| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | ii. | The crank radius of a horizontal engine is 300 mm. The mass of the reciprocating parts is 250 kg. When the crank has travelled 60° from I.D.C., the difference between the driving and the back pressures is 0.35 N/mm$^2$. The connecting rod length between centres is 1.2 m and the cylinder bore is 0.5 m. If the engine runs at 250 r.p.m. and if the effect of piston rod diameter is neglected, calculate: (a) Pressure on slide bars, (b) Thrust in the connecting rod, (c) Tangential force on the crank-pin, and (d) Turning moment on the crank shaft. | **6** | 03 | 01<br>03 | 03 | 01 |
| OR | iii. | The turning moment diagram for a multicylinder engine has been drawn to a scale 1 mm = 600 N-m vertically and 1 mm = 3° horizontally. The intercepted areas between the output torque curve and the mean resistance line, taken in order from one end, are as follows :+ 52, – 124, + 92, – 140, + 85, – 72 and + 107 mm$^2$, when the engine is running at a speed of 600 r.p.m. If the total fluctuation of speed is not to exceed ± 1.5% of the mean, find the necessary mass of the flywheel of radius 0.5 m. | **6** | 03 | 01<br>03 | 03 | 01 |
| Q.6 | | Attempt any two: | | | | | |
| | i. | State any two advantages of spring loaded governor over dead weight governor. Define and explain the following terms relating to governors (a) Stability, (b) Sensitiveness, (c) Isochronism, and (d) Hunting. | **5** | 02 | 01<br>03 | 02 | 01 |
| | ii. | Derive an expression for height of Porter governor. | **5** | 03 | 01<br>03 | 03 | 01 |
| | iii. | 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 15 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. Find the minimum and maximum speeds and range of speed of the governor. | **5** | 03 | 01<br>03 | 03 | 01 |

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*Total No. of Questions: 6* *Total No. of Printed Pages:4*

**Enrollment No.....**

Faculty of Engineering

End Sem Examination Dec 2024

RA3CO52 Kinematics & Dynamics of Machines

Programme: B.Tech. Branch/Specialisation: RA

**Duration: 3 Hrs.** **Maximum Marks: 60**

Note: All questions are compulsory. Internal choices, if any, are indicated. Answers of Q.1 (MCQs) should be written in full instead of only a, b, c or d. Assume suitable data if necessary. Notations and symbols have their usual meaning.

| | | | **Marks** | **BL** | **PO** | **CO** | **PSO** |
|---|---|---|---|---|---|---|---|
| Q.1 | i. | A ball and a socket joint forms a-<br>(a) Turning pair (b) Rolling pair<br>(c) Sliding pair (d) Spherical pair | **1** | 01 | 01 | 01 | 01 |
| | ii. | Which of the following is not an inversion of single slider crank chain?<br>(a) Whitworth quick return motion mechanism<br>(b) Beam engine<br>(c) Rotating cylinder<br>(d) Elliptical trammels | **1** | 01 | 01 | 01 | 01 |
| | iii. | Pitch point in cam is the point at which-<br>(a) Pressure angle has zero value<br>(b) Pressure angle has maximum value<br>(c) Pressure angle has minimum value<br>(d) Pressure angle has right angle | **1** | 01 | 01 | 01 | 01 |
| | iv. | The cam follower extensively used in air-craft engines is-<br>(a) Knife edge follower<br>(b) Flat faced follower<br>(c) Spherical faced follower<br>(d) Roller follower | **1** | 01 | 01 | 01 | 01 |
| | v. | The module for spur gear is given by-<br>(a) d/t (b) t/d<br>(c) π d/t (d) 2πd/t | **1** | 01 | 01 | 01 | 01 |
| | vi. | The contact ratio for spur gears must be-<br>(a) Zero<br>(b) Less than one<br>(c) Between 1-2<br>(d) More than two | **1** | 01 | 01 | 01 | 01 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| vii. | If a mean radius of a rim-type flywheel is Double, its stored energy is_____ of the original flywheel at the same speed.<br>(a) Double<br>(b) Half<br>(c) Same as<br>(d) Four times | **1** | 01 | 01 | 01 | 01 |
| viii. | The ratio of the maximum fluctuation of speed to the mean speed is called-<br>(a) Fluctuation of speed<br>(b) Maximum fluctuation of speed<br>(c) Coefficient of fluctuation of speed<br>(d) None of these | **1** | 01 | 01 | 01 | 01 |
| ix. | The height of a Watt's governor (in metres) in equal to (where N = Speed of the arm and ball about the spindle axis)-<br>(a) $8.95/N^2$ (b) $89.5/N^2$<br>(c) $895/N^2$ (d) $8950/N^2$ | **1** | 01 | 01 | 01 | 01 |
| x. | Which of the following is a spring controlled governor?<br>(a) Hartnell<br>(b) Watt<br>(c) Porter<br>(d) Proell | **1** | 01 | 01 | 01 | 01 |
| Q.2 i. | Write differences between machine and mechanism. | **2** | 02 | 01 03 | 02 | 01 |
| ii. | Define inversion of a mechanism. Explain any two inversion of single slider crank chain. | **3** | 02 | 01 03 | 02 | 01 |
| iii. | What is the condition for correct steering? Enlist main types of steering mechanism. Explain any one steering mechanism with neat sketch. | **5** | 03 | 01 03 | 03 | 01 |
| OR iv. | Explain classification of kinematic pair with the help of diagrams to represent them. | **5** | 03 | 01 03 | 03 | 01 |
| Q.3 i. | What is cam & follower mechanism? Give basic classification of cam and follower. | **3** | 02 | 01 03 | 02 | 01 |
| ii. | A cam is to give the following motion to a knife-edged follower (a) Outstroke during 90° of cam rotation; (b) Dwell for the next 30° of cam rotation; (c) Return stroke during next 90° of cam rotation, and (d) Dwell for the remaining of cam rotation. The stroke of the follower | **7** | 03 | 01 03 | 03 | 01 |



| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | is 40 mm and the minimum radius of the cam is 50 mm. The follower moves with SHM during both the outstroke and return strokes. Draw the profile of the cam when the axis of the follower passes through the axis of the cam shaft. | | | | | | | |
| OR iii. | A cam is to be designed for a roller follower of 20mm radius with the following data (a) Cam lift = 40 mm during 90° of cam rotation. (b) Dwell for the next 30°. (c) Return stroke during the next 90° of cam rotation, (d) Dwell during the remaining of cam rotation. Draw the profile of the cam when the line of stroke is passing from the axis of the cam shaft. The radius of the base circle of the cam is 40 mm. The follower moves with uniform velocity during both the outstroke and return strokes. | **7** | 03 | 01 03 | 03 | 01 |
| Q.4 i. | Define term's used for spur gear pressure angle, module, circular pitch and pitch circle. | **2** | 01 | 01 | 01 | 01 |
| ii. | Write differences between cycloidal and involute profile tooth. | **3** | 02 | 01 03 | 02 | 01 |
| iii. | Two gear wheels mesh externally and have pinion pitch circle diameter as 60 mm. The no. of teeth are 18 and 36. The teeth are of involute type: Addendum = 0.4 times of circular pitch, Pressure angle = 20º. Find, (a) Length of path of contact, (b) Length of arc of contact and (c) Contact ratio. | **5** | 03 | 01 03 | 03 | 01 |
| OR iv | 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 r.p.m. 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 r.p.m. in the clockwise direction, what will be the speed of gear B? | **5** | 03 | 01 03 | 03 | 01 |
| Q.5 i. | What is the function of a flywheel? How does it differ from that of a governor? Define the terms 'Coefficient of fluctuation of energy' and 'Coefficient of fluctuation of speed', in the case of flywheels. | **4** | 02 | 01 03 | 02 | 01 |

## Marking Scheme

## RA3CO52 (T) Kinematics and Dynamics of Machines (T)

| | | | |
|---|---|---|---|
| Q.1 | i) | (d) Spherical pair | **1** |
| | ii) | (d) Elliptic Trammel | **1** |
| | iii) | (b) pressure angle has maximum value | **1** |
| | iv) | (d) roller follower | **1** |
| | v) | (a) d/t | **1** |
| | vi) | (c)Between 1-2 | **1** |
| | vii) | d) Four times | **1** |
| | viii) | (c) coefficient of fluctuation of speed | **1** |
| | ix) | (c) $895/N^2$ | **1** |
| | x) | (a) Hartnell | **1** |

| | | | |
|---|---|---|---|
| Q.2 | i. | Any two difference between machine and mechanism. 1+1 | **2** |
| | ii. | Define inversion of a mechanism. 1M<br>Explain any two inversion of single slider crank chain. 1+1M | **3** |
| | iii. | the condition for correct steering.1M<br>Enlist main types of steering mechanism.1M<br>Explain any one steering mechanism with neat sketch. 3M | **5** |
| OR | iv. | classification of kinematic pair with definition 3M<br>with the help of diagrams to represent them. 2M | **5** |

| | | | |
|---|---|---|---|
| Q.3 | i. | Explain cam & follower mechanism.1M<br>Give basic classification of cam and follower. 1M<br>Give its practical application where they can use. 1M | **3** |
| | ii. | Displacement diagram for SHM 2M<br>profile of the cam 5M | **7** |
| OR | iii. | Displacement diagram for SHM 2M<br>profile of the cam 5M | **7** |

| | | | |
|---|---|---|---|
| Q.4 | i. | For each definition **0.5 marks Each** | **2** |
| | ii. | At least three main difference **1 marks Each** | **3** |
| OR | iii. | Given data and formula used 1M<br>i)length of path of contact 2M<br>ii) length of arc of contact 1M<br>iii) Contact ratio. 1M<br>Table method 3M<br>A which is fixed, determine the speed of gear B. 1M<br>If the gear A instead of being fixed, makes 300 r.p.m. in the clockwise direction, what will be the speed of gear B ? 1M | **5** |
| Q.5 | i. | What is the function of a flywheel? 1M<br>differ from that of a governor 2M<br>Define the terms 'coefficient of fluctuation of energy' 'coefficient of fluctuation of speed **0.5 marks Each** | **5** |

ii. **Solution.** Given: $r = 300$ mm $= 0.3$ m ; $m_R = 250$ kg; $\theta = 60°$; $p_1 - p_2 = 0.35$ N/mm$^2$ $l = 1.2$ m ; $D = 0.5$ m $= 500$ mm ; $N = 250$ r.p.m. or $\omega = 2\pi \times 250/60 = 26.2$ rad/s **6**

**1M**

First of all, let us find out the piston effort ($F_P$).

We know that net load on the piston,

$$F_L = (p_1 - p_2)\frac{\pi}{4} \times D^2 = 0.35 \times \frac{\pi}{4}(500)^2 = 68730 \text{ N}$$

...(∵ Force = Pressure × Area)

Ratio of length of connecting rod and crank,

$$n = l/r = 1.2/0.3 = 4$$

and accelerating or inertia force on reciprocating parts,

$$F_I = m_R \cdot \omega^2 r\left(\cos\theta + \frac{\cos 2\theta}{n}\right)$$

$$= 250\,(26.2)^2\ 0.3\left(\cos 60° + \frac{\cos 120°}{4}\right) = 19306 \text{ N}$$

∴ Piston effort, $F_P = F_L - F_I = 68\,730 - 19\,306 = 49\,424$ N $= 49.424$ kN

*1. Pressure on slide bars*

**2M**

Let $\phi$ = Angle of inclination of the connecting rod to the line of stroke.

We know that, $\sin\phi = \frac{\sin\theta}{n} = \frac{\sin 60°}{4} = \frac{0.866}{4} = 0.2165$

∴ $\phi = 12.5°$

We know that pressure on the slide bars,

$$F_N = F_P \tan\phi = 49.424 \times \tan 12.5° = 10.96 \text{ kN}$$ Ans.

*2. Thrust in the connecting rod*

We know that thrust in the connecting rod,

**1M**

$$F_Q = \frac{F_P}{\cos\phi} = \frac{49.424}{\cos 12.5°} = 50.62 \text{ kN}$$ Ans.

*3. Tangential force on the crank-pin*

**1M**

We know that tangential force on the crank pin,

$$F_T = F_Q \sin(\theta + \phi) = 50.62 \sin(60° + 12.5°) = 48.28 \text{ kN}$$ Ans. **1M**

*4. Turning moment on the crank shaft*

We know that turning moment on the crank shaft,

$$T = F_T \times r = 48.28 \times 0.3 = 14.484 \text{ kN-m}$$ Ans.

OR iii. The turning moment diagram for a multicylinder engine **6**

1M



Given data and formula used 1M

$\Delta E$ = Maximum energy – Minimum energy 2M

$= (E + 52) - (E - 120) = 172 = 172 \times 31.42 = 5404$ N-m

$5404 = m.R2.\omega2.CS = m \times (0.5)2 \times (62.84)2 \times 0.03 =$

$29.6$ m ∴ m $= 5404 / 29.6 = 183$ kg 2M

Q.6

i. two advantages of spring loaded governor **5**

Define and explain the following terms relating to governors 1.Stability, 2.Sensitiveness, 3.Isochronism, and 4.Hunting. **1 marks Each**

ii. Diagram and FBD 1M **5**

Complete Derivation for height of Porter governor. 4M

iii. Diagram 1M **5**

Given data and formula used 2M

range of speed of the governor. 2M

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