Course Code: 23CE0102 **R23**

SIDDHARTH INSTITUTE OF ENGINEERING & TECHNOLOGY:: PUTTUR (AUTONOMOUS)
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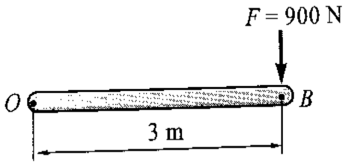
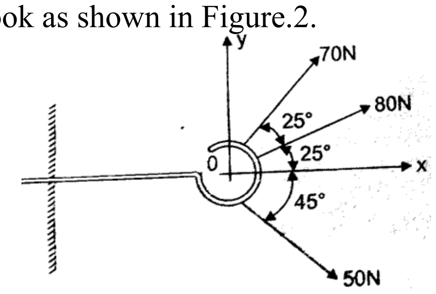
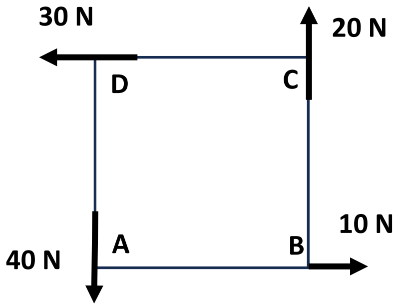
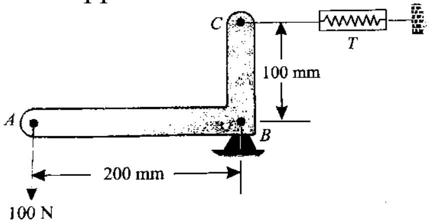
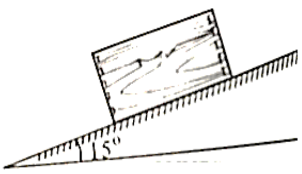
QUESTION BANK (DESCRIPTIVE)

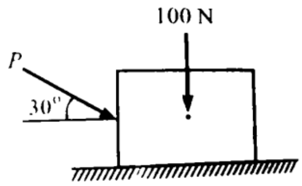
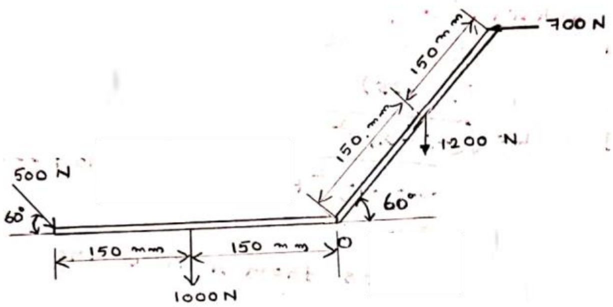
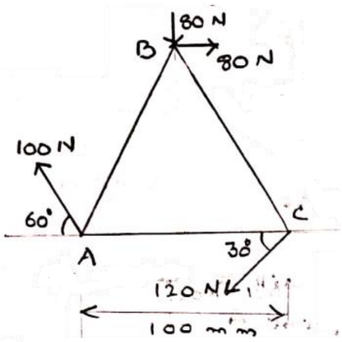
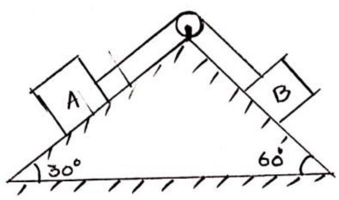
Subject with Code: Engineering Mechanics (23CE0102) **Course & Branch**: B.Tech (CE & ME)

Year & Sem: I/II **Regulation:** R23

UNIT – I
Introduction to Engineering Mechanics
Systems of Forces
Friction

1.	a) Define and give examples of Scalar, Vector and Tensor.		[L1][CO1]	[2M]
	b) Resolve the force F = 900 N acting at B into a couple and a force at O as shown in the Figure.1.  **Figure.1**		[L3][CO1]	[2M]
	c) List different system of Coplanar forces and give example for each.		[L1][CO1]	[2M]
	d) Discuss briefly the application of moment of force.		[L2][CO1]	[2M]
	e) Explain cone of friction.		[L2][CO1]	[2M]
2.	The following forces act at a point: (i) 20 N inclined at 30° towards North of East (ii) 25 N towards North (iii) 30 N towards North West, and (iv) 35 N towards at 40° towards South of West. Find the magnitude and direction of the resultant force.		[L3][CO1]	[10M]
3.	Determine the resultant and its inclination with the horizontal axis of three forces acting on a hook as shown in Figure.2.  **Figure.2**		[L4][CO1]	[10M]

4.		Four forces of magnitudes 10 N, 20 N, 30 N and 40 N are acting respectively along the four sides of a square ABCD as shown in Figure.3. Determine the magnitude, direction and position of the resultant forces.  **Figure.3**	[L3][CO1]	[10M]
5.		A 200 N force passes through points A (10, 25, -35) and B (-20, 20, 10) and is directed from A to B. Determine the cartesian component of the force.	[L3][CO1]	[10M]
6.	a)	State Coulomb's laws of dry friction.	[L1][CO1]	[5M]
	b)	Figure.4 shows a crank-lever ABC with a tension spring (T). the lever weights 0.2 N/mm. Determine the tension developed in the spring, when a load of 100 N is applied at A.  **Figure.4**	[L3][CO1]	[5M]
7.	a)	Define the following: (i) Coefficient of static friction (ii) Coefficient of kinetic friction (iii) Limiting force of friction (iv) Angle of friction (v) Angle of repose.	[L1][CO1]	[5M]
	b)	A wooden block of mass 40 kg is on rough inclined plane as shown in Figure.5. Find the frictional force at surface in contact if μ_s = 0.4 and μ_k = 0.35.  **Figure.5**	[L3][CO1]	[5M]

8.	Determine the frictional force developed on the block shown in Figure.6 when (i) P = 40 N (ii) P = 80 N . Coefficient of static friction between the block and floor is $\mu_s = 0.3$ and $\mu_k = 0.25$ and (iii) Also find the value of P when the block is about to move.  **Figure.6**	[L4][CO1]	[10M]
9.	The system of forces acting on a bell crank is shown in Figure.7. Determine the magnitude, direction and the point of application of the resultant.  **Figure.7**	[L3][CO1]	[10M]
10.	Find the resultant of the force system shown in Figure.8 acting on a lamina of equilateral triangular shape.  **Figure.8**	[L3][CO1]	[10M]
11.	Two blocks A and B are placed on inclined planes as shown in Figure.9. The block A weighing 1000 N. Determine minimum weight of the bock B for maintaining the equilibrium of the system. Assume that the blocks are connected by an inextensible string passing over a frictionless pulley. Coefficient of friction between block A and plane also block B and plane is 0.25.  **Figure.9**	[L4][CO1]	[10M]

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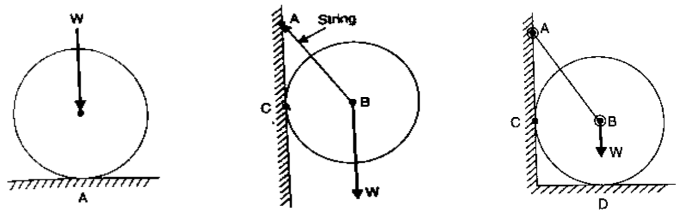
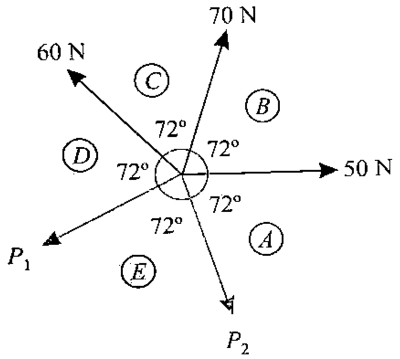
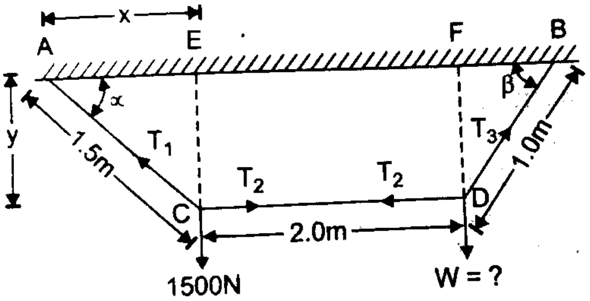
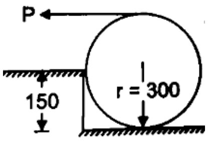
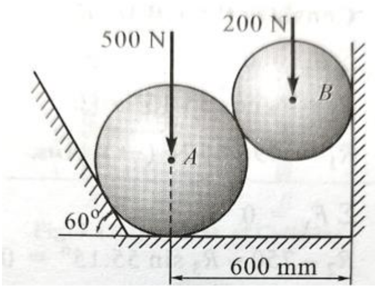
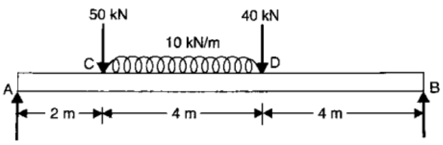
UNIT – II

Equilibrium of Systems of Forces

1.	a)	State and explain Triangle Law of forces.	[L1][CO2]	[2M]
	b)	Briefly explain Free Body Diagram.	[L2][CO2]	[2M]
	c)	State converse of the Law of Polygon of Forces.	[L1][CO2]	[2M]
	d)	What are condition of equilibrium of Non-Concurrent System of Forces.	[L1][CO2]	[2M]
	e)	Define virtual work? List its applications.	[L1][CO2]	[2M]
2.	a)	With the help of a neat sketch, state and prove Lami's theorem.	[L2][CO2]	[5M]
	b)	Draw the free body diagrams for the following as shown in Figure. (a),(b) & (c).  **(a)** **(b)** **(c)** **Figure.1**	[L3][CO2]	[5M]
3.		Five strings are tied at a point and are pulled in all directions, equally spaced from one another as shown in Figure.2. If the magnitude of the pulls on three consecutive strings is 50 N, 70 N and 60 N respectively, find graphically the magnitude of the pulls on two other strings.  **Figure.2**	[L3][CO2]	[10M]
4.		A rope AB, 4.5 m long is connected at two points A and B at the same level 4 m apart. A load of 1500 N is suspended from a point C on the rope 1.5 m from A as shown in Figure.3. What load connected at point D on the rope, 1 m from B will be necessary to keep the position CD level?	[L3][CO2]	[10M]

	 **Figure.3**		
5.	A roller of radius r = 300 mm and weight 2000 N is to be pulled over a curb of height 150 mm as shown in Figure.4 by a horizontal force P applied to the end of a string around tightly around the circumference of the roller. Find the magnitude of P required to start the roller move over the curb. What is the least pull P through the centre of the wheel to just turn the roller over the curb?  **Figure.4**	[L3][CO2]	[10M]
6.	Two spheres A and B are resting in a smooth through as shown in Figure.5. Draw the free body diagrams of A and B showing all the forces acting on them both in magnitude and direction. Radius of spheres A and B are 250 mm and 200 mm, respectively.  **Figure.5**	[L4][CO2]	[10M]
7.	A simply supported beam of length 10 m, carries the uniformly distributed load and two point loads as shown in Figure.6. calculate the support reactions.  **Figure.6**	[L3][CO2]	[10M]

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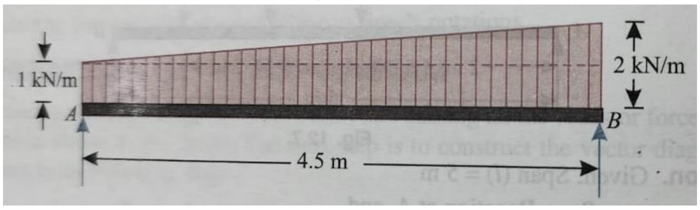
<table>
<tr><td>8.</td><td colspan="2">A simply supported beam shown in Figure.7. Find the support reactions at A & B.


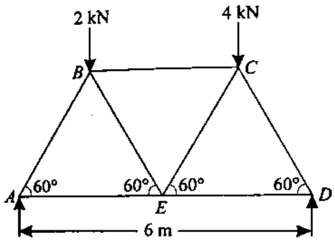
Figure.7</td><td>[L3][CO2]</td><td>[10M]</td></tr>
<tr><td>9.</td><td>a)</td><td>Define the following terms: (i) Perfect frame (ii) Imperfect frame (iii) Deficient frame and (iv) Redundant frame.</td><td>[L1][CO2]</td><td>[6M]</td></tr>
<tr><td></td><td>b)</td><td>What are assumptions made in find the forces in a frame?</td><td>[L1][CO2]</td><td>[4M]</td></tr>
<tr><td>10.</td><td colspan="2">Using the method of joints, find the axial forces in all the members of a truss with the loading shown in Figure.8


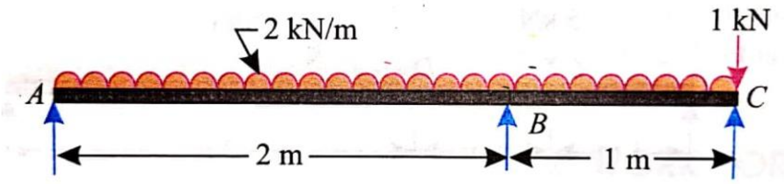
Figure.8</td><td>[L3][CO2]</td><td>[10M]</td></tr>
<tr><td>11.</td><td colspan="2">An overhanging beam ABC of span 3 m is loaded as shown in Figure.9. Using the principle of virtual work, find the reactions at A and B.


Figure.9</td><td>[L3][CO2]</td><td>[10M]</td></tr>
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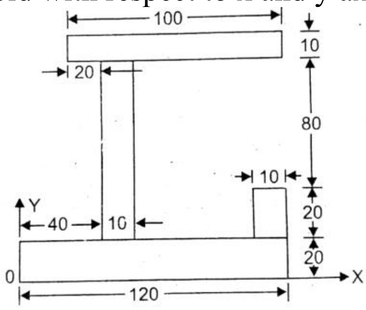
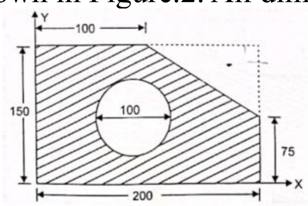
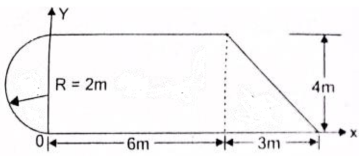
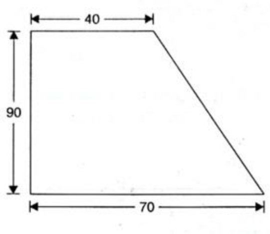
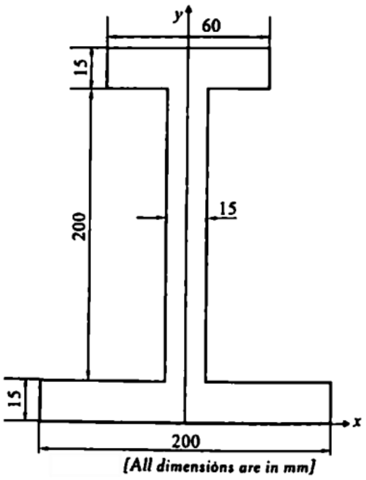
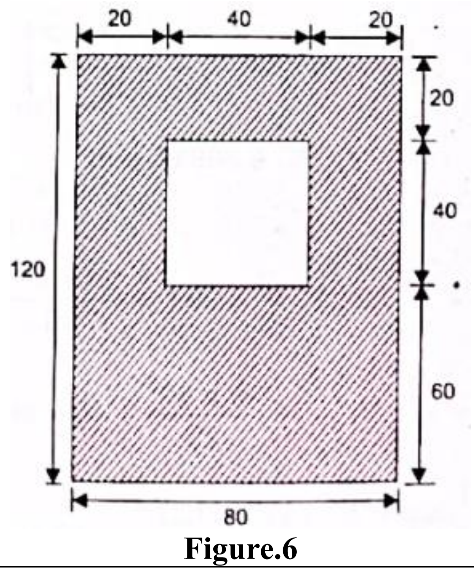
UNIT – III
Centroid
Centre of Gravity
Area Moments of Inertia
Mass Moment of Inertia

1.	a)	Define the terms centroid and centre of gravity.	[L1][CO3]	[2M]
	b)	Define the terms moment of inertia and radius of gyration.	[L1][CO3]	[2M]
	c)	What are values of moment of inertia and polar moment of inertia for a circle of diameter ‘d’?	[L1][CO3]	[2M]
	d)	State parallel axis theorem.	[L1][CO3]	[2M]
	e)	List when the product of inertia will be zero for an area.	[L2][CO3]	[2M]
2.	a)	State and prove Pappus-Guldinus theorems.	[L2][CO3]	[5M]
	b)	Determine the centroid of a semicircle of radius R about its diametral axis.	[L3][CO3]	[5M]
3.		Determine the centroid of the built-up section shown in Figure.1. Express the coordinates of the centroid with respect to x and y axes shown.  **Figure.1**	[L3][CO3]	[10M]
4.		Determine the coordinates x_c and y_c of the centre of a 100 mm diameter circular hole cut in a thin plate so that this point will be the centroid of the remaining shaded area shown in Figure.2. All dimensions are in mm.  **Figre.2**	[L3][CO3]	[10M]
5.		Determine the centroid of the area shown in Figre.3 with respect to the axes shown.  **Figre.3**	[L3][CO3]	[10M]
6.		Locate the centre of gravity of the right circular cone of base radius ‘r’ and height ‘h’.	[L3][CO3]	[10M]
7.	a)	Derive Transfer Theorem in terms of Area Moment of Inertia.	[L2][CO4]	[5M]
	b)	Figure.4 shows a plane area. Determine the product moment of inertia of the given area. All dimensions are in mm.	[L3][CO4]	[5M]

		 **Figure.4**		
8.	Find the centroid of the unequal I-section shown in Figure.5 and calculate moment inertia about the centroid x and y axis. Also find moment inertia about base.  **Figure.5**		[L4][CO4]	[10M]
9.	The cross-section of a rectangular hollow beam is as shown in Figure.6. Determine the polar moment of inertia of the section about centroidal axes.  **Figure.6**		[L4][CO4]	[10M]
10.	a)	Find the polar moment of inertia of a circle.	[L3][CO4]	[5M]
	b)	For a triangle of base ‘b’ and height ‘h’ find the moment of inertia about its base.	[L3][CO4]	[5M]
11.	Determine the moment of inertia of a solid sphere of radius R about its diametral axis.		[L3][CO4]	[10M]

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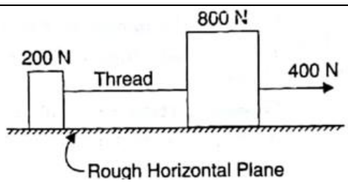
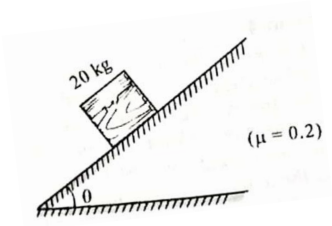
UNIT – IV
Rectilinear and Curvilinear motion of a particle

1.	a)	What is the difference between study of particle motion under *Kinetics & Kinematics*.	[L1][CO5]	[2M]
	b)	Explain the terms *Rectilinear* and *Curvilinear* motion.	[L2][CO5]	[2M]
	c)	Define the terms *Time of Flight* and *Range* in projectile motion.	[L1][CO5]	[2M]
	d)	Explain the terms *Work* and *Energy*. Give their units in SI system.	[L2][CO5]	[2M]
	e)	What is *Impulse*? Write *Impulse Momentum* equation.	[L1][CO5]	[2M]
2.		Three marks 'A', 'B', and 'C' at a distance of 100 m each are made along a straight road. A car starting from rest and with uniform acceleration passes the mark 'A' and takes 10 seconds to reach 'B' and further 8 seconds to reach the mark 'C'. Calculate (i) the magnitude of acceleration of the car (ii) the velocity of the car at 'A', (iii) the velocity of car at B and (iv) the distance of the mark 'A' from the starting point.	[L1][CO5]	[10M]
3.		Determine the time required for a car to travel 1 km along a road if the car starts form rest, reaches a maximum speed at some intermediate point, and then stops at the end of the road. The car can accelerate or decelerate at 1.5 m/s^2.	[L3][CO5]	[10M]
4.		The velocity of a particle moving in a straight line is given by the expression $v = t^3-t^2-2t+2$. The particle is found to be at a distance 4 m from station A after 2 seconds. Determine: (i) acceleration and displacement after 4 seconds; (ii) Maximum/ minimum acceleration.	[L3][CO5]	[10M]
5.		A stone is thrown vertically upwards with a velocity of 19.6 m/s from the top of tower 24.5 m high. Calculate: (i) time required for the stone to reach the ground (ii) velocity of the stone in its downward travel at the point in the same level as the point of projection. (iii) the maximum height to which the stone will rise in its flight.	[L4][CO5]	[10M]
6.	a)	Derive an equation for the path traced by a projectile when projected into space with a velocity 'u' at an angle 'α' with the horizontal.	[L3][CO5]	[5M]
	b)	A pilot flying his bomber at a height of 2000 m with, a uniform horizontal velocity of 600 kmph wants to strike a target. At what distance from the target, he should release the bomb?	[L3][CO5]	[5M]
7.		A projectile is aimed at a mark on the horizontal plane through the point of projection and falls 12 m short when the angle of projection is 15°, while it overshoots the mark by 24 m when the same angle is 45°. Find the angle of projection to the mark. Assume no air resistance. Take the velocity of projection constant in all cases.	[L1][CO5]	[10M]
8.	a)	State and prove work energy principle.	[L2][CO5]	[5M]
	b)	A man weighing W Newton entered a lift which moves with an acceleration of a m/s^2. Find the force exerted by the man on the floor of lift when (i) lift is moving downward (ii) lift is moving upward.	[L4][CO5]	[5M]
9.		Two weights 800 N and 200 N are connected by a thread and move along a rough horizontal plane under the action of force 400 N applied to the first weight of 800 N as shown in Figure.1. The coefficient of friction between the sliding surfaces of the weights and the plane is 0.3. Determine the acceleration of the weights and the tension in the thread using D' Alembert's principle.	[L3][CO5]	[10M]

	 **Figure.1**		
10.	A mass of 20 kg is projected up an inclined of 26° with velocity of 4 m/s as shown in Figure.2. If μ = 0.2, (i) find maximum distance that the package will move along the plane and (ii) What will be the velocity of the package when it comes back to initial position?  **Figure.2**	[L4][CO5]	[10M]
11.	A 20 kN automobile is moving at a speed of 70 kmph when the brakes are fully applied causing all four wheels to skid. Determine the time required to stop the automobile (a) on concrete road for which μ = 0.75, (b) on ice for which μ = 0.08.	[L3][CO5]	[10M]

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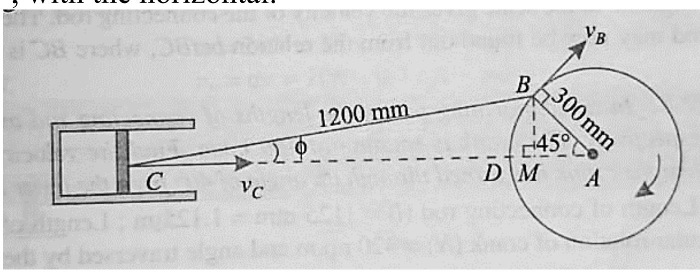
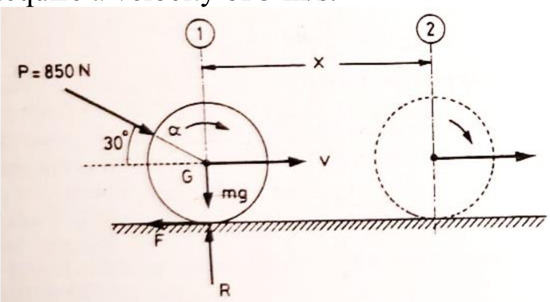
UNIT – V
Rigid body Motion

1.	a)	Define the terms (i) angular velocity and (ii) angular acceleration.	[L1][CO6]	[2M]
	b)	A pulley 2 m in diameter is keyed to a shaft which makes 240 rpm. Find the linear velocity of a particle on the periphery of the pulley.	[L3][CO6]	[2M]
	c)	What is angular displacement? What is units?	[L1][CO6]	[2M]
	d)	Explain plane motion with an example.	[L2][CO6]	[2M]
	e)	Write the work energy equation of a body when it rotates about a fixed axis and explain the terms.	[L2][CO6]	[2M]
2.		Derive the following equations of motion of a body moving a circular path with uniform angular acceleration: (i) $\omega = \omega_o + \alpha t$ (ii) $\theta = \omega_o t + \frac{1}{2} \alpha t^2$ (iii) $\omega^2 - \omega_o^2 = 2\alpha\theta$.	[L2][CO6]	[10M]
3.		A wheel rotating about a fixed axis at 20 revolutions per minute is uniformly accelerated for 70 seconds during which it makes 50 revolutions. Find the (i) angular velocity at the end of this interval and (ii) time required for the velocity to reach 100 revolutions per minute.	[L3][CO6]	[10M]
4.		A griding wheel is attached to the shaft of an electric motor of rated speed of 1800 rpm. When power is switched on the unit attains the rated speed in 5 sec. and when the power is switched off the unit coasts to rest in 90 sec. Assuming uniformly accelerated motion, determine the number of revaluation the units turns (a) to attain the rated speed (b) to come to rest.	[L3][CO6]	[10M]
5.		The angular acceleration of a flywheel is given by $\alpha = 12 - t$, where α is in rad/sec^2 and t is in seconds. If the angular velocity of the flywheel is 60 rad/sec at the end of 4 seconds, determine the angular velocity at the end of 6 seconds. How many revolutions take place in these 6 seconds?	[L4][CO6]	[10M]
6.		The equation for angular displacement of a body, moving in a circular path of radius 200 m is given by $\theta = 18t + 3t^2 - 2t^3$ where θ is the angular displacement at the end of t sec. Find (i) angular velocity and acceleration at start, (ii) time when the body reaches its maximum angular velocity; and (iii) maximum angular velocity of the particle.	[L4][CO6]	[10M]
7.		In a crank and connecting rod mechanism, the radius of crank and length of the connecting rod are 300 mm and 1200 mm respectively. The crank is rotating at 180 r.p.m. Find the velocity of the piston, when the crank is at an angle of 45°, with the horizontal.  **Figure.1**	[L3][CO6]	[10M]
8.		Derive the relationship between the linear motion of geometric centre and angular motion of a wheel rolling without slipping.	[L2][CO6]	[10M]

9.	A flywheel weighing 50 kN and having radius of gyration 1 m loses its speed from 400 rpm to 280 rpm in 2 minutes. Calculate (i) the retarding torque acting on it. (ii) change in its kinetic energy during the above period.	[L3][CO6]	[10M]
10.	A roller of mass m = 600 kg and radius r = 0.25 m is pushed with a constant force P = 850 N on a rough horizontal plane as show in Figure.2. If the roller starts from rest and rolls without slipping, find the distance required to be rolled if it is to acquire a velocity of 3 m/s.  **Figure.2**	[L3][CO6]	[10M]
11.	A glass marble, whose weight is 0.2 N, falls from a height of 10 m and rebounds to a height of 8 metres. Find the impulse and the average force between the marble and the floor, if the time during which they are in contact is 1/10 of a second.	[L3][CO6]	[10M]

Prepared by C Siva Kumar Prasad, Associate Professor, Department of Civil Engineering