B.E. / B.Tech. - DEGREE EXAMINATIONS, NOV / DEC 2024

Fifth Semester

Mechanical Engineering

20MEPC503 - THEORY OF MACHINES

Regulations - 2020

Duration: 3 Hours | Max. Marks: 100

PART - A (MCQ) (20 × 1 = 20 Marks)
Answer ALL Questions

		Marks	K-Level	CO

1. When one of the links of a kinematic chain is fixed, the chain is known as a — **1 K1 CO1**
   (a) structure   (b) mechanism   (c) inversion   (d) machine

2. In a kinematic chain, a quaternary joint is equivalent to — **1 K1 CO1**
   (a) one binary joint   (b) two binary joints
   (c) three binary joints   (d) four binary joints

3. The Grubler's criterion for determining the degrees of freedom (n) of a mechanism having plane motion is — **1 K1 CO1**
   (a) $n = (l-1) - j$ (b) $n = 2(l-1) - 2j$
   (c) $n = 3(l-1) - 2j$ (d) $n = 4(l-1) - 3j$

4. The locus of a point on the pitch circle from the beginning to end of engagement of two mating gears is called as _____ — **1 K1 CO2**
   (a) Arc of contact   (b) Path of contact
   (c) Path of approach   (d) Arc of approach

5. The contact ratio is the ratio of arc of contact to the _____ — **1 K1 CO2**
   (a) module   (b) circular pitch
   (c) dedendum   (d) circular pitch

6. An imaginary circle which by pure rolling action, gives the same motion as the actual gear, is called — **1 K1 CO2**
   (a) addendum circle   (b) dedendum circle
   (c) pitch circle   (d) clearance circle

7. The cam follower generally used in automobile engines is — **1 K1 CO3**
   (a) knife edge follower   (b) flat faced follower
   (c) spherical faced follower   (d) roller follower

8. In a radial cam, the follower moves — **1 K1 CO3**
   (a) in a direction perpendicular to the cam axis
   (b) in a direction parallel to the cam axis
   (c) in any direction irrespective of the cam axis
   (d) along the cam axis

9. For low and moderate speed engines, the cam follower should move with — **1 K1 CO3**
   (a) uniform velocity   (b) simple harmonic motion
   (c) uniform acceleration and retardation   (d) cycloidal motion

10. The effect of inertia force on the engine crankshaft is mainly due to: — **1 K1 CO4**
    (a) rotating flywheel   (b) reciprocating pistons
    (c) governor action   (d) crankcase movement

11. Secondary balancing is concerned with: — **1 K1 CO4**
    (a) centrifugal forces only   (b) primary inertia forces only
    (c) higher harmonic inertia forces   (d) primary balancing only

12. In balancing rotating masses, the primary aim is to: — **1 K1 CO4**
    (a) reduce fuel consumption   (b) decrease inertia
    (c) minimize vibration   (d) control temperature

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

13. Longitudinal vibrations are said to occur when the particles of a body moves   *1*   *K1*   *CO5*
    (a) perpendicular to its axis   (b) parallel to its axis
    (c) in a circle about its axis   (d) inclined to its axis
14. Which type of damping causes the system to return to equilibrium without   *1*   *K1*   *CO5*
    oscillation?
    (a) Over damping   (b) Under damping
    (c) Critical damping   (d) No damping
15. What type of vibration is caused by a periodic external force applied to a system?   *1*   *K1*   *CO5*
    (a) Free vibration   (b) Forced vibration
    (c) Torsional vibration   (d) Longitudinal vibration
16. Frequency is defined as: *1*   *K1*   *CO5*
    (a) The time taken for one complete vibration
    (b) The maximum displacement from the equilibrium
    (c) The number of vibrations per unit time
    (d) The force applied to start the vibration
17. Which factor reduces the power transmitted by a belt?   *1*   *K1*   *CO6*
    (a) Decreasing pulley diameter   (b) Increasing belt tension
    (c) Belt slipping   (d) Increasing coefficient of friction
18. The screw thread used in a screw jack is usually: *1*   *K1*   *CO6*
    (a) Acme thread   (b) Buttress thread
    (c) Square thread   (d) Metric thread
19. Which type of load does a footstep bearing primarily handle?   *1*   *K1*   *CO6*
    (a) Radial load   (b) Axial load
    (c) Torsional load   (d) Bending load
20. Which material is commonly used for the lining of a footstep bearing?   *1*   *K1*   *CO6*
    (a) Cast iron   (b) Bronze   (c) Steel   (d) Copper

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

21. Differentiate machine and a structure.   *2*   *K1*   *CO1*
22. State the difference between lower and higher pairs.   *2*   *K1*   *CO1*
23. Define Pressure angle of Gears.   *2*   *K1*   *CO2*
24. Define Diametral pitch.   *2*   *K1*   *CO2*
25. Define Trace point as applied to cam.   *2*   *K1*   *CO3*
26. Differentiate between Radial and Offset follower.   *2*   *K2*   *CO3*
27. Discuss the difference between Flywheel and Governor.   *2*   *K2*   *CO4*
28. State the concept involved in balancing of Rotating masses.   *2*   *K1*   *CO4*
29. Write the governing equation of Free vibration.   *2*   *K2*   *CO5*
30. Discuss why rolling motion of a ship has no gyroscopic effect.   *2*   *K2*   *CO6*

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

31. a) Explain the Inversions of Double slider crank Mechanism with neat sketches and   *10*   *K3*   *CO1*
    state some applications.

OR

    b) PQRS is a four bar chain with link PS fixed. The lengths of the links are   *10*   *K3*   *CO1*
    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 diagram when angle
    QPS = 60° and Q and R lie on the same side of PS. Find the angular velocity of
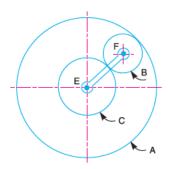   links QR and RS.

32. a) A pinion having 30 teeth drives a gear having 80 teeth. The profile of the gears is involute with 20° pressure angle, 12 mm module and 10 mm addendum. Find the length of path of contact, arc of contact and Contact ratio.   *10*   *K3*   *CO2*

OR

b) An epicyclic gear consists of three gears A, B and C as shown in Fig. 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.   *10*   *K3*   *CO2*

33. a) A cam, with a minimum radius of 50 mm, rotating clockwise at a uniform speed is required to give a knife edge follower, the, motion described below :   *10*   *K2*   *CO3*
1. To move outwards through 40 mm during 100° rotation of the cam
2. To dwell for the next 80°
3. To return to its starting position during next 90° and 4. To dwell during rest of the revolution i.e. 90°
Draw the profile of the cam when the line of stroke of the follower passes through the axis of the cam shaft. The displacement of the follower is to take place with Uniform acceleration and uniform retardation.

OR

b) It is required to set out the profile of a cam to give the following motion to the reciprocating follower with a knife edge.   *10*   *K2*   *CO3*
(i) Follower to have a stroke of 20 mm during 120° of cam rotation ;
(ii) Follower to dwell for 30° of cam rotation ;
(iii) Follower to return to its initial position during 120° of cam rotation ; and
(iv) Follower to dwell for remaining 90° of cam rotation.
The minimum radius of the cam is 25 mm. The out stroke of the follower is performed with simple harmonic motion and the return stroke with equal uniform acceleration and retardation.

34. a) A vertical double acting steam engine has a cylinder 300 mm diameters and 450 mm stroke and runs at 200 r.p.m. The reciprocating parts have a mass of 225 kg and the piston rod is 50 mm diameter. The connecting rod is 1.2 m long. When the crank has turned through 125°from the top dead centre, the steam pressure above the piston is 30 KN/m^2 and below the piston is 1.5 KN/m$^{2.}$ Calculate the effective turning moment on the crank shaft.   *10*   *K3*   *CO4*

OR

b) 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*   *K3*   *CO4*

35. a) Calculate the whirling speed of a shaft of 20 mm diameter and 0.6 m long carrying a mass of 1 kg at its mid-point. The density of the shaft material is 40 Mg/m^3, and Young's modulus is 200 GN/m^2. Assume the shaft to be freely supported.   *10   K3   CO5*

OR

    b) The mass of a single degree damped vibrating system is 7.5 kg and makes 24 free oscillations in 14 seconds when disturbed from its equilibrium position. The amplitude of vibration reduces to 0.25 of its initial value after five oscillations. Determine: 1. Stiffness of the spring, 2. Logarithmic decrement and 3. Damping factor, i.e. the ratio of the system damping to critical damping.   *10   K3   CO5*

36. a) A Porter governor has all four arms 250 mm long. The upper arms are attached on the axis of rotation and the lower arms are attached to the sleeve at a distance of 30 mm from the axis. The mass of each ball is 5 kg and the sleeve has a mass of 50 kg. The extreme radii of rotation are 150 mm and 200 mm. Determine the range of speed of the governor.   *10   K3   CO6*

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: *10   K3   CO6*

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.