Question Paper Code | **13270**

B.E. / B.Tech. - DEGREE EXAMINATIONS, NOV / DEC 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 (MCQ) (20 × 1 = 20 Marks)
Answer ALL Questions

		Marks	K–Level	CO
1.	Which of the following is a lower pair?	1	K1	CO1
	(a) Cam and follower (b) Screw pair (c) Revolute pair (d) All of the above			
2.	In a slider-crank mechanism, which part is the fixed link?	1	K1	CO1
	(a) Slider (b) Crank (c) Frame (d) Connecting rod			
3.	The degree of freedom of a planar mechanism is given by	1	K1	CO1
	(a) 3(n - 1) - 2j (b) 2(n - 1) + j (c) 3n - 2j - h (d) None of the above			
4.	What type of motion does a crank-rocker mechanism produce?	1	K1	CO1
	(a) Purely rotary (b) Reciprocating			
	(c) Oscillatory (d) Mixed rotary and oscillatory			
5.	A gear train where each shaft carries only one gear is called	1	K1	CO2
	(a) Simple gear train (b) Compound gear train			
	(c) Reverted gear train (d) Epicyclic gear train			
6.	The face width of a gear tooth is	1	K1	CO2
	(a) The axial width of the tooth (b) The tangential width of the tooth			
	(c) The radial width of the tooth (d) None of the above			
7.	In a cam profile, dwell means	1	K1	CO3
	(a) Constant velocity of the follower (b) No motion of the follower			
	(c) Uniform acceleration and retardation (d) Cycloidal motion			
8.	In a cylindrical cam, the follower moves	1	K1	CO3
	(a) Axially along the cam (b) Radially around the cam			
	(c) Linearly in a straight path (d) None of the above			
9.	In a centrifugal governor, the controlling force is provided by	1	K1	CO4
	(a) Gravity (b) Springs (c) Both gravity and springs (d) Centrifugal force only			
10.	The effect of friction in a governor results in	1	K1	CO4
	(a) Reduction in sensitivity (b) Increase in speed fluctuation			
	(c) Erratic operation of the governor (d) All of the above			
11.	The controlling force curve for a stable governor should be	1	K1	CO4
	(a) A straight line passing through the origin (b) A parabola			
	(c) A hyperbola (d) None of the above			
12.	A gyroscope produces a reactive force when	1	K1	CO4
	(a) Its axis is tilted (b) Its angular velocity changes			
	(c) It rotates at a constant angular velocity (d) Both (a) and (b)			
13.	For balancing multiple rotating masses in a single plane, the resultant force is calculated using	1	K1	CO5
	(a) Vector addition of all forces (b) Algebraic addition of forces			
	(c) Subtraction of maximum and minimum forces (d) None of the above			
14.	Dynamic balancing of a system with multiple planes requires	1	K1	CO5
	(a) Equal masses in each plane (b) Resolving forces and moments into planes			
	(c) A single counterweight (d) Both (a) and (b)			

K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate; K6 – Create   **13270**

15. Balancing machines are used to   *1 K1 CO5*
    (a) Measure and correct unbalance in rotating parts
    (b) Test dynamic stability of systems
    (c) Calibrate measurement instruments
    (d) Both (a) and (b)
16. In a balancing machine, unbalance is detected using   *1 K1 CO5*
    (a) Vibration sensors   (b) Displacement sensors
    (c) Both (a) and (b)   (d) None of the above
17. Forced vibration is caused by   *1 K1 CO6*
    (a) Internal forces only   (b) A periodic external force
    (c) Both internal and external forces   (d) None of the above
18. The natural frequency of a vibrating system depends on   *1 K1 CO6*
    (a) Mass and stiffness of the system   (b) Damping coefficient only
    (c) External force magnitude   (d) Amplitude of vibration
19. Critical speed of a shaft is defined as the speed at which   *1 K1 CO6*
    (a) The shaft vibrates with minimum amplitude
    (b) Resonance occurs in lateral vibrations
    (c) Rotational inertia is negligible
    (d) None of the above
20. A shaft is said to operate safely if   *1 K1 CO6*
    (a) Operating speed is below the critical speed
    (b) Operating speed is above the critical speed
    (c) Operating speed is far from the critical speed
    (d) All of the above

PART - B (10 × 2 = 20 Marks)
Answer ALL Questions

21. Classify the inversions of four bar mechanisms.   *2 K2 CO1*
22. What is Mechanical Advantage?   *2 K1 CO1*
23. Differentiate between Involute profile and Cycloidal profile.   *2 K2 CO2*
24. Tell about Lift (or) Stroke in cam.   *2 K1 CO3*
25. List the types of governors.   *2 K1 CO4*
26. Show the applications of gyroscopic couple.   *2 K1 CO4*
27. Define Tractive force.   *2 K1 CO5*
28. Relate the condition for static balancing.   *2 K1 CO5*
29. Recall the principle of Raleigh's method.   *2 K1 CO6*
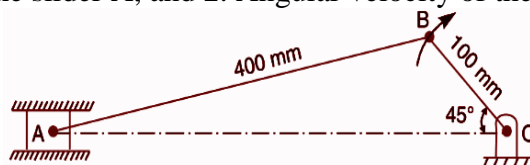30. Classify any three types of damping.   *2 K2 CO6*

PART - C (6 × 10 = 60 Marks)
Answer ALL Questions

31. a) Explain the various inversions of the double slider crank mechanism with a neat   *10 K2 CO1*
       sketch.

OR

    b) Locate all the instantaneous centres of the slider crank mechanism as shown in Fig.   *10 K2 CO1*
       1 The lengths of crank OB and connecting rod AB are 100 mm and 400 mm
       respectively. If the crank rotates clockwise with an angular velocity of 10 rad/s,
       find: 1. Velocity of the slider A, and 2. Angular velocity of the connecting rod AB.

Fig.1

K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate; K6 – Create   **13270**

32. a) A pair of gears, having 40 and 20 teeth respectively, are rotating in mesh, the speed   *10*   *K2*   *CO2*
of the smaller being 2000 r.p.m. Determine the velocity of sliding between the gear
teeth faces at the point of engagement, at the pitch point, and at the point of
disengagement if the smaller gear is the driver. Assume that the gear teeth are 20°
involute form, addendum length is 5 mm and the module is 5 mm.

OR

b) An epicyclic gear consists of three gears A, B and C as shown in Fig. 2 The gear A   *10*   *K2*   *CO2*
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.
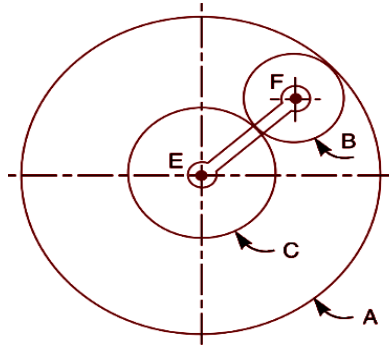
Fig. 2

33. a) A cam, with a minimum radius of 50 mm, rotating clockwise at a uniform speed, is   *10*   *K3*   *CO3*
required to give a knife edge follower the motion as described below :
1. To move outwards through 40 mm during 100° rotation of the cam ; 2. To dwell
for next 80° ; 3. To return to its starting position during next 90°, and 4. To dwell
for the rest period of a revolution i.e. 90°.
Draw the profile of the cam
When the line of stroke of the follower passes through the centre of the cam shaft,
The displacement of the follower is to take place with uniform acceleration and
uniform retardation. Determine the maximum velocity and acceleration of the
follower when the cam shaft rotates at 900 r.p.m.
Draw the displacement, velocity and acceleration diagrams for one complete
revolution of the cam.

OR

b) Construct the profile of a cam to suit the following specifications :   *10*   *K3*   *CO3*
Cam shaft diameter = 40 mm ; Least radius of cam = 25 mm ; Diameter of roller =
25 mm; Angle of lift = 120° ; Angle of fall = 150° ; 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.

34. a) A Proell governor has equal arms of length 300 mm. The upper and lower ends of   *10*   *K3*   *CO4*
the arms are pivoted on the axis of the governor. The extension arms of the lower
links are each 80 mm long and parallel to the axis when the radii of rotation of the
balls are 150 mm and 200 mm. The mass of each ball is 10 kg and the mass of the
central load is 100 kg. Determine the range of speed of the governor.

OR

b) The turbine rotor of a ship has a mass of 3500 kg. It has a radius of gyration of 0.45 m and a speed of 3000 r.p.m. clockwise when looking from stern. Determine the gyroscopic couple and its effect upon the ship: 1. when the ship is steering to the left on a curve of 100 m radius at a speed of 36 km/h. 2. When the ship is pitching in a simple harmonic motion, the bow falling with its maximum velocity. The period of pitching is 40 seconds and the total angular displacement between the two extreme positions of pitching is 12 degrees.

10   K3   CO4

35. a) A, B, C and D are four masses carried by a rotating shaft at radii 100, 125, 200 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. Find the required mass A and the relative angular settings of the four masses so that the shaft shall be in complete balance.

10   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.

10   K2   CO5

36. 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. Assuming that the damping force varies as the velocity, Determine: 1. the resistance of the dashpot at unit velocity; 2. the ratio of the frequency of the damped vibration to the frequency of the undamped vibration; and 3. the periodic time of the damped vibration.

10   K3   CO6

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

10   K3   CO6