NARASIMHA REDDY ENGINEERING COLLEGE
(Autonomous)
Approved by AICTE, New Delhi & Affiliated to JNTUH, Hyderabad
Accredited by NAAC with A Grade, Accredited by NBA

DEPARTMENT OF MECHANICAL ENGINEERING

QUESTION BANK

Course Title : Kinematics of Machinery

Course Code : ME2202PC

Regulation : NR21

Course Objectives

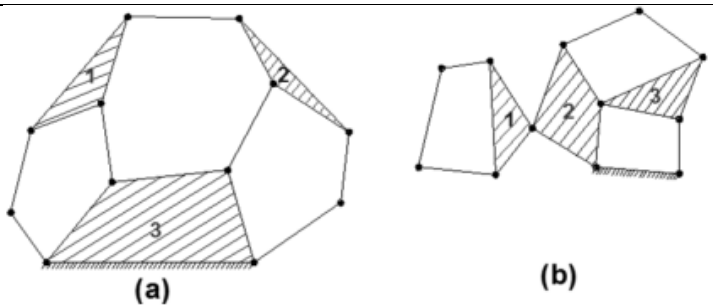
1. Comprehend the fundamentals of kinematics. And to understand the concept of machines, mechanisms and related terminologies.
2. To understand the principles in analyzing the kinematics from the geometric point of view to determine mobility, velocity and acceleration using graphical methods.
3. To understand the mechanisms with lower pairs to obtain steering, copying and straight line motions in automobiles and other allied applications.
4. To understand the kinematic analysis of cams (higher pairs) imparting motion to knife edged, roller and mushroom followers.
5. To understand the basic concepts of toothed gearing and kinematics of gear trains in motion transmission and in machine components.

Course Outcomes (CO's)

CO No.	Course Outcomes(CO's)
At the end of the course student will be able to	
C222.1	Differentiate and evaluate the performance of different mechanisms with their inversions.
C222.2	Evaluate and compute the velocity and acceleration associated with operation of links in kinematic chain by applying graphical method.
C222.3	Interpret the straight line motion mechanisms, also can choose the correct steering mechanisms for automobiles. And can evaluate the velocity ratios of Hooke's joint in automotive applications.
C222.4	Develop cam profiles for different follower motions and analyze the performance of followers.
C222.5	Analyze the concept of law of gearing to evaluate the gear tooth geometry and can compute the velocities of gear trains at different conditions.

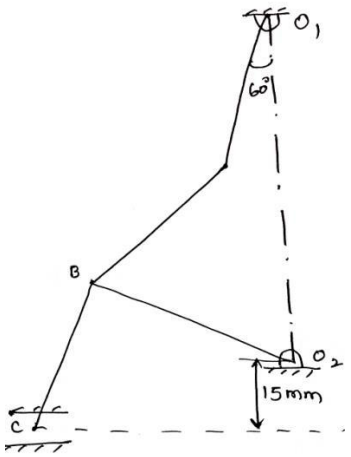
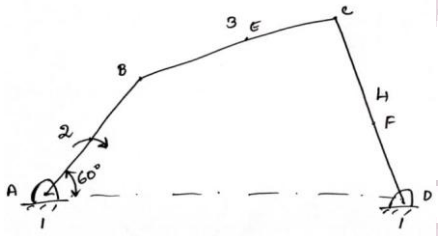
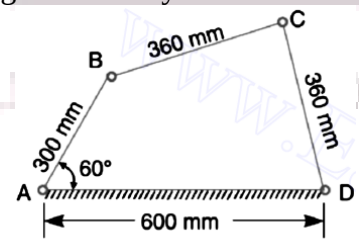
Unit-I

Part – A (Short Answer Questions)					
S.No.		**Question**	**BT**	**CO**	**PO**
1		Define Kinematic Chain.	L1	CO1	1,3,9
2		Define inversion of a mechanism.	L1	CO1	1,3,9
3		Differentiate between machine and mechanism	L1	CO1	1,3,9
4		Differentiate between machine and structure	L1	CO1	1,3,9
5		Classify kinematic link	L1	CO1	1,3,9
6		What do you mean by constrained motion and explain the types of constrained motions?	L2	CO1	1,3,9
7		Enlist various inversions of three types of Kinematic Chain	L1	CO1	1,3,9
8		What is meant by spatial mechanism and equivalent mechanism?	L1	CO1	1,3,9
9		Compare Movability and Mobility.	L2	CO1	1,3,9
10		Explain Grubler's criteria?	L2	CO1	1,3,9
Part – B (Long Answer Questions)					
11	a)	Explain different types of pairs with neat sketch?	L2	CO1	1,3,9
	b)	A crank and slotted lever mechanism used in a shaper has a centre distance of 300 mm between the centre of oscillation of the slotted lever and the centre of rotation of the crank. The radius of the crank is 120 mm. Determine the ratio of the time of cutting to the time of return stroke.	L3	CO1	1,3,9
12		Sketch and explain the various inversions of a single slider crank chain	L2	CO1	1,3,9
13	a)	Explain the coupled wheels of locomotive.	L2	CO1	1,3,9
	b)	Explain the beam engine with neat sketch.	L2	CO1	1,3,9
14		Sketch and explain the following mechanisms: i) Elliptical trammel ii) Scotch Yoke mechanism iii) Oldham's coupling	L2	CO1	1,3,9
15		In a crank and slotted lever quick return motion mechanism, the distance between the fixed centres is 240mm and the length of the driving crank is120mm. Evaluate the inclination of the slotted bar with the vertical in the extreme position and time ratio of cutting stroke to the return stroke. If the length of the slotted bar is 450mm, Evaluate the length of the stroke if the line of stroke passes through the extreme positions of the free end of the lever.	L3	CO1	1,3,9
16	a)	The distance between the axes of two parallel shafts of an Oldham coupling is 20 mm. The driving shaft rotates at 300 rpm. Calculate the maximum speed of sliding of the tongue of the intermediate piece along its groove.	L3	CO1	1,3,9
	b)	Determine the degree of freedom of mechanisms of mechanism shown:	L3	CO1	1,3,9

		 Figure: 1			

Unit-II

Part – A (Short Answer Questions)				
S.No.	**Question**	**BT**	**CO**	**PO**
1	Define Coriolis component of acceleration.	L1	CO2	1,2
2	Define instantaneous centre and instantaneous axis.	L1	CO2	1,2
3	Explain how the direction of coriolis acceleration is obtained.	L2	CO2	1,2
4	State the objective of Kinematic analysis.	L2	CO2	1,2
5	State the rules to locate the instantaneous centre.	L2	CO2	1,2
6	Define Kennedy's theorem.	L2	CO2	1,2
7	How can you represent the direction of linear velocity of any point on a link with respect to another point on the same link?	L3	CO2	1,2
8	Classify the instantaneous centres.	L1	CO2	1,2
9	Define rubbing velocity.	L1	CO2	1,2
10	A pin joins two links A & B. A rotates with ω_A angular velocity and B rotates with ω_B angular velocity in opposite direction. What is the rubbing velocity of that point?	L2	CO2	1,2
Part – B (Long Answer Questions)				
11	In a four bar mechanism, the dimensions of links are as below: AB=50mm, BC=66mm, CD=56mm and AD=100mm and at a given instant when angle DAB=60^o the angular velocity of the link AB=10.5rad/sec in CCW direction. Determine: i. Velocity of Point C ii. Velocity of point E on link BC when BE=40mm. iii. The angular velocity of link BC and CD iv. The velocity of an offset point F on link BC, if BF=45mm, CF=30mm and BCF Read clockwise. v. The velocity of an offset point G on link CD, if CG=24mm, DG=44mm and DCG read clockwise. vi. The velocity of rubbing of pins A, B, C and D. The ratios of pins are 30mm, 40mm, 25mm and 35mm respectively.	L3	CO2	1,2
12	In a slider crank mechanism, the lengths of crank and connecting rod are 200mm and 800mm respectively. When the crank has turned 30^o from its IDC determine the velocity of slider and angular velocity of connecting rod if crank rotates at 40rad/sec.	L3	CO2	1,2
13	In the mechanism as shown, the crank O_1A rotates at a	L3	CO2	1,2

		uniform speed of 650rpm. Determine the linear velocity of slider C and the angular speed link BC. O_1A=30mm, AB=45mm, BC=50mm O_2B=65mm, O_1O_2=70mm.  			
14		In the four-bar mechanism as shown, link 2 is rotating at angular velocity of 15rad/sec in CW direction. Locate all instantaneous centres of the mechanism and Determine: a. the angular speeds of link 3 and link 4 b. linear velocities of links 3& 4 c. linear velocities of points E & F, where, AB=200mm, BC=250mm, CD=300mm, AD=500mm, angle BAD=600, BE=FD=150mm.  	L3	CO2	1,2
15		In a pin jointed four bar mechanism, as shown in Figure, AB = 300 mm, BC=CD=360 mm, and AD = 600 mm. The angle BAD = 60°. The crank AB rotates uniformly at 100 rpm in clockwise. Locate all the instantaneous centres and find the angular velocity of the link BC.  	L3	CO2	1,2
16		The crank of a slider crank mechanism rotates clockwise at a constant speed of 300rpm. The crank is 150 mm and the connecting rod is 600 mm long. Determine: 1. Linear velocity and acceleration of the midpoint of the connecting rod, and 2. Angular velocity and angular acceleration of the connecting rod, at a crank angle of 45° from inner dead centre position.	L3	CO2	1,2

Unit-III

Part – A (Short Answer Questions)					
S.No.		**Question**	**BT**	**CO**	**PO**
1		Explain the Hooke's joint with application.	L1	CO3	1,9
2		What is an automobile steering gear? What are its types? Which steering gear is preferred and why?	L1	CO3	1,9
3		List out the advantages and disadvantages of Davis steering gear.	L2	CO3	1,9
4		What is the main advantage of Hart mechanism over Peaucellier mechanism, and what is its limitation?	L2	CO3	1,9
5		What are straight line mechanisms? Sketch any straight line mechanism.	L2	CO3	1,9
6		When will the speeds of driving and driven shafts connected by a Hooke's joint be equal?	L2	CO3	1,9
7		Sketch and explain the Double's Hooke's Joint.	L3	CO3	1,9
8		What is Scott-Russel mechanism? What is its limitation?	L1	CO3	1,9
9		Explain why two Hooke's joints are used to transmit motion from engine to the differential of an automobile.	L1	CO3	1,9
10		Sketch two exact and two approximate straight line motion mechanisms.	L2	CO3	1,9
Part – B (Long Answer Questions)					
11		Sketch a mechanism such that a point traces an exact straight line. The mechanism must be made of only revolute pairs. Prove that the point traces an exact straight line motion.	L3	CO3	1,9
12	a)	Describe Watt's parallel mechanism for straight line motion and derive the condition under which the straight line is traced.	L3	CO3	1,9
	b)	Sketch a Pantograph and explain its working principle.	L3	CO3	1,9
13		Sketch and explain the working principle of Ackerman steering gear mechanism and derive the condition required to take a turn.	L3	CO3	1,9
14	a)	Derive the expression for ratio of angular velocities of the shafts of a Hooke's joint.	L2	CO3	1,9
	b)	Two shafts are connected by a Hooke's joint. The angle between the shafts is 18^o. What will be the angle turned by the driving shaft when the velocity ratio is maximum?	L3	CO3	1,9
15		The angle between the axis of 2 shafts joined by Hooke's joint is 25^o. The driving shaft rotates at uniform speed of 180rpm. The driven shaft carries a steady load of 7.5KW. Calculate the mass of the flywheel of driven shaft if its radius of gyration is 150mm and the output torque of the driven shaft does not vary by more than 15% of the input shaft.	L3	CO3	1,9
16	a)	Explain the Hooke's joint with application.	L2	CO3	1,9
	b)	A Hooke's joint connects 2 shafts whose axis intersects at 25^o. What will be the angle turned by driving shaft when the i. Velocity ratio is maximum, minimum and unity. ii. Acceleration of the driven shaft is maximum, minimum and zero.	L3	CO3	1,9

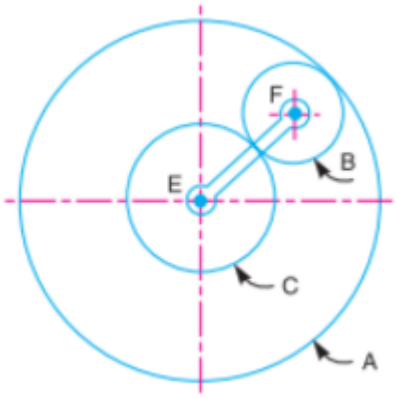
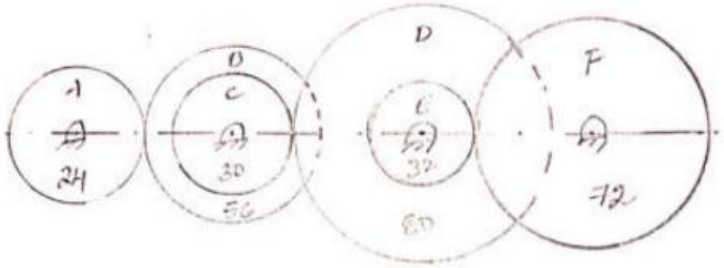
Unit-IV

Part – A (Short Answer Questions)					
S.No.		**Question**	**BT**	**CO**	**PO**
1		Define pressure angle with respect to cams.	L1	CO4	2,3
2		Define trace point in the study of cams.	L1	CO4	2,3
3		Classify the followers according to shape and motion with neat sketches wherever required.	L2	CO4	2,3
4		Define undercutting in cam. How it occurs?	L2	CO4	2,3
5		Where are the roller follower extensively used?	L2	CO4	2,3
6		State the necessary elements of a cam mechanism with its application.	L2	CO4	2,3
7		Define a) angle of ascent, b) angle of descent and c) angle of dwell.	L3	CO4	2,3
8		Define pitch curve of the cam.	L1	CO4	2,3
9		Classify the cam based on the constraint of the follower and based on the shape with sketch.	L1	CO4	2,3
10		What are the different shapes of high speed cams?	L2	CO4	2,3
Part – B (Long Answer Questions)					
11		A cam is to be designed for a knife edge follower with the following data: 1. Cam lift = 40 mm during 90^o of cam rotation with simple harmonic motion. 2. Dwell for the next 30^o. 3. During the next 60^o of cam rotation, the follower returns to its original position with simple harmonic motion. 4. Dwell during the remaining 180^o. 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. Determine the maximum velocity and acceleration of the follower during its ascent and descent, if the cam rotates at 240 r.p.m.	L3	CO4	2,3
12		Draw the profile of the cam operating a knife edge follower having a lift of 30mm the cam raises the follower with SHM for $150^o$of the rotation followed by a period of dwell for 60^0. The follower descends for the next 100^orotation of the cam with uniform velocity again followed by a dwell period. The cam rotates at uniform velocity of 120rpm and has a least radius of 20mm.	L3	CO4	2,3
13		Draw the profile of a cam to raise a valve with SHM through 40mm in $1/4^{th}$ of the cam rotation, keep it fully raised through $1/10^{th}$of the cam rotation, and to lower it again it with uniform velocity in $1/6^{th}$of the cam rotation. The valve remains closed during the rest of the cam rotation. The diameter of the roller follower is 20mm, and the minimum radius of the cam is to be 30mm. The axis of the follower passes through the axis of the cam shaft.	L3	CO4	2,3
14		Draw the profile of the CAM when the cam shaft diameter is 50mm, diameter of roller20mm, angle of lift 100^o, angle of fall is 130^o, lift of the follower is 35mm. The number of dwells are two of equal interval between rotations. During lift, the motion on is SHM and during fall the motion is uniform velocity. If the speed of the cam shaft is 600rpm, determine the maximum velocity and acceleration during lift.	L2	CO4	2,3

15		A symmetrical circular arc cam operating a flat faced follower has the following particulars: Least diameter of cam = 30 mm; lift = 20 mm; Angle of lift = 75; Nose radius = 5 mm; speed =600rpm. Determine: (i) The principal dimensions of cam, (ii) The acceleration of the follower at the beginning of lift, at the end of contact with the circular flank, at the beginning of contact with nose and at the apex of nose.	L3	CO4	2,3
16		A symmetrical arc cam using flat faced follower has the following particulars, Total lift = 25 mm Least radius = 35mm Angle of lift = 90 degrees Flank radius = 105 mm Speed = 1200 rpm Calculate (i) main dimensions of the cam, (ii) Acceleration of the follower at the beginning of the lift, at the end of contact with flank, at the beginning of contact with nose and at the apex of nose.	L2	CO4	2,3

Unit-V

Part – A (Short Answer Questions)					
S.No.		**Question**	**BT**	**CO**	**PO**
1		State the law of gearing.	L1	CO5	1,2
2		Compare cycloidal and involute gear tooth profile.	L1	CO5	1,2
3		Define contact ratio.	L2	CO5	1,2
4		What are the conditions to be satisfied for interchangeability of all gears?	L2	CO5	1,2
5		When involute interference occurs.	L2	CO5	1,2
6		List out the function of differential gear used in the rear drive of an automobile.	L2	CO5	1,2
7		What is angle of obliquity in gears?	L3	CO5	1,2
8		What is the principle reason for employing non-standard gears?	L1	CO5	1,2
9		Define: i) path of contact. ii) Length of path of contact.	L1	CO5	1,2
10		Classify the gear trains with neat sketches.	L2	CO5	1,2
Part – B (Long Answer Questions)					
11		In a reverted epicyclic gear train, the arm A carries two gears B&C and a compound gear D-E. The gear B meshes with gear E and the gear C meshes with gear D. The number of teeth on gears B, C and D are 75, 30 and 90 respectively. Determine the speed and direction of gear C when gear B is fixed and the arm A makes 100rpm clockwise.	L3	CO5	1,2
12	a)	State and prove law of gearing	L3	CO5	1,2
	b)	Determine the number of pairs of teeth in contact at any given instant of two involute gears of 18 teeth of pressure angle 19.5^{o}have addendum of 0.8 module.	L3	CO5	1,2
13		Two gears with 42 and 19 teeth are cut with involute teeth of pressure angle 200andmodule 5mm. The addendum of each is 5mm. Determine: i. The length of arc of contact. ii. The number of pair of teeth in contact.	L3	CO5	1,2
14	a)	Derive an expression to determine the length of path of	L2	CO5	1,2

		contact and arc of contact of two involute gears in terms of pressure angle, the pith circle radii and the addendum radii.			
	b)	Pair of gear in mesh has a module of 10mm and a pressure angle 25^{o}. The number of teeth on the pinion and gear are 20 and 52 respectively. The addendum on both the gear is equal to one module. Determine the ratio of velocity of sliding to the rolling velocity at the pitch point and at the beginning and at the end of the engagement.	L3	CO5	1,2
15		An epi-cyclic gear consists of 3 gears A, B& C as shown. The gear A has 72 internal teeth& gear C has 32 external teeth. The gear B meshes with both A&C and is carried on an arm EF which rotates about centre of A at 18rpm. If the gear A fixed, determine the speeds of gear B&C. 	L3	CO5	1,2
16	a)	Explain 'Interference' in involute gears, and derive a relation for the minimum number of teeth on the pinion and gear wheel required to avoid interference.	L2	CO5	1,2
	b)	A compound gear train as shown consists of compound gears B-C & D-E. All gears are mounted on parallel shafts. The motor shaft rotating at 800rpm is connected to the gear A and output shaft to the gear F. The number of teeth on gears A, B, C, D, E & F are 24, 56, 30, 80, 32&72respectively. Determine the speed of gear F. 	L2	CO5	1,2

* **Blooms Taxonomy Level (BT)**

L1 – Remembering; L2 – Understanding; L3 – Applying; L4 – Analyzing; L5 – Evaluating; L6 – Creating

Course Outcomes (CO)

Program Outcomes (PO)

Prepared By: Mr. R Sai Syam **HoD**