U.S.N.										

B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

June 2025 Semester End Main Examinations

Programme: B.E. **Semester: V**

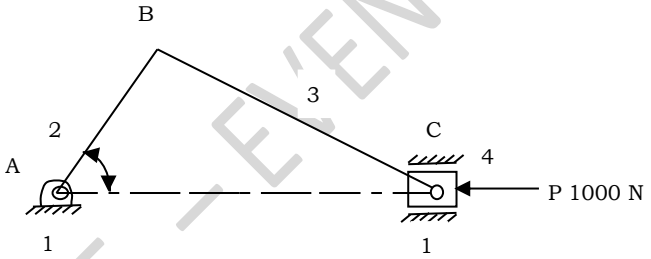
Branch: Mechanical Engineering **Duration: 3 hrs.**

Course Code: 20ME5DCDOM / 16ME5DCDOM **Max Marks: 100**

Course: Dynamics of Machines

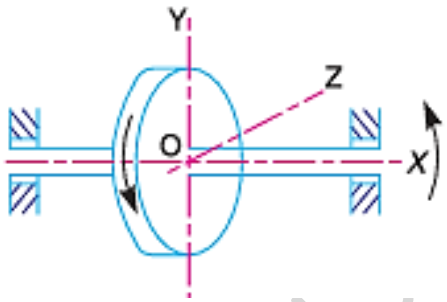
Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

			UNIT - I	*CO*	*PO*	Marks
1	a)	A slider crank mechanism as shown in Fig. 1. The force applied to the piston is 1000 N when the crank is at 60° from IDC. Calculate the driving torque T_2, applied to the link AB. The dimensions of the various links are AB = 100 mm and BC = 300 mm.  Fig. 1	*CO1*	*PO2*	**14**
	b)	State and derive the principle of virtual work.	*CO1*	*PO1*	**06**
		OR			
2	a)	A single cylinder, single acting, four stroke gas engine develops 20 kW at 300 rpm. The work done by the gases during the expansion stroke is three times the work done on the gases during the compression stroke, the work done during the suction and exhaust strokes being negligible. If the total fluctuation of speed is not to exceed ± 2 per cent of the mean speed and the turning moment diagram during compression and expansion is assumed to be triangular in shape, find the moment of inertia of the flywheel.	*CO2*	*PO2*	**14**
	b)	Draw the turning moment diagrams for a single cylinder double acting steam engine, four stroke cycle IC engine and multi-cylinder engine.	*CO2*	*PO1*	**06**

			UNIT - II			
	3	a)	Derive an expression for the ratio of belt tensions in flat belt drives.	*CO3*	*PO1*	**06**
		b)	Determine the width of a 9.75 mm thick leather belt required to transmit 15 kW from a motor running at 900 rpm. The diameter of the driving pulley of the motor is 300 mm. The driven pulley runs at 300 rpm. and the distance between the centre of two pulleys is 3m. The density of the leather is 1000 kg/m^3. The maximum allowable stress in the leather is 2.5 MPa. The coefficient of friction between the leather and pulley is 0.3. Assume open belt drive and neglect the sag and slip of the belt.	*CO3*	*PO2*	**08**
		c)	Derive an expression for power lost in friction in a flat pivot bearing considering uniform pressure.	*CO3*	*PO1*	**06**
			OR			
	4	a)	A shaft has a number of a collars integral with it. The external diameter of the collars is 400 mm and the shaft diameter is 250mm. If the intensity of pressure is 0.35 N/mm^2 (uniform) and the coefficient of friction is 0.05, estimate: i) power absorbed when the shaft runs at 105 rpm. carrying a load of 150 kN; and ii) number of collars required.	*CO3*	*PO2*	**06**
		b)	A cam has straight working faces which are tangential to a base circle of diameter 90 mm. The follower is a roller of diameter 40 mm and the centre of roller moves along a straight line passing through the centre line of the cam shaft. The angle between the tangential faces of the cam is 90° and the faces are joined by a nose circle of 10 mm radius. The speed of rotation of the cam is 120 rpm. Find the acceleration of the roller centre for the following cases: i) when during the lift, the roller is just about to leave the straight flank; and ii) when the roller is at the outer end of its lift.	*CO4*	*PO2*	**14**
			UNIT – III			
	5	a)	A shaft carries four masses A, B, C and D of magnitude 200 kg, 300 kg, 400 kg and 200 kg respectively and revolving at radii 80mm, 70 mm, 60 mm and 80 mm in planes measured from A at 300 mm, 400 mm and 700 mm. The angles between the cranks measured anticlockwise are A to B 45°, B to C 70° and C to D 120°. The balancing masses are to be placed in planes X and Y. The distance between the planes A and X is 100 mm, between X and Y is 400 mm and between Y and D is 200 mm. If the balancing masses revolve at a radius of 100 mm, find their magnitudes and angular positions.	*CO5*	*PO2*	**14**

		b)	Discuss the method of balancing several masses rotating in the same plane.	*CO5*	*PO1*	**06**
			OR			
	6		A shaft has three eccentrics, each 75 mm diameter and 25 mm thick, machined in one piece with the shaft. The central planes of the eccentric are 60 mm apart. The distance of the centres from the axis of rotation are 12 mm, 18 mm and 12 mm and their angular positions are 120° apart. The density of metal is 7000 kg/m^3. Find the amount of out-of-balance force and couple at 600 rpm. If the shaft is balanced by adding two masses at a radius 75 mm and at distances of 100 mm from the central plane of the middle eccentric, find the amount of the masses and their angular positions.	*CO5*	*PO2*	**20**
			UNIT – IV			
	7	a)	The three cylinders of an air compressor have their axes 120° to one another, and their connecting rods are coupled to a single crank. The stroke is 100 mm and the length of each connecting rod is 150 mm. The mass of the reciprocating parts per cylinder is 1.5kg. Find the maximum primary and secondary forces acting on the frame of the compressor when running at 3000 rpm. Describe clearly a method by which such forces may be balanced.	*CO5*	*PO2*	**10**
		b)	Deduce the expression for resultant primary and secondary force while balancing a V-engine.	*CO5*	*PO1*	**10**
			OR			
	8		The firing order in a 6-cylinder vertical four stroke in-line engine is 1-4-2-6-3-5. The piston stroke is 100 mm and the length of each connecting rod is 200 mm. The pitch distances between the cylinder centre lines are 100 mm, 100 mm, 150 mm, 100 mm, and 100 mm respectively. The reciprocating mass per cylinder is 1 kg and the engine runs at 3000 rpm. Determine the out-of-balance primary and secondary forces and couples on this engine, taking a plane midway between the cylinder 3 and 4 as the reference plane. Determine out-of-balance primary & secondary forces and primary & secondary couples.	*CO5*	*PO2*	**20**
			UNIT – V			
	9	a)	Derive an expression for a gyroscopic couple on a spinning disc.	*CO4*	*PO1*	**06**
		b)	A ship propelled by a turbine rotor which has a mass of 5 tonnes and a speed of 2100 rpm. The rotor has a radius of gyration of 0.5m and rotates in a clockwise direction when viewed from the stern. Find the gyroscopic effects in the following conditions: i) The ship sails at a speed of 30 km/h and steers to the left in a curve having 60 m radius. ii) The ship pitches 6 degrees above and 6 degrees below the	*CO4*	*PO2*	**08**

			horizontal position. The bow is descending with its maximum velocity. The motion due to pitching is simple harmonic and the periodic time is 20 seconds. iii) The ship rolls and at a certain instant it has an angular velocity of 0.03 rad/s clockwise when viewed from stern. Determine also the maximum angular acceleration during pitching. Explain how the direction of the motion due to gyroscopic effect is determined in each case.			
		c)	A uniform disc of 150 mm diameter has a mass of 5 kg. It is mounted centrally in bearings which maintain its axle in a horizontal plane. The disc spins about its axle with a constant speed of 1000 rpm. While the axle precesses uniformly about the vertical at 60 rpm. The directions of rotation are as shown in Fig.2. If the distance between the bearings is 100 mm, find the resultant reaction at each bearing due to the mass and gyroscopic effects.  Fig. 2	*CO4*	*PO2*	**06**
			OR			
	10	a)	A rear engine automobile is travelling along a track of 100 meters mean radius. Each of the four road wheels has a moment of inertia of 2.5 kg-m^2 and an effective diameter of 0.6 m. The rotating parts of the engine have a moment of inertia of 1.2 kg-m^2. The engine axis is parallel to the rear axle and the crankshaft rotates in the same sense as the road wheels. The ratio of engine speed to back axle speed is 3:1. The automobile has a mass of 1600 kg and has its center of gravity 0.5 m above road level. The width of the track of the vehicle is 1.5 m. Determine the limiting speed of the vehicle around the curve for all four wheels to maintain contact with the road surface. Assume that the road surface is not cambered and center of gravity of the automobile lies centrally with respect to the four wheels.	*CO4*	*PO2*	**14**
		b)	Find the angle of inclination with respect to the vertical of a two-wheeler negotiating a turn. The data given are as follows: combined mass of the vehicle with its rider 250 kg; moment of inertia of the engine flywheel 0.3 kg-m^2; moment of inertia of each road wheel 1 kg-m^2; speed of engine flywheel 5 times that of road wheels and in the same direction; height of centre of gravity of rider with vehicle 0.6 m; two-wheeler speed 90 km/h; wheel radius 300 mm; radius of turn 50 m.	*CO4*	*PO2*	**06**

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