Reg. No.												

Question Paper Code	12678

B.E. / B.Tech. - DEGREE EXAMINATIONS, APRIL / MAY 2024

Fourth Semester

Mechanical and Automation Engineering

20MUPC402 - THEORY OF MACHINES

Regulations - 2020

(Use of *A3 Sheet* is permitted)

Duration: 3 Hours | Max. Marks: 100

PART - A (10 × 2 = 20 Marks)

Answer ALL Questions

		Marks	K – Level	CO
1.	Recall the difference between a Machine and a Structure.	2	K1	CO1
2.	What is the space centrode and body centrode?	2	K1	CO1
3.	State the law of gearing.	2	K1	CO2
4.	What is the prime circle of a cam?	2	K1	CO3
5.	Define controlling force in the governor.	2	K1	CO4
6.	List the applications of gyroscopic principles.	2	K1	CO4
7.	What is meant by balancing of rotating masses?	2	K1	CO5
8.	Define Tractive force.	2	K1	CO5
9.	What is the principle of Raleigh's method?	2	K1	CO6
10.	Define Vibration isolation.	2	K1	CO6

PART - B (5 × 13 = 65 Marks)

Answer ALL Questions

			Marks	K – Level	CO
11.	a)	Explain the working of any one quick return motion mechanism with a neat sketch.	13	K2	CO1
		OR			
	b)	PQRS is a four-bar chain with link PS fixed. The lengths of the links are PQ = 62.5 mm; QR = 175 mm; RS = 112.5 mm; and PS = 200 mm. The crank PQ rotates at 10 rad/s clockwise. Draw the velocity and acceleration diagram when angle QPS = 60° and Q and R lie on the same side of PS. Identify the angular velocity and angular acceleration of links QR and RS.	13	K3	CO1
12.	a)	Determine the length of the path of contact, the arc of contact, and the contact ratio for a pinion with 30 teeth driving a gear with 80 teeth. Consider the gear's involute profile with a 20° pressure angle, 12 mm module, and 10 mm addendum.	13	K3	CO2
		OR			

b) An epicyclic gear consists of three gears A, B, and C as shown in Figure12. b. Gear A has 72 internal teeth and Gear C has 32 external teeth. Gear B meshes with both A and C and is carried on an arm EF which rotates about the center of A at 18 r.p.m. If gear A is fixed, measure the speed of gears B and C. *13 K3 CO2*

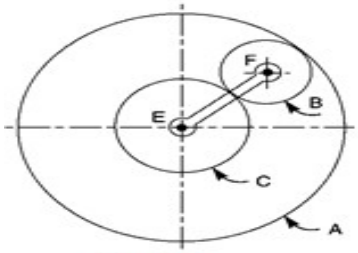

Fig.12.b

13. a) In an engine governor of the Porter type, the upper and lower arms are 200 mm and 250 mm respectively and pivoted on the axis of rotation. The mass of the central load is 15 kg, the mass of each ball is 2 kg and friction of the sleeve together with the resistance of the operating gear is equal to a load of 25 N at the sleeve. If the limiting inclinations of the upper arms to the vertical are 30° and 40°, find, taking friction into account, range of speed of the governor. *13 K3 CO4*

OR

b) A ship sails at a speed of 125 km/hr. The mass of its turbine rotor is 600 kg having a radius of gyration of 0.6 m. It rotates at 1600 rpm in a clockwise direction when looking from its stern. When the ship steers to the left in a radius of curvature of 110m, what would be the gyroscopic couple acting on the ship and what would be its effect. *13 K3 CO4*

14. a) A, B, C, and D are four masses carried by a rotating shaft at radii 100 mm,125 mm, 200 mm, and 150 mm respectively. The planes in which the masses revolve are spaced 600 mm apart and the mass of B, C, and D, are 10 kg, 5 kg, and 4 kg, respectively. Determine the required mass A, and the relative angular settings of the four masses so that the shaft shall be in complete balance. *13 K3 CO5*

OR

b) A four-cylinder two-stroke in-line engine running at 1500 r.p.m. has cranks of 50 mm. The lengths of the connecting rods are 200 mm, and the cylinders are spaced 200 mm apart. The cylinders are numbered 1 to 4 from one end, and the firing order is 1-3-2-4. The reciprocating mass per cylinder is 2 kg. Determine: (i) Unbalanced primary and secondary forces if any, and (ii) Unbalanced primary and secondary couples about the central plane of the engine. *13 K3 CO5*

15. a) A machine of mass 75 kg is mounted on springs and is fitted with a dashpot to damp out vibrations. There are three springs each of stiffness 10 N/mm and it is found that the amplitude of vibration diminishes from 38.4 mm to 6.4 mm in two complete oscillations. *13 K3 CO6*

Assuming that the damping force varies as the velocity, determine: (i) the resistance of the dashpot at unit velocity; (ii) the ratio of the frequency of the damped vibration to the frequency of the undamped vibration; and (iii) the periodic time of the damped vibration.

OR

b) A vehicle has a mass of 490 kg and the total spring constant of its suspension system is 58800 N/m. The profile of the road may be approximated to a sine wave of amplitude 40 mm and wavelength 4.0 meters. Determine: (i) the critical speed of the vehicle, (ii) the amplitude of the steady state motion of the mass when the vehicle is driven at critical speed and the damping factor is 0.5 and (iii) the amplitude of steady state motion of the mass when the vehicle is driven at 57 km/hr and the damping factor is 0.5. *13 K3 CO6*

PART - C (1 × 15 = 15 Marks)

16. a) Design the profile of a cam operating a knife edge follower when the axis of the follower passes through the axis of the camshaft from the following data: (i) Follower to move outwards through 30 mm with simple harmonic motion during 120° of cam rotation, (ii) Follower to dwell for the next 60°, (iii) Follower to return to its original position with uniform velocity during next 90° of cam rotation, (iv) Follower to dwell for the rest of the cam rotation. The least radius of the cam is 20 mm , and the cam rotates at 240 r.p.m. *15 K3 CO3*

OR

b) A cam, with a minimum radius of 25 mm, rotating clockwise at a uniform speed is to be designed to give a roller follower, at the end of a valve rod, motion described below : *15 K3 CO3*

1. To raise the valve through 50mm during 120° rotation of the cam ;
2. To keep the valve fully raised through next 30°;
3. To lower the valve during next 60°; and
4. To keep the valve closed during rest of the revolution i.e. 150° ;

The diameter of the roller is 20 mm and the diameter of the cam shaft is 25 mm. Draw the profile of the cam when the line of stroke of the valve rod passes through the axis of the cam shaft, The displacement of the valve, while being raised and lowered, is to take place with simple harmonic motion. Determine the maximum acceleration of the valve rod when the cam shaft rotates at 100 r.p.m. Draw the displacement, the velocity and the acceleration diagrams for one complete revolution of the cam.