 80km/h is brought to halt after 50 seconds. Find the retardation and the distance travelled by the train before it comes to a halt.	2	CO4	L3	1.6.1
3	Explain the difference between kinematics and kinetics.	2	CO4	L2	1.6.1
4	State the principle of work and energy.	2	CO4	L2	1.6.1
5	What is D'Alembert's principle?	2	CO4	L1	1.6.1
6	What do you mean by impact of elastic bodies?	2	CO4	L1	1.6.1
7	State Newton's law concerning equilibrium of particle.	2	CO4	L2	1.6.1
8	A body moves along a straight line so that its displacement from a fixed point on the line is given by $s = 3t^2+2t$. Find the velocity and acceleration at the end of 3 seconds.	2	CO4	L3	1.6.1
9	A point P moves along a straight line according to the equation $x = 4t^3-2t-5$, where x is in meters. Is in seconds. Determine the velocity and acceleration when t =3sec.	2	CO4	L3	1.6.1
10	A train running at 80 km/h is brought to a standing halt after 50 seconds. Find the retardation and the distance traveled by the train before it comes to a halt.	2	CO4	L3	1.6.1
11	A particle of mass 10 kgf all vertically from the height of 100mfrom ground. What is the change in potential energy when it has reached a height of 50m?	2	CO4	L3	1.6.1
12	A stone is dropped from the top of a tower. It strikes the ground after four seconds. Find the height of the tower.	2	CO4	L3	1.6.1
	PART B				
1	A uniform ladder of weight 1000 N and of length 4m rests on a horizontal ground leans against a smooth vertical wall. The ladder makes an angle of 60^0 with horizontal. When a man of weight 750N stands on the ladder at a distance of 3m from the top of the ladder, the ladder is at the point of sliding. Determine the co-efficient of friction between the ladder and the floor.	13	CO4	L3	1.6.2
2	Block A weighing 100N rests over block B, which weighs 2000N. block A is tied to wall with a horizontal string as shown in fig. find the value of P to move block B if the coefficient of friction between A and B is 0.5 and the coefficient between B and the floor is 0.33.	13	CO4	L3	1.6.1

3	What should be the value of the angle θ so that motion of the 390N block as shown in fig. impends down the plane? The coefficient of friction for all surfaces is 1/3.  	13	CO4	L3	1.6.2
4	A 7m long ladder rest against a vertical wall, with which it makes an angle of 45^0 and on a floor. If a man whose weight is one half that of ladder climbs it, at what distance along the ladder will he be, when the ladder us about to slip? Take coefficient of friction between the ladder and the wall is 1/3 and that between the ladder and the floor is 1/2.	13	CO4	L3	1.6.2
5	A ball of mass I kg moving with a velocity of 6 m/s strikes another ball of mass 2kg movingwithavelocityof2m/s at the instant of impact the velocities of the two balls are parallel and inclined at 30°to the line joining their centers as shown in figure below.The coefficient restitutions 0.5, find the velocity and the direction the two balls after impact. Also calculate the loss in kinetic energy due to impact and the percentage of loss.  	13	CO4	L3	1.6.2
6	Two trains A and B leave the same station on parallel lines. A starts with a uniform acceleration of $0.15m/s^2$and attains the speed of 24 km/hour after which its speed remains constant. B leaves 40 seconds later with uniform acceleration of 0.30 m/s^2 to attainamaximumof48km/hour,itsspeedalsobecomesconstantthere after.Whenwill B overtake A.	13	CO4	L3	1.6.2
7	The10mkg block shown in figure hangs form the end of a cable wrapped around the cylindrical drum of radius 400mm.The system starts form rest when the block is at 1.5mabovethefloor.Determinethemass of the drum which will allow the block to hit the floor at $1/4^{th}$ the speed it would have attained if the block alone were simply dropped from the same height.	13	CO4	L3	1.6.2

					
8	Car A accelerates uniformly from rest on a straight level road. Car B starting from the same point 6 seconds later with zero initial velocity accelerates at $6m/s^2$. It over takes the car A at 400m from the starting point. What is the acceleration of the car A?	13	CO4	L3	1.6.2
9	A stone is dropped into a well. The sound of the splash is heard 3.63 seconds later. How far below the ground is the surface of water in the well? Assume the velocity of sound as 331m/s.	13	CO4	L3	1.6.2
10	Block P of weight 100N and block Q of weight 50N are connected by a rope that passes over a smooth pulley as shown in fig. find the acceleration of the blocks and the tension in the rope, when the system is released from rest. Neglect them as so the pulley.	13	CO4	L3	1.6.2
11	A 2000kg automobiles is a speed of 100km/h when the brakes are applied causing a constant total braking force (applied by the road on the tires) of 7KN.Determine the distance travelled by automobile as it comes to a stop.	13	CO4	L3	1.6.2
	PART C				
1	A ball of mass 2kg, moving with a velocity of 3m/s, impinges on a ball of mass 4kg moving with a velocity of 1m/s. The velocities of the two balls are parallel and inclined at 30°to the line of joining their centers at the instant of impact. If the coefficient of restitution is 0.5, find.	15	CO4	L3	1.6.2
2	A block of mass 50 kg slides down a 35°inclined and strikes a spring 1.5m away from it as shown in Fig below. The maximum compression of the spring is 300 mm when the block comes to rest. If the spring constant is 1kN/m, find the coefficient of kinetic friction between the block and the plane. 	15	CO4	L3	1.6.2

3	A block and pulley system is shown in fig below. The coefficient of kinetic friction Between the block and the plane is 0.25.The pulley is frictionless. Find the acceleration of the blocks and the tension in the string when the system is just released. Also find the time required for 200kg block to come down by 2m. 	15	CO4	L3	1.6.1

UNIT V **DYNAMICS OF PARTICLES**

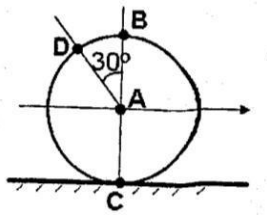
Kinematics - Rectilinear Motion and Curvilinear Motion of Particles. Kinetics- Newton's Second Law of Motion -Equations of Motions, Dynamic Equilibrium, Energy and Momentum Methods - Work of a Force, Kinetic Energy of a Particle, Principle of Work and Energy, Principle of Impulse and Momentum, Impact of bodies.

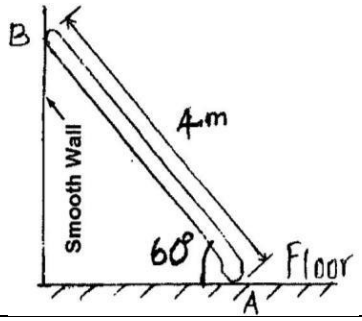
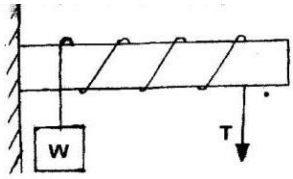
Assessment Questions for UNIT V

Bloom's Taxonomy Levels: L1- Remember, L2- Understand, L3- Apply, L4 - Analyze, L5- Evaluate, L6- Create

Thinking Skills: L1, L2, and L3 & L4.

Sl. No.	Questions	Marks	CO	BL	PI Code
	PART A				
1	State the principle of work and energy.	2	CO5	L2	1.6.1
2	State the laws of dry friction	2	CO5	L2	1.6.1
3	Define coefficient of kinetic friction.	2	CO5	L1	1.6.1
4	What is coloum friction?	2	CO5	L1	1.6.1
5	Define: coefficient of static friction	2	CO5	L1	1.6.1
6	List out the different types of friction. What is coefficient of static friction?	2	CO5	L2	1.6.1
7	When do we say that the motion of a body is impending?	2	CO5	L2	1.6.1
8	What is general plane motion?	2	CO5	L1	1.6.1
9	A rigid body is acted upon by a force of 100 N, the velocity of body changes from 15 m/s to 25 m/s during a period of 50 s. Find the mass of body and the distance moved by the body during the time of interval.	2	CO5	L3	1.6.1
10	A rigid body rotates about a fixed axis. Write the expression for angular velocity when the rotation is uniformly accelerated	2	CO5	L3	1.6.1
11	How so, at any given instant, the velocity and acceleration of different points of a rigid body vary when it is undergoing translation?	2	CO5	L3	1.6.1
	PART B				
1	Two stations P and Q are 5.2 km apart. An automobile starts from rest from station P and accelerates uniformly to attain a speed o 48 kmph in 30	13	CO5	L3	1.6.2

	seconds. This speed is maintained until the brakes are applied. The automobile comes to rest at station Q with a uniform retardation of one metre per second. Determine the total time required to cover the distance between these two stations.				
2	A ball of mass 500 g, moving a velocity of 1 m/sec impinges on a ball of mass 1 kg, moving with a velocity of 0.75 m/sec. at the time of impact, the velocities of the balls are parallel and inclined at 60^0 to the line joining their centres. Determine the velocities and directions of the balls after impact. Take = 0.6.	13	CO5	L3	1.6.2
3	A block weighing 36N is resting on a rough inclined plane having an inclination of 30º. A force of 12N is applied at an angle of 10ºup the plane and the block is just on the point of moving down the plane. Determine the coefficient of friction	13	CO5	L3	1.6.2
4	A flat belt developes a tight side tension of 2000N during power transmission; the coefficient of friction between pulley and belt is 0.3,the angle of lap on smaller pulley is 165º and the belt speed is 18m/s. Determine the power that can be transmitted , if the belt is assumed to be perfectly elastic without mass.	13	CO5	L3	1.6.2
5	A rigid body is undergoing general plane motion. Write down the relationship of the velocities of two points A & B on it and explain.	13	CO5	L3	1.6.2
6	An automobile travels to the right at a constant speed of 72km/h. The diameter of the wheel is 560mm. Determine the magnitude and direction of the following: (1) Angular velocity of the wheel (2) Velocity of the point B (3) Velocity of the point C (4) Velocity of the point D 	13	CO5	L3	1.6.2
7	Two blocks A and B of mass are connected by a string C which passes through a frictionless pulley connected with the fixed wall by another string D as shown in figure. Find the force P required to pull the block B. Also find the tension in the string D. Take coefficient of friction at all contact surfaces as 0.3.	13	CO5	L3	1.6.2
8	In a belt drive, the smallest pulley is subjected to a tension T_1 on the tight side and a tension T_2 on the slack side. Derive a relation between these tensions in terms of the coefficient of friction and the angle of wrap.	13	CO5	L3	1.6.1
PART C					

1	A ladder of weight 1000N and 4m length in figure below. If a 750 N weight is applied at a distance of 3m from the top of ladder, it is at the point of Sliding. Determine the coefficient of friction between ladder and the floor 	15	CO5	L3	1.6.2
2	A rope is wrapped three times around shown in figure below. Determine the force required on the free end of the rope, to support a load of W = 20KN.Take μ as 0.30. 	15	CO5	L3	1.6.1
3	A pull of 250 N inclined at is required just to move a body kept on a rough horizontal plane. But the push required just to move the body is 300N.If the push is inclined at 30° to the horizontal .Find the weight of the body and the coefficient of friction.	15	CO5	L3	1.6.2

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