| Reg. No. | | | | | | | | | | | | | | | |
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| Question Paper Code | 13546 |
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**B.E. / B.Tech. - DEGREE EXAMINATIONS, APRIL / MAY 2025**

Fifth Semester

**Mechanical Engineering**

**20MEPC503 – THEORY OF MACHINES**

Regulations - 2020

(Use of PSG Design Data Book is permitted)

Duration: 3 Hours Max. Marks: 100

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

Answer ALL Questions

| | | Marks | K – Level | CO |
|---|---|---|---|---|
| 1. | In a kinematic chain, a quaternary joint is equivalent to<br>(a) One binary joint (b) Two binary joints<br>(c) Three binary joints (d) Four binary joints | 1 | K1 | CO1 |
| 2. | Which of the following is a higher pair?<br>(a) Belt and pulley (b) Turning pair<br>(c) Screw pair (d) Sliding pair | 1 | K1 | CO1 |
| 3. | Velocity of sliding at the pitch point = $(\omega_p + \omega_g)$ x _____<br>(a) arc of approach (b) path of contact<br>(c) path of recess (d) zero | 1 | K1 | CO2 |
| 4. | The type of gears used to connect two non-parallel non-intersecting shafts are<br>(a) spur gears (b) helical gears<br>(c) spiral gears (d) none of the mentioned | 1 | K1 | CO2 |
| 5. | The cam follower generally used in automobile engines is<br>(a) nife edge follower (b) flat faced follower<br>(c) spherical faced follower (d) roller follower | 1 | K1 | CO3 |
| 6. | A cam-follower system is commonly used in:<br>(a) Gearboxes (b) Internal combustion engines<br>(c) Hydraulics (d) Electrical circuits | 1 | K1 | CO3 |
| 7. | Which engine component is primarily affected by inertia force?<br>(a) connecting rod (b) flywheel<br>(c) crankshaft (d) cylinder block | 1 | K1 | CO4 |
| 8. | Balancing of rotating masses reduces:<br>(a) centrifugal forces (b) inertia forces<br>(c) gyroscopic effects (d) only primary forces | 1 | K1 | CO4 |
| 9. | The factor which affects the critical speed of a shaft is<br>(a) diameter of the disc (b) span of the shaft<br>(c) eccentricity (d) all of these | 1 | K1 | CO5 |
| 10. | A Porter governor is different from a Watt governor due to:<br>(a) different ball sizes (b) additional spring<br>(c) extra weight on sleeve (d) use of gears | 1 | K1 | CO6 |

**PART - B (12 × 2 = 24 Marks)**

Answer ALL Questions

| | | Marks | K – Level | CO |
|---|---|---|---|---|
| 11. | List the difference between lower and higher pairs. | 2 | K2 | CO1 |
| 12. | State the Grashof's law. | 2 | K1 | CO1 |
| 13. | Define Addendum and Dedendum. | 2 | K1 | CO2 |
| 14. | What is meant by Interference of gears? | 2 | K1 | CO2 |
| 15. | Define Trace point as applied to cam. | 2 | K1 | CO3 |

| | | | | |
|---|---|---|---|---|
| 16. | Differentiate between Radial and Offset follower. | *2* | *K2* | *CO3* |
| 17. | State D-Alembert's principle. | *2* | *K1* | *CO4* |
| 18. | Discuss on the crank pin effort. | *2* | *K2* | *CO4* |
| 19. | Write the governing equation of Free, Damped vibration. | *2* | *K1* | *CO5* |
| 20. | Discuss on the differences between free vibration and forced vibration. | *2* | *K2* | *CO5* |
| 21. | Why 'Watt governor' cannot be used to control high speeds? | *2* | *K2* | *CO6* |
| 22. | Compare the Open and Crossed Belt drive. | *2* | *K2* | *CO6* |

**PART - C (6 × 11 = 66 Marks)**

Answer ALL Questions

| | | | | | |
|---|---|---|---|---|---|
| 23. | a) | In a crank and slotted lever quick return motion mechanism, the distance between the fixed centres O and C is 200 mm. The driving crank CP is 75 mm long. The pin Q on the slotted lever, 360 mm from the fulcrum O, is connected by a link QR 100 mm long, to a pin R on the ram. The line of stroke of R is perpendicular to OC and intersects OC produced at a point 150 mm from C. Find the inclination of the slotted bar with the vertical in the extreme position and also determine the ratio of times taken on the cutting and return strokes. | *11* | *K3* | *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 diagram when angle QPS = 60° and Q and R lies on the same side of PS. Find the angular velocity of links QR and RS. | *11* | *K3* | *CO1* |
| 24. | a) | Two gears of module 4mm have 24 and 33 teeth. The pressure angle is 20° and each gear has a standard addendum of one module. Find the length of arc of contact and the maximum velocity of sliding if the pinion rotates at 120 r.p.m. | *11* | *K3* | *CO2* |
| | | **OR** | | | |
| | 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* | *K3* | *CO2* |

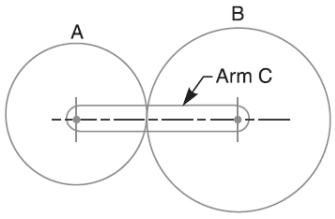


*Fig 1*

| | | | | | |
|---|---|---|---|---|---|
| 25. | a) | Design a cam for operating the exhaust valve of an oil engine. It is required to give equal uniform acceleration and retardation during opening and closing of the valve each of which corresponds to 60° of cam rotation. The valve must remain in the fully open position for 20° of cam rotation. The lift of the valve is 37.5 mm and the least radius of the cam is 40 mm. The follower is provided with a roller of radius 20 mm and its line of stroke passes through the axis of the cam. | *11* | *K3* | *CO3* |
| | | **OR** | | | |
| | b) | A cam is to be designed for a knife edge follower with the following data :<br>1. Cam lift = 40 mm during 90° of cam rotation with simple harmonic motion.<br>2. Dwell for the next 30°.<br>3. During the next 60° of cam rotation, the follower returns to its original position | *11* | *K3* | *CO3* |

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.

26. a) Four masses *A*, *B*, *C* and *D* are attached to a shaft and revolve in the same plane. The masses are 12kg, 10 kg, 18 kg and 15 kg respectively and their radii of rotations are 40 mm, 50 mm, 60 mm and30 mm. The angular position of the masses *B*, *C* and *D* are 60°, 135° and 270° from the mass *A*. Find the magnitude and position of the balancing mass at a radius of 100mm. *11 K3 CO4*

**OR**

b) A vertical double acting steam engine has a cylinder 300 mm diameter 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. *11 K3 CO4*

27. a) The measurements on a mechanical vibrating system show that it has amass 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 CO5*

**OR**

b) A shaft of diameter 10 mm carries at its centre a mass of 12 kg. It is supported by two short bearings, the centre distance of which is 400 mm. Find the whirling speed: 1. neglecting the mass of the shaft, and 2. taking the mass of the shaft also into consideration. The density of shaft material is 7500 kg/$m^3$. *11 K3 CO5*

28. 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. *11 K3 CO6*

**OR**

b) A shaft rotating at 200 r.p.m. drives another shaft at 300 r.p.m. and transmits 6 kW through a belt. The belt is 100 mm wide and 10 mm thick. The distance between the shafts is 4m. The smaller pulley is 0.5 m in diameter. Calculate the stress in the belt, if it is an open belt drive, Take $\mu = 0.3$. *11 K3 CO6*