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Question Paper Code	13537

B.E. / B.Tech. - DEGREE EXAMINATIONS, APRIL / MAY 2025

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 (MCQ) (10 × 1 = 10 Marks)

Answer ALL Questions

		Marks	K – Level	CO
1.	A ball and a socket joint forms a (a) turning pair (b) rolling pair (c) sliding pair (d) spherical pair	1	K1	CO1
2.	The component of the acceleration, parallel to the velocity of the particle, at the given instant is called (a) radial component (b) tangential component (c) coriolis component (d) none of these	1	K1	CO1
3.	Tooth interference in an external involute spur gear pair can be reduced by (a) Decreasing center distance between gear pair (b) Decreasing module (c) Decreasing pressure angle (d) Increasing number of gear teeth	1	K1	CO2
4.	The gear train usually employed in clock is (a) Reverted gear train (b) Simple gear train (c) Sun and planet gear train (d) Differential gear train	1	K1	CO2
5.	The type of follower used in automobiles is (a) knife edge (b) roller (c) mushroom with flat face (d) mushroom with spherical face	1	K1	CO3
6.	For high speed engines, the cam follower should move with (a) uniform velocity (b) simple harmonic motion (c) uniform acceleration and retardation (d) cycloidal motion	1	K1	CO3
7.	The engine of an aeroplane rotates in clockwise direction when seen from the tail end and the aeroplane takes a turn to the left. The effect of the gyroscopic couple on the aeroplane will be (a) to raise the nose and dip the tail (b) to dip the nose and raise the tail (c) to raise the nose and tail (d) to dip the nose and tail	1	K1	CO4
8.	The function of a governor is to (a) reduce the speed fluctuations during a cycle (b) maintain the prime mover speed within prescribed limits (c) not to influence the speed of the prime mover (d) not to control the variation in load on the prime mover.	1	K1	CO4
9.	Hammer blow in locomotives results in (a) pulsating torque (b) tendency to lift wheels from rails (c) uneven speed (d) variable horizontal force	1	K1	CO5
10.	Damping ratio (ζ) is defined as: (a) $\zeta = \frac{C_c}{C}$ (b) $\zeta = \frac{C}{C_c}$ (c) $\zeta = C \times C_c$ (d) $\zeta = \left(\frac{C}{C_c}\right)^2$	1	K1	CO6

PART - B (12 × 2 = 24 Marks)

Answer ALL Questions

11.	State Grashoff's law for a four-bar linkage.	2	K1	CO1
12.	Define Instantaneous centre of rotation.	2	K1	CO1
13.	Classify gears based on position of teeth on the wheel.	2	K2	CO2
14.	What is reverted gear train?	2	K1	CO2
15.	Differentiate between radial cam and cylindrical cam.	2	K2	CO3

16.	Draw the Displacement, Acceleration and Velocity Diagrams for a follower when it moves with simple harmonic motion.	2	K2	CO3
17.	What is the effect of gyroscopic couple on rolling of ship? Why?	2	K1	CO4
18.	Define Sensitivity of Governor.	2	K1	CO4
19.	Define Swaying couple.	2	K1	CO5
20.	State the condition for static balancing.	2	K1	CO5
21.	Vibration can have desirable effects – justify.	2	K2	CO6
22.	List the sources of excitation in forced vibration.	2	K1	CO6

PART - C (6 × 11 = 66 Marks)

Answer ALL Questions

23.	a)	Explain the inversions of the four-bar mechanism with a neat sketch and suitable examples.	11	K2	CO1
		OR			
	b)	An engine mechanism is shown in Figure 1. The crank CB = 100 mm and the connecting rod BA = 300 mm with centre of gravity G, 100 mm from B. In the position shown, the crankshaft has a speed of 75 rad/s and an angular acceleration of 1200 rad/s^2. Find: 1. velocity of G and angular velocity of AB, and 2. acceleration of G and angular acceleration of AB.	11	K2	CO1

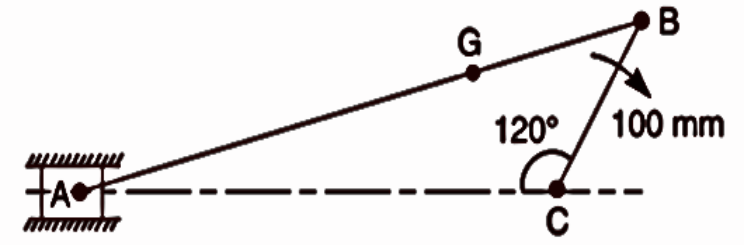

Figure 1

24.	a)	Two gear wheels mesh externally and are to give a velocity ratio of 3 to 1. The teeth are of involute form ; module = 6 mm, addendum = one module, pressure angle = 20°. The pinion rotates at 90 rpm. Determine : 1. The number of teeth on the pinion to avoid interference on it and the corresponding number of teeth on the wheel 2. The length of path and arc of contact 3. The number of pairs of teeth in contact, and 4. The maximum velocity of sliding.	11	K2	CO2
		OR			
	b)	In an epicyclic gear train, an arm carries two gears A and B having 36 and 45 teeth respectively. If the arm rotates at 150 rpm. in the anticlockwise direction about the centre of the gear A which is fixed, determine the speed of gear B. If the gear A instead of being fixed, makes 300 rpm. in the clockwise direction, what will be the speed of gear B?	11	K2	CO2

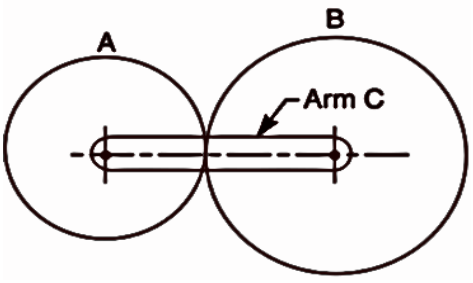

Figure 2

25. a) A cam is to be designed for a knife edge follower with the following data: 1. Cam lift = 40 mm during 90° of cam rotation with simple harmonic motion. 2. Dwell for the next 30°. 3. During the next 60° of cam rotation, the follower returns to its original position with simple harmonic motion. 4. Dwell during the remaining 180°. Draw the profile of the cam when the line of stroke is offset 20 mm from the axis of the cam shaft. The radius of the base circle of the cam is 40 mm. Determine the maximum velocity and acceleration of the follower during its ascent and descent, if the cam rotates at 240 rpm. *11 K2 CO3*

OR

b) Draw the profile of the cam when the roller follower moves with cycloid motion during out stroke and return stroke, as given below : 1. Out stroke with maximum displacement of 31.4 mm during 180° of cam rotation, 2. Return stroke for the next 150° of cam rotation, 3. Dwell for the remaining 30° of cam rotation. The minimum radius of the cam is 15 mm and the roller diameter of the follower is 10 mm. The axis of the roller follower is offset by 10 mm towards right from the axis of cam shaft. *11 K2 CO3*

26. a) A Porter governor has equal arms each 250 mm long and pivoted on the axis of rotation. Each ball has a mass of 5 kg and the mass of the central load on the sleeve is 25 kg. The radius of rotation of the ball is 150 mm when the governor begins to lift and 200 mm when the governor is at maximum speed. Model the minimum and maximum speeds and range of speed of the governor. *11 K3 CO4*

OR

b) The mass of the turbine rotor of a ship is 20 tonnes and has a radius of gyration of 0.60 m. Its speed is 2000 rpm. The ship pitches 6° above and 6° below the horizontal position. A complete oscillation takes 30 seconds and the motion is simple harmonic. Determine the following: 1. Maximum gyroscopic couple, 2. Maximum angular acceleration of the ship during pitching, and 3. The direction in which the bow will tend to turn when rising, if the rotation of the rotor is clockwise when looking from the left. *11 K3 CO4*

27. a) Four masses m_1, m_2, m_3 and m_4 are 200 kg, 300 kg, 240 kg and 260 kg respectively. The corresponding radii of rotation are 0.2 m, 0.15 m, 0.25 m and 0.3 m respectively and the angles between successive masses are 45°, 75° and 135°. Find the position and magnitude of the balance mass required, if its radius of rotation is 0.2 m. *11 K2 CO5*

OR

b) An inside cylinder locomotive has its cylinder centre lines 0.7 m apart and has a stroke of 0.6 m. The rotating masses per cylinder are equivalent to 150 kg at the crank pin, and the reciprocating masses per cylinder to 180 kg. The wheel centre lines are 1.5 m apart. The cranks are at right angles. The whole of the rotating and 2/3 of the reciprocating masses are to be balanced by masses placed at a radius of 0.6 m. Find the magnitude and direction of the balancing masses. Find the fluctuation in rail pressure under one wheel, variation of tractive effort and the magnitude of swaying couple at a crank speed of 300 r.p.m. *11 K2 CO5*

28. a) A vibrating system consists of a mass of 8 kg, spring of stiffness 5.6 N/mm and a dashpot of damping coefficient of 40 N/m/s. Find: (a) the critical damping coefficient (b) the damping factor (c) the natural frequency of damped vibration (d) the logarithmic decrement (e) the ratio of two consecutive amplitudes and (f) the number of cycles after which the original amplitude is reduced to 20 %. *11 K3 CO6*

OR

b) A steel shaft ABCD 1.5m long has flywheel at its end A and D. The mass of the flywheel A is 600kg and has a radius of gyration of 0.6m. The mass of the flywheel D is 800 kg and has a radius of gyration of 0.9m. The connecting shaft has a diameter of 50mm for the portion AB which is of 0.4m long; and has a diameter of 60mm for the portion BC which is 0.5m and has a diameter of d mm for the portion CD which is 0.6m long. Determine 1. The diameter "d" of the portion CD so that the node of the torsion vibration of the system will be at the centre of the length BC and 2. The natural frequency of the torsion vibration The modulus of rigidity for the shaft material is $80GN/m^2$. *11 K3 CO6*