Enrollment No......................................

Faculty of Engineering
End Sem Examination Dec-2023
AU3CO33 Theory of Machines

Programme: B.Tech.   Branch/Specialisation: AU

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.

Q.1 i.   A ball and a socket joint forms a-   **1**
           (a) Turning pair   (b) Rolling pair
           (c) Sliding pair   (d) Spherical pair

     ii.   Which of the following is an inversion of double slider crank chain?   **1**
           (a) Whitworth quick return motion mechanism
           (b) Beam engine
           (c) Watt's indicator mechanism
           (d) Elliptical trammels

     iii. According to Aronhold Kennedy's theorem, if three bodies move   **1**
           relatively to each other, their instantaneous centres will lie on a-
           (a) Straight line   (b) Parabolic curve
           (c) Ellipse   (d) None of these

     iv.   The direction of linear velocity of any point on a link with respect to   **1**
           another point on the same link is-
           (a) Parallel to the link joining the points
           (b) Perpendicular to the link joining the points
           (c) At 45° to the link joining the points
           (d) None of these

     v.   Pitch point in cam is the point at which-   **1**
           (a) Pressure angle has zero value
           (b) Pressure angle has maximum value
           (c) Pressure angle has minimum value
           (d) Pressure angle has right angle
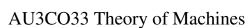
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ii.   An aeroplane makes a complete half circle of 100 metres radius, **5** towards left, when flying at 500 km per hr. The rotary engine and the propeller of the plane has a mass of 1000 kg and a radius of gyration of 0.3 m. The engine rotates at 5000 r.p.m. clockwise when viewed from the rear. Find the gyroscopic couple on the aircraft and state its effect on it.

iii. A ship propelled by a turbine rotor which has a mass of 5 tonnes at a **5** speed of 2000 rpm. The rotor has a radius of gyration of 0.5 m and rotates clockwise when seen from stern. Find the gyroscopic effects in the following conditions:

      (a) The ship sails at a speed of 50 km/hr. and steers to the left in a curve of 60 m radius.

      (b) The ship pitches 6° above and 6° below the horizontal position. The bow is descending with its maximum velocity. The motion during pitching is simple harmonic and periodic time is 20 sec.

      (c) The ship rolls and at a certain instant has angular velocity of 0.03 rad./sec. clockwise when viewed from the stern.

      Also determine the maximum angular acceleration during pitching. Explain how the direction of motion due to gyroscopic effect is determined in each case.

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vi. The cam follower extensively used in air-craft engines is- **1**
(a) Knife edge follower
(b) Flat faced follower
(c) Spherical faced follower
(d) Roller follower

vii. The product of the diametral pitch and circular pitch is equal to- **1**
(a) 1   (b) $1/\pi$ (c) π (d) 2π

viii. The contact ratio for gears must be- **1**
(a) Zero   (b) Less than one
(c) Greater than one   (d) Greater than two

ix. The engine of an aeroplane rotates in clockwise direction when seen from the rear end and the aeroplane takes a turn to the left. The effect of the gyroscopic couple on the aeroplane will be- **1**
(a) To raise the nose and dip the tail
(b) To dip the nose and raise the tail
(c) To raise the nose and tail
(d) To dip the nose and tail

x. When the pitching of a ship is downward, the effect of gyroscopic couple acting on it will be- **1**
(a) To move the ship towards port side
(b) To move the ship towards star-board
(c) To raise the bow and lower the stern
(d) To raise the stern and lower the bow

Q.2 i. Write difference between machine and mechanism. **2**
ii. Define inversion of a mechanism. Explain any two inversion of single slider crank chain. **3**
iii. What is the condition for correct steering? Enlist main types of steering mechanism. Explain any one steering mechanism with neat sketch. **5**
OR iv. Give classification of kinematic pair with the help of diagrams to represent them. **5**

Q.3 i. State and prove Aronhold Kennedy's theorem for ICR. **4**
ii. In a four bar chain ABCD, AD is fixed and is 150 mm long. The crank AB is 40 mm long and rotates at 120 r.p.m. clockwise, while the link CD = 80 mm oscillates about D. BC and AD are of equal length. Find the angular velocity of link CD when angle BAD = 60°. **6**
OR iii. Draw and explain kiln's construction for a slider crank mechanism. **6**

[3]

Q.4 i. Explain cam & follower mechanism. Give basic classification of cam and follower. Give its practical application where they can use. **3**
ii. A cam is to give the following motion to a knife-edged follower- **7**
(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 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 20 mm 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 offset 20 mm 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**

Q.5 i. State and prove the law of gearing with the help of neat sketch. **4**
ii. Two gear wheels mesh externally and have gear ratio as 4 :1. The teeth are of involute type: module = 6mm; addendum = one module, Pressure angle = 20°. The pinion rotates at 100 rpm. Find- **6**
(a) The minimum no. of teeth on the pinion to avoid interference and corresponding teeth on the gear, (b) Length of path of contact, (c) Length of arc of contact, and (d) Contact ratio. Also determine the ratio of the sliding velocity to the rolling velocity at the instant of engagement commences, engagement terminates and at the pitch point.
OR iii. Derive the velocity ratio & Train value for simple & compound gear train. Explain tabular method to calculate the velocity ratio of epicyclic gear train. **6**

Q.6 Attempt any two:
i. Explain with neat sketch the direction of axis of spin, axis of precession and active gyro-couple and their corresponding planes for a rotating disc. Also derive the expression for gyroscopic couple for a rotating disc. **5**

Marking Scheme
AU3CO33 (T)-Theory of Machines

Q.1	i)	(d) spherical pair	1
	ii)	(d) Elliptical trammels	1
	iii)	(a) straight line	1
	iv)	(b) perpendicular to the link joining the points	1
	v)	(b) pressure angle has maximum value	1
	vi)	(d) roller follower	1
	vii)	(c) π	1
	viii)	(c) Greater than one	1
	ix)	(a) to raise the nose and dip the tail	1
	x)	(a) to move the ship towards port side	1

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

Q.3		State Aronhold Kennedy's theorem for ICR.	1
		Prove Aronhold Kennedy's theorem for ICR.	3
	i.	Given data and formula used	1
		Configuration diagram	1
		Velocity diagram	2
		Find the angular velocity of link CD when angle BAD = 60°.	2
OR	ii.	Draw klins construction for a slider crank mechanism.	3
		explain klins construction for a slider crank mechanism.	3

Q.4	i.	Explain cam & follower mechanism.	1
		Give basic classification of cam and follower.	1
		Give its practical application where they can use.	1
	ii.	Displacement diagram for SHM	2

		profile of the cam	5
OR	ii.	Displacement diagram for SHM	2
		profile of the cam	5

Q.5	i.	Statement of the law of gearing	1
		prove the law of gearing with the help of neat sketch.	3
	ii.	i)The minimum no. of teeth on the pinion to avoid interference and corresponding teeth on the gear.	1
		ii) length of path of contact	1
		\iii) length of arc of contact	1
		iv) Contact ratio.	1
		ratio of the sliding velocity to the rolling velocity a) engagement commences b) engagement terminates and c) at the pitch point.	2
OR	ii.	velocity ratio & Train value for simple & compound gear train.	2
		Explain tabular method to calculate the velocity ratio of epicyclic gear train.	4

Q.6	i.	Explain with neat sketch the direction of axis of spin, axis of precession and active gyro-couple and their corresponding planes for a rotating disc.	2
		Also derive the expression for gyroscopic couple for a rotating disc.	3
	ii.	Given data and formula used	1
		gyroscopic couple on the aircraft and	3
		state its effect on it with diagram	1
	iii.	Given data and formula used	1
		.Find the gyroscopic effects in the following conditions:	
		i) The ship sails at a speed of 50 km/hr. and steers to the left in a curve of 60m radius.	
		ii)The ship pitches 6° above and 6° below the horizontal position. The bow is descending with its maximum velocity. The motion during pitching is simple harmonic and periodic time is 20 sec.iii)	2
		The ship rolls and at a certain instant has angular velocity of 0.03 rad./sec. clockwise when viewed from the stern.	1
		Also determine the maximum angular acceleration during pitching. Explain how the direction of motion due to gyroscopic effect is determined in each case.	1

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[2]

[3]