

**B.E. / B.Tech. - DEGREE EXAMINATIONS, NOV / DEC 2025**

Fourth Semester

**Mechanical and Automation Engineering****20MUPC402 - THEORY OF MACHINES**

Regulations - 2020

(A3 Sheets need to be issued)

Duration: 3 Hours

Max. Marks: 100

**PART - A (MCQ) (10 × 1 = 10 Marks)**

Answer ALL Questions

	<i>Marks</i>	<i>K- Level</i>	<i>CO</i>
1. The cam and follower without a spring forms a (a) lower pair      (b) higher pair      (c) self closed pair      (d) force closed pair	1	K1	CO1
2. A point B on a rigid link A B moves with respect to A with angular velocity $\omega$ rad/s. The total acceleration of B with respect to A will be equal to (a) vector sum of radial component and coriolis component (b) vector sum of tangential component and coriolis component (c) vector sum of radial component and tangential component (d) vector difference of radial component and tangential component	1	K1	CO1
3. The tooth profile most commonly used in gear drives for power transmission is (a) a cycloid      (b) an involute      (c) a hyperbola      (d) a spiral	1	K1	CO2
4. In a gear train where the axes of gears have motion are called (a) Reverted gear train      (b) Epicyclic gear train (c) Compound gear train      (d) Bevel wheel gear train	1	K1	CO2
5. The minimum radius circle drawn to the cam profile is called (a) prime circle      (b) base circle      (c) pitch circle      (d) pitch curve	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. A motor car moving at a certain speed takes a left turn in a curved path. If the engine rotates in the same direction as that of wheels, then due to the centrifugal forces (a) the reaction on the inner wheels increases and on the outer wheels decreases (b) the reaction on the outer wheels increases and on the inner wheels decreases (c) the reaction on the front wheels increases and on the rear wheels decreases (d) the reaction on the rear wheels increases and on the front wheels decreases	1	K1	CO4
8. Isochronism in a governor is desirable when (a) the engine operates at low speeds      (b) the engine operates at high speeds (c) the engine operates at variable speeds      (d) one speed is desired under one load	1	K1	CO4
9. Which of the following methods gives lower bound on the natural frequency? (a) Dunkerley's method      (b) Energy method (c) Rayleigh's method      (d) Equilibrium method	1	K1	CO5
10. At resonance, the amplitude of vibration is (a) Very large      (b) small      (c) zero      (d) depends upon frequency	1	K1	CO6

**PART - B (12 × 2 = 24 Marks)**

Answer ALL Questions

11. State Grashof's law for a four-bar linkage.	2	K1	CO1
12. Define Corioli's component of acceleration.	2	K1	CO1
13. What is axial pitch of a helical gear?	2	K1	CO2
14. List out the applications of epicyclic gear train.	2	K1	CO2

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|---|---|----|-----|
| 15. Differentiate between radial cam and cylindrical cam.                           | 2 | K2 | CO3 |
| 16. Define the term jump speed of a cam.  | 2 | K1 | CO3 |
| 17. Indicate the function of a governor.  | 2 | K2 | CO4 |
| 18. What is the gyroscopic effect on stability of two-wheeler when it takes a turn? | 2 | K1 | CO4 |
| 19. Define static balancing.  | 2 | K1 | CO5 |
| 20. What you meant by primary and secondary balancing?                              | 2 | K1 | CO5 |
| 21. Define node in torsional vibration.   | 2 | K1 | CO6 |
| 22. When will the maximum amplitude of vibration occur?                             | 2 | K1 | CO6 |

**PART - C (6 × 11 = 66 Marks)**

Answer ALL Questions

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| 23. a) | Summarize the inversions of single slider-crank mechanism with suitable examples. | 11 | K2 | CO1 |
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**OR**

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|----|--|----|----|-----|
| 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. Find the angular velocity and angular acceleration of links QR and RS. | 11 | K2 | CO1 |
|----|--|----|----|-----|

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|--------|---|----|----|-----|
| 24. a) | Two mating gears have 20 and 40 involute teeth of module 10 mm and 20° pressure angle. The addendum on each wheel is to be made of such a length that the line of contact on each side of the pitch point has half the maximum possible length. Determine the addendum height for each gear wheel, length of the path of contact, arc of contact and contact ratio. | 11 | K2 | CO2 |
|--------|---|----|----|-----|

**OR**

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|----|--|----|----|-----|
| b) | An epicyclic gear consists of three gears A, B and C as shown in Fig. 1. The gear A has 72 internal teeth and gear C has 32 external teeth. The gear B meshes with both A and C and is carried on an arm EF which rotates about the centre of A at 18 r.p.m. If the gear A is fixed, determine the speed of gears B and C. | 11 | K2 | CO2 |
|----|--|----|----|-----|

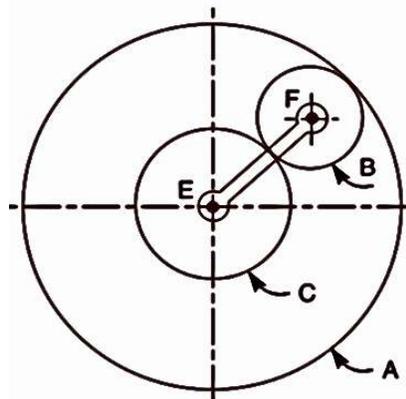


Fig. 1

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|--------|---|----|----|-----|
| 25. a) | A cam drives a flat reciprocating follower in the following manner: During first 120° rotation of the cam, follower moves outwards through a distance of 20 mm with simple harmonic motion. The follower dwells during next 30° of cam rotation. During next 120° of cam rotation, the follower moves inwards with simple harmonic motion. The follower dwells for the next 90° of cam rotation. The minimum radius of the cam is 25 mm. Draw the profile of the cam. | 11 | K2 | CO3 |
|--------|---|----|----|-----|

**OR**

- b) Construct the profile of a cam to suit the following specifications : Cam shaft diameter = 40 mm ; Least radius of cam = 25 mm ; Diameter of roller = 25 mm; Angle of lift =  $120^\circ$  ; Angle of fall =  $150^\circ$  ; Lift of the follower = 40 mm ; Number of pauses are two of equal interval between motions. During the lift, the motion is S.H.M. During the fall the motion is uniform acceleration and deceleration. The speed of the cam shaft is uniform. The line of stroke of the follower is off-set 12.5 mm from the centre of the cam. 11 K2 CO3

26. a) A loaded Porter governor has four links each 250 mm long, two revolving masses each of 3 kg and a central dead weight of mass 20 kg. All the links are attached to respective sleeves at radial distances of 40 mm from the axis of rotation. The masses revolve at a radius of 150 mm at minimum speed and at a radius of 200 mm at maximum speed. Determine the range of speed. 11 K3 CO4

**OR**

- b) The turbine rotor of a ship has a mass of 2000 kg and rotates at a speed of 3000 r.p.m. clockwise when looking from a stern. The radius of gyration of the rotor is 0.5 m. Determine the gyroscopic couple and its effects upon the ship when the ship is steering to the right in a curve of 100 m radius at a speed of 16.1 knots (1 knot = 1855 m/hr). Calculate also the torque and its effects when the ship is pitching in simple harmonic motion, the bow falling with its maximum velocity. The period of pitching is 50 seconds and the total angular displacement between the two extreme positions of pitching is  $12^\circ$ . Find the maximum acceleration during pitching motion. 11 K3 CO4

27. a) A shaft carries four masses in parallel planes A, B, C and D in this order along its length. The masses at B and C are 18 kg and 12.5 kg respectively, and each has an eccentricity of 60 mm. The masses at A and D have an eccentricity of 80 mm. The angle between the masses at B and C is  $100^\circ$  and that between the masses at B and A is  $190^\circ$ , both being measured in the same direction. The axial distance between the planes A and B is 100 mm and that between B and C is 200 mm. If the shaft is in complete dynamic balance, determine : 1. The magnitude of the masses at A and D ; 2. the distance between planes A and D ; and 3. the angular position of the mass at D. 11 K2 CO5

**OR**

- b) The following data refer to two cylinder locomotive with cranks at  $90^\circ$  : Reciprocating mass per cylinder = 300 kg ; Crank radius = 0.3 m ; Driving wheel diameter = 1.8 m ; Distance between cylinder centre lines = 0.65 m ; Distance between the driving wheel central planes = 1.55 m. Determine : 1. the fraction of the reciprocating masses to be balanced, if the hammer blow is not to exceed 46 kN at 96.5 km. p.h. ; 2. the variation in tractive effort ; and 3. the maximum swaying couple. 11 K2 CO5

28. a) The measurements on a mechanical vibrating system show that it has a mass of 8 kg and that the springs can be combined to give an equivalent spring of stiffness 5.4 N/mm. If the vibrating system have a dashpot attached which exerts a force of 40 N when the mass has a velocity of 1 m/s, find : 1. critical damping coefficient, 2. damping factor, 3. logarithmic decrement, and 4. ratio of two consecutive amplitudes. 11 K3 CO6

**OR**

- b) A machine of mass 75kg is mounted on springs of stiffness 1200 kN/m and with an assumed damping factor of 0.2. A piston within the machine of mass 2 kg has a reciprocating motion with a stroke of 80mm and a speed of 3000 cycles/min. Assuming the motion to be simple harmonic. Find: (i) the amplitude of motion of the machine (ii) its phase angle with respect to the exciting force (iii) the force transmitted to the foundation (iv) the phase angle of transmitted force with respect to the exciting force and (v) the phase lag of the transmitted force with respect to the applied force. 11 K3 CO6