Q.5	i.	Explain the terms: (a) Module (b) Pressure angle (c) Addendum (d) Dedendum	**4**	1	3	1
	ii.	Derive an expression for the length of the arc of contact in a pair of meshed spur gears.	**6**	2	3	2
OR	iii.	A pair of spur gears with involute teeth is to give a gear ratio of 4**:** 1. The arc of approach is not to be less than the circular pitch and smaller wheel is the driver. The angle of pressure is 14.5°. Find: (a) the least number of teeth that can be used on each wheel, and (b) The addendum of the wheel in terms of the circular pitch	**6**	2	2	2
Q.6		Attempt any two:				
	i.	What do you understand by gyroscopic couple? Derive a formula for its magnitude.	**5**	2	1	2
	ii.	A pair of locomotive driving wheels with the axle, have a moment of inertia of 180 kg-m^2. The diameter of the wheel treads is 1.8 m and the distance between wheel centres is 1.5 m. When the locomotive is travelling on a level track at 95 km/h, defective ballasting causes one wheel to fall 6 mm and to rise again in a total time of 0.1 s. If the displacement of the wheel takes place with simple harmonic motion, find: (a) The gyroscopic couple set up, and (b) The reaction between the wheel and rail due to this couple.	**5**	3	2	3
	iii.	The turbine rotor of a ship has a mass of 8 tonnes and a radius of gyration 0.6 m. It rotates at 1800 r.p.m. clockwise, when looking from the stern. Determine the gyroscopic couple, if the ship travels at 100 km/hr and steer to the left in a curve of 75 m radius.	**5**	3	2	3

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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
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.

			Marks	**BL**	**PO**	**CO**	**PSO**
Q.1	i.	In a reciprocating steam engine, which of the following forms a kinematic link? (a) Cylinder and piston (b) Piston rod and connecting rod (c) Crank shaft and flywheel (d) Flywheel and engine frame	**1**	1	3	1	
	ii.	The relation between the number of pairs (p) forming a kinematic chain and the number of links (l) is- (a) l = 2p – 2 (b) l = 2p – 3 (c) l = 2p – 4 (d) l = 2p – 5	**1**	1	3	1	
	iii.	The direction of linear velocity of any point on a link with respect to 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	**1**	1	2	2	
	iv.	When a slider moves on a fixed link having curved surface, their instantaneous centre lies- (a) On their point of contact (b) At the centre of curvature (c) At the centre of circle (d) At the pin joint	**1**	2	2	2	

v.	The angle between the direction of the follower motion and a normal to the pitch curve is called- (a) Pitch angle (b) Prime angle (c) Base angle (d) Pressure angle	**1**	1	3	1
vi.	For high speed engines, the cam follower should move with- (a) Uniform velocity (b) Simple harmonic motion (c) Uniform acceleration and retardation (d) Cycloidal motion	**1**	1	2	2
vii.	An imaginary circle which by pure rolling action, gives the same motion as the actual gear, is called- (a) Addendum circle (b) Dedendum circle (c) Pitch circle (d) Clearance circle	**1**	1	1	2
viii.	The radial distance of a tooth from the pitch circle to the bottom of the tooth, is called- (a) Dedendum (b) Addendum (c) Clearance (d) Working depth	**1**	1	1	2
ix.	The rotor of a ship rotates in clockwise direction when viewed from the stern and the ship takes a left turn. The effect of the gyroscopic couple acting on it will be- (a) To raise the bow and stern (b) To lower the bow and stern (c) To raise the bow and lower the stern (d) To lower the bow and raise the stern	**1**	2	2	3
x.	The air screw of an aeroplane is rotating clockwise when looking from the front. If it makes a left turn, the gyroscopic effect will- (a) Tend to depress the nose and raise the tail (b) Tend to raise the nose and depress the tail (c) Tilt the aeroplane (d) None of these	**1**	2	2	3
Q.2 i.	Explain the terms: (a) Lower pair (b) Higher pair (c) Kinematic chain (d) Inversion	**4**	1	3	1

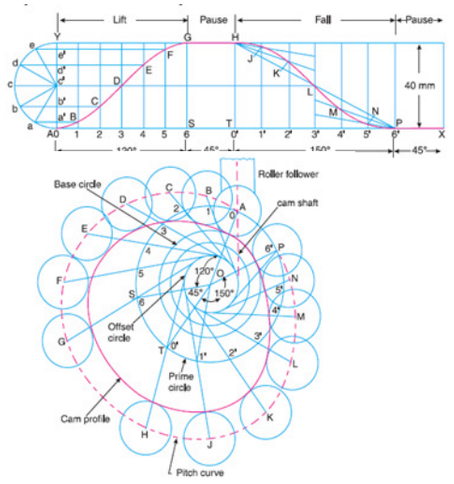
	ii.	Sketch and explain any two inversions of a double slider crank chain.	**6**	2	3	1
OR	iii.	Explain law of correct steering. Also derive relation for Davis steering mechanism.	**6**	2	2	2
Q.3	i.	Define rubbing velocity at a pin joint.	**2**	1	3	1
	ii.	The crank of a slider crank mechanism rotates clockwise at a constant speed of 300 r.p.m. The crank is 150 mm and the connecting rod is 600 mm long. Determine: (a) Linear velocity and acceleration of the midpoint of the connecting rod, and (b) angular velocity and angular acceleration of the connecting rod, at a crank angle of 45° from inner dead centre position.	**8**	3	2	2
OR	iii.	Draw and explain Klin's construction for slider crank mechanism.	**8**	2	2	2
Q.4	i.	Define the following terms as applied to cam with a neat sketch: (a) Base circle, (b) Pitch circle, (c) Pressure angle, and (d) Stroke of the follower.	**4**	1	3	1
	ii.	Draw the displacement, velocity and acceleration diagrams for a follower when it moves with simple harmonic motion. Derive the expression for velocity and acceleration during outstroke and return stroke of the follower.	**6**	2	1	2
OR	iii.	Construct the profile of a cam to suit the following specifications: Cam shaft diameter = 40 mm; Least radius of cam = 25 mm; Diameter of roller = 25 mm; Angle of lift = 120°; Angle of fall = 150°; Lift of the follower = 40 mm; Number of pauses are two of equal interval between motions. During the lift, the motion is S.H.M. During the fall the motion is uniform acceleration and deceleration. The speed of the cam shaft is uniform. The line of stroke of the follower is off-set 12.5 mm from the centre of the cam.	**6**	3	2	3

Marking Scheme
AU3CO33 (T) Theory of Machines (T)

Q.1	i)	(c) crank shaft and flywheel	**1**
	ii)	(c) l = 2p – 4	**1**
	iii)	(b) perpendicular to the link joining the points	**1**
	iv)	(b) at the centre of curvature	**1**
	v)	(d) pressure angle	**1**
	vi)	(d) cycloidal motion	**1**
	vii)	(c) pitch circle	**1**
	viii)	(a) dedendum	**1**
	ix)	(c) to raise the bow and lower the stern	**1**
	x)	(b) tend to depress the nose and depress the tail	**1**

Q.2	i.	Each one marks	**4**
	ii.	Explain 4 marks and 2 marks for diagram	**6**
OR	iii.	Explain 5 marks and 1 marks for diagram	

Q.3	i.	Definition rubbing velocity	**2**
	ii.	1. Linear velocity of the midpoint of the connecting rod	**2**
		V_D = vector od = 4.1 m/s	
		Acceleration of the midpoint of the connecting rod	**2**
		ad = vector o' d' = 117 m/s^2	
		2. Angular velocity of the connecting rod	**2**
		5.67 rad/s (Anticlockwise)	
		Angular acceleration of the connecting rod	**2**
		171.67 rad/s (Clockwise)	
OR	iii.	Construction of Klem's diagram – 5 marks	**8**
		Explanation- 3 marks	

Q.4	i.	Each one marks	**4**
	ii.	Draw the displacement, velocity and acceleration diagrams for a follower when it moves with simple harmonic motion.	**3**
		Derive the expression for velocity and acceleration during outstroke and return stroke of the follower.	**3**
OR	iii.		**2** **4**

Q.5	i.	Each one marks	**4**
	ii.	Expression for the length of the arc of contact in a pair of meshed spur gears.	**6**
OR	iii.	1. Least number of teeth on each wheel	**3**
		T = G.t = 4 × 25 = 100	
		2. Addendum of the wheel	**3**
		0.85 m = 0.85 × pc / π = 0.27 pc	

Q.6			
	i.	What do you understand by gyroscopic couple?	**2**

P.T.O.

Derive a formula for its magnitude. **3**

ii. 1. Gyroscopic couple set up **3**

C = I.ω.ωP max = 180 × 29.3 × 0.126 = 664.5 N-m

2. Reaction between the wheel and rail due to the gyroscopic couple **2**

P = C / x = 664.5 / 1.5 = 443 N

iii. I = m.k2 = 8000 (0.6)2 = 2880 kg-m2 **2**

angular velocity of precession,

ωP = v / R = 27.8 / 75 = 0.37 rad/s **1**

We know that gyroscopic couple,

C = I.ω.ωP= 2880 × 188.5 × 0.37 = 200 866 N-m **2**

= 200.866 kN-m

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