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**

ii. An aeroplane makes a complete half circle of 100 metres radius, 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. **5**

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

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

******

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

Enrollment No.....

Faculty of Engineering
End Sem Examination May-2024
ME3CO47 Kinematics of Machines

Programme: B.Tech. Branch/Specialisation: ME

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 Piston and cylinder forms a **1**

(a) Turning pair (b) Rolling pair

(c) Sliding pair (d) Spherical pair

ii. Which of the following is a turning pair? **1**

(a) Piston and cylinder of a reciprocating steam engine

(b) Shaft with collars at both ends fitted in a circular hole

(c) Lead screw of a lathe with nut

(d) Ball and socket joint

iii. The total number of instantaneous centres for a mechanism consisting of n links are- **1**

(a) n (b) n/2 (c) (n-1)/2 (d) n(n-1)/2

iv. When a slider moves on a fixed link having curved surface, their instantaneous centre lies- **1**

(a) On their point of contact (b) At the centre of curvature

(c) At the centre of circle (d) At the pin joint

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

vi. The cam follower extensively used in automobile engines is- **1**

(a) Knife edge follower (b) Flat faced follower

(c) Spherical faced follower (d) Roller follower

vii. The size of a gear is usually specified by- **1**

(a) Pressure angle (b) Circular pitch

(c) Diametral pitch (d) Pitch circle diameter

P.T.O.

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 structure. **2**

ii. Define inversion of a mechanism. Explain any two inversions of four bar chain. **3**

iii. What is the condition for correct steering? Explain Davis steering mechanism with neat sketch. **5**

OR iv. Give classification of kinematic pair with the help of neat sketch. **5**

Q.3 i. Define ICR. Draw all the ICR for a four-bar chain ABCD, AD is fixed and is 150 mm long. The crank AB is 40 mm long CD = 80 mm oscillates about D. BC and AD are of equal length angle BAD = 30°. **4**

ii. In a four-bar chain ABCD, AD is fixed and is 100 mm long. The crank AB is 40 mm long and rotates at 200 r.p.m. clockwise, while the link CD = 70 mm oscillates about D. BC and AD are of equal length. Find the angular velocity of link CD when angle BAD = 45°. **6**

OR iii. Draw and explain Kiln's construction for a single slider crank mechanism. **6**

Q.4 i. Define cam & follower mechanism. Give basic classification of follower. Give its practical application. **4**

ii. A cam is to give the following motion to a roller follower of 20mm diameter- **6**
(a) Outstroke during 120° of cam rotation
(b) Dwell for the next 30° of cam rotation
(c) Return stroke during next 90° of cam rotation
(d) Dwell for the remaining of cam rotation
The stroke of the follower is 50 mm and the minimum radius of the cam is 40 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 Knife edge follower with the following data- **6**
(a) Cam lift = 40 mm during 120° of cam rotation
(b) Dwell for the next 60°
(c) Return stroke during the next 120° 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.

Q.5 i. Define the following term with respect to spur gear- **4**
(a) Gear ratio (b) Circular pitch
(c) Pressure angle (d) Contact ratio

ii. Two gear wheels mesh externally and have gear ratio as 3 :1. The teeth are of involute type: module = 10mm; addendum = one module, Pressure angle = 20º. The pinion rotates at 200 rpm. Find- (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 (d) Contact ratio. **6**

OR iii. 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? **6**

Marking Scheme

Kinematics of Machines (T) - ME3CO47 (T)

Q.1	i)	(c) sliding pair	**1**
	ii)	(b) Shaft with collars at both ends fitted in a circular hole	**1**
	iii)	(d) n(n-1)/2	**1**
	iv)	(b) at the centre of curvature	**1**
	v)	(b) pressure angle has maximum value	**1**
	vi)	(c) spherical faced follower	**1**
	vii)	(d) pitch circle diameter	**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 structure.	**1+1**
	ii.	Define inversion of a mechanism.	**1**
		Explain any two inversion of 4 bar chain.	**1+1**
	iii.	The condition for correct steering.	**2**
		Explain Davis steering mechanism with neat sketch.	**3**
OR	iv.	classification of kinematic pair with definition with the help of diagrams to represent them.	**3** **2**
Q.3	i.	Define ICR.	**1**
		Draw all the ICR for a four bar chain	**3**
	ii.	Given data and formula used	**1**
		Configuration diagram	**1**
		Velocity diagram	**2**
		Find the angular velocity of link CD.	**2**
OR	iii.	Draw klins construction for a slider crank mechanism.	**3**
		explain klins construction for a slider crank mechanism.	**3**
Q.4	i.	Define cam & follower mechanism.	**1**
		Give basic classification of follower.	**2**
		Give its practical application.	**1**
	ii.	Displacement diagram for SHM	**2**
		profile of the cam	**4**
OR	iii.	Displacement diagram for SHM	**2**
		profile of the cam	**4**
Q.5	i.	Define the following term with respect to spur gear ,i)Gear ratio ii)Circular pitch iii)Pressure angle iv)Contact ratio	**1Marks each**
	ii.	i)The minimum no. of teeth on the pinion to avoid interference and corresponding teeth on the gear.	**3** **1**
		ii) length of path of contact	**1**
		\iii) length of arc of contact	**1**
		iv) Contact ratio.	
OR	iii.	tabular method to calculate the velocity ratio of epicyclic gear train.	**2**
		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.	**2**
		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 ?	**2**
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**
		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) The ship rolls and at a certain instant has angular velocity of 0.03 rad./sec. clockwise when viewed from the stern.	**2** **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**

******