INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

MECHANICAL ENGINEERING

DEFINITIONS AND TERMINOLOGY QUESTION BANK

Course Title	KINEMATICS OF MACHINES				
Course Code	AMEB10				
Program	B.Tech				
Semester	IV	ME			
Course Type	Core				
Regulation	IARE - R18				
Course Structure		**Theory**			**Practical**
		Lectures	Tutorials	Credits	Laboratory	Credits
		3	1	4	-	-
Chief Coordinator	Mr. B.V.S.N.RAO, Associate Professor				
Course Faculty	Mr. V.V.S.H. Prasad, Associate Professor				

COURSE OBJECTIVES:

The course should enable the students to:	
I	Understand the basic principles of kinematics and the related terminology of machines.
II	Identify mobility; enumerate links and joints in the mechanisms.
III	Explain the concept of analysis of different mechanisms.
IV	Understand the working of various straight line mechanisms, gears, gear trains, steering gear mechanisms, cams and Hooke's joint.
V	Determine the mechanisms for displacement, velocity and acceleration of links in a machine.

DEFINITIONS AND TERMINOLOGY QUESTION BANK

S.No	QUESTION	ANSWER	Blooms Level	CO	CLO	CLO Code
		MODULE-I				
1	What is theory of machines?	Theory of machines deals with the study of relative motion between various parts of a machine and the forces acting on it.	Understand	CO 1	CLO1	AMEB10.01
2	Define statics?	Statics deals with the forces acting on the stationary bodies in equilibrium.	Remember	CO 1	CLO1	AMEB10.01

S.No	QUESTION	ANSWER	Blooms Level	CO	CLO	CLO Code
3	What is dynamics?	Dynamics is the study of forces on moving bodies.	Remember	CO 1	CLO2	AMEB10.01
4	Define kinematics?	Kinematics is the study of the geometry of motion. It is used to relate displacement, velocity, acceleration and time, without reference to the cause of the motion.	Remember	CO 1	CLO1	AMEB10.01
5	Define kinetics?	Kinetics is concerned with the motion and its causes, specifically forces and torques.	Remember	CO 1	CLO1	AMEB10.01
6	Explain the term rigid link?	A link is said to be rigid, if the relative positions of any two Particles do not change under the action of force.	Remember	CO 1	CLO1	AMEB10.01
7	Define constrained motion?	In a kinematic pair, if one element has got only one definite motion relative to the other, then the motion is called constrained motion.	Remember	CO 1	CLO1	AMEB10.01
8	Define degrees of freedom of a mechanism?	It is the number of inputs required to describe the configuration or position of all the links of the mechanism, with respect to the fixed link at any given instant.	Remember	CO 1	CLO2	AMEB10.03
9	What is Mechanical advantage?	Mechanical advantage of a mechanism is the ratio of output force or torque to the input force or torque at any instant.	Remember	CO 1	CLO2	AMEB10.02
10	Define a Machine?	A machine is a mechanism or collection of mechanisms, which transmit force from the source of power to the resistance to be overcome.	Remember	CO 1	CLO3	AMEB10.02
11	What is a mechanism?	A mechanism is a constrained kinematic chain. This means that the motion of any one link in the kinematic chain will give a definite and predictable motion relative to each of the others.	Remember	CO 1	CLO2	AMEB10.03
12	Define inversion?	Different mechanisms can be obtained by fixing different links of the same kinematic chain. These are called as inversions of the mechanism	Remember	CO 1	CLO1	AMEB10.03
13	What are the Inversions of Four bar chain?	The inversions of four bar chain are Beam engine, Watt's mechanism and coupling rod of a locomotive.	Understand	CO 1	CLO1	AMEB10.03
14	What are the Inversions of Single slider crank chain?	The inversions of single slider crank chain mechanism are Oscillating cylinder engine, crank and slotted lever quick return mechanism and Whitworth quick return mechanism.	Understand	CO 1	CLO1	AMEB10.03

S.No	QUESTION	ANSWER	Blooms Level	CO	CLO	CLO Code
15	What are the Inversions of Double slider Crank chain?	The inversions of double slider crank chain mechanism are Scotch yoke mechanism, elliptical trammel and Oldham's coupling.	Remember	CO 1	CLO1	AMEB10.03
16	Define rubbing velocity?	Rubbing velocity is the algebraic sum of the angular velocities of individual links.	Remember	CO 1	CLO4	AMEB10.04
17	Explain quick return mechanism	Quick return mechanisms are used in machine tools such as shapers and power driven saws for the purpose of giving the reciprocating cutting tool a slow cutting stroke and a quick return stroke with a constant angular velocity of the driving crank	Understand	CO 1	CLO4	AMEB10.01
18	Define Grashof's law?	The Grashof's law states that for a four-bar linkage system, the sum of the shortest and longest link of a planar quadrilateral linkage is less than or equal to the sum of the remaining two links, then the shortest link can rotate fully with respect to a neighboring link.	Remember	CO 1	CLO4	AMEB10.01
19	What is Kutzbach equation?	Kutzbach's equation is modified Grubler's Equation that takes into consideration full (1 DOF) and half (2 DOF) joints. DOF= 3(L-1)-2P-H Where L= number of links P=lower pairs, H=higher pairs	Understand	CO 1	CLO1	AMEB10.01
20	Define lower pair?	If the joint by which two members are connected has surface contact, the pair is known as lower pair. E.g. pin joints, shaft rotating in bush, slider in slider crank mechanism	Remember	CO 1	CLO1	AMEB10.01
21	Define higher pair?	If the contact between the pairing elements takes place at a point or along a line, such as in a ball bearing or between two gear teeth in contact, it is known as a higher pair.	Understand	CO 1	CLO1	AMEB10.01
22	State Grubler's criterion?	Gruebler's Equation is the most commonly used equation for evaluating simple linkages. DOF= 3(L-1)-2J L= number of links J= number of joints	Remember	CO 1	CLO1	AMEB10.01
23	Define a structure ?	In structure, no relative motion exists between its members. They only resist forces.	Understand	CO 1	CLO1	AMEB10.01
24	What is the difference between machine and a structure?	In structure, no relative motion exists between its members and in machine relative motion exists. Members of a structure resist forces and in machine they transmit forces.	Remember	CO 1	CLO2	AMEB10.01

25	What is a redundant chain?	There is no motion possible in the redundant chain. It can be concluded that this chain is locked due to its geometry.	Remember	CO 1	CLO2	AMEB10.01
MODULE-II						
1	What is meant by relative velocity?	The velocity of a point with respect to another point in a link is relative velocity.	Remember	CO 1	CLO 6	AMEB10.06
2	Define angular velocity of a link?	The speed with which a body undergoing rotational dynamics rotates is known as angular velocity.	Remember	CO 1	CLO 6	AMEB10.06
3	What is the component of acceleration parallel to velocity?	The component of the acceleration parallel to the velocity of the particle is tangential component of acceleration.	Understand	CO 2	CLO 6	AMEB10.07
4	What is radial component of acceleration?	The component of the acceleration, perpendicular to the velocity of the particle, at the given instant is called radial component of acceleration.	Understand	CO 2	CLO 6	AMEB10.06
5	Define Coriolis component of acceleration?	Coriolis component of acceleration is the acceleration under consideration when the body moves in circular motion towards the centre or outward from the centre. Its magnitude is $2v\omega$. where v is the velocity of the body towards centre or outside from centre and ω is the angular velocity of the body.	Understand	CO 2	CLO 6	AMEB10.06
6	What is space centrode?	The path traced by the instantaneous centre of a rotating three-dimensional body moving relative to an inertial frame of reference.	Remember	CO 2	CLO 6	AMEB10.05
7	Define axode?	The path traced by the instantaneous axis of a figure when it undergoes motion in a plane.	Remember	CO 2	CLO 6	AMEB10.05
8	What is body centrode?	The locus of instantaneous center of a moving body relative to a fixed body is known as body centrode.	Remember	CO 2	CLO 6	AMEB10.05
9	What is Instantaneous center?	The instant center of rotation, is the point fixed to a body undergoing planar movement that has zero velocity at a particular instant of time.	Remember	CO 2	CLO 6	AMEB10.06
10	State Kennedy's theorem?	If three bodies are in relative motion with respect to one another, the three instantaneous centers of velocity are collinear.	Remember	CO 2	CLO 7	AMEB10.06
11	What is the use of Klien's construction?	Klein's construction can be used to determine acceleration of various parts when the crank is at inner dead center, outer dead center, at right angles to the line of the stroke and at 45° to the line of the stroke.	Remember	CO 2	CLO 7	AMEB10.06

			Remember	CO 2	CLO 7	AMEB10.07
12	What is the magnitude of Coriolis component of acceleration?	The magnitude of Coriolis component of acceleration is $2v\omega$. where v is the velocity of the body towards center or outside from center and ω is the angular velocity of the body.	Remember	CO 2	CLO 7	AMEB10.07
13	List different types of Instantaneous centers?	Types of Instantaneous centers are:1.Fixedinstantaneous centers 2. Permanent instantaneous centers and 3. Neither fixed nor permanent.	Remember	CO 2	CLO 7	AMEB10.07
14	What is Instantaneous axis?	Instantaneous axis of rotation means at a particular instant of time it will change as the time changes, also it talks about rotation which means it involves both rolling and translation motion and the axis is line along which something rotates so it is an axis along which the whole body is rotating at a particular instant of time.	Remember	CO 2	CLO 7	AMEB10.08
15	Define centrode?	The path traced by the instantaneous rotational centers of a plane figure when it undergoes motion in a plane.	Remember	CO 2	CLO 6	AMEB10.06
MODULE-III						
1	What is a straight line mechanism?	A mechanism that produces a straight-line output motion from an input element that rotates, oscillates, or moves in a straight line.	Understand	CO 3	CLO7	AMEB10.07
2	Explain Watt's straight line mechanism?	The straight line mechanism developed by James Watt, to guide the piston of steam engines through a straight line path, is considered to be as the best and simplest mechanism able to generate close to straight line motion for considerable distance.	Remember	CO 3	CLO7	AMEB10.07
3	What is an exact straight line mechanism?	Exact straight line mechanisms are those in which locus of tracing point on mechanism is an exact straight line no matter what is the position of other links.	Remember	CO 3	CLO7	AMEB10.07
4	What is an approximate straight line mechanism?	In Approximate straight line mechanisms trace point gives a straight line for small span or rather it is approximated to be a straight line for that very short span.	Remember	CO 3	CLO7	AMEB10.07
5	Name copied straight line mechanism consisting of one sliding pair?	It is possible to generate an exact straight line using Scott-Russell Mechanism. Based on the geometry of the linkage the output motion is a simple straight line copied by the drive link.	Remember	CO 3	CLO7	AMEB10.07

6	What is a Peaucellier mechanism?	Peaucellier linkage can convert an input circular motion to the exact straight line motion. The construction of this mechanism is such that the point which is connected to the crank moves in a circular path and the point traversing the straight line is selected as the output point.	Understand	CO 3	CLO7	AMEB10.07
7	Describe Hart's mechanism?	Hart's mechanism is based on 6-bar linkage. It can be used to convert rotary motion to a perfect straight line by fixing a point on one short link and driving a point on another link in a circular arc.	Remember	CO 3	CLO7	AMEB10.07
8	What is Robert's mechanism?	Robert's straight line mechanism is normally used in the coupler driven mode, that is, the mechanism is not driven by either of the cranks or rockers instead the coupler extension is used to just guide the requisite point along an approximate straight line.	Understand	CO 3	CLO7	AMEB10.07
9	Explain Tchebecheff' mechanism?	Tchebecheff's straight line mechanism is simple in construction. It is a double rocker mechanism and the mid point of the coupler is the point tracing the approximate linear path.	Remember	CO 3	CLO7	AMEB10.07
10	Describe a Hooke's joint?	A universal coupling or a Hooke's joint is a joint or coupling connecting rigid rods whose axes are inclined to each other, and is commonly used in shafts that transmit rotary motion. It consists of a pair of hinges located close together, oriented at 90° to each other, connected by a cross shaft.	Remember	CO 3	CLO7	AMEB10.07
11	What is double Hooke's joint?	A double Hooke's joint gives uniform velocity ratio if: 1) Axis of driven and driving shaft are in same plane. 2) Input and output shafts make equal angles with the intermediate shaft. - The driving and driven shafts in double Hooke's joint rotate at same angular speed, hence velocity ratio is unity.	Remember	CO 3	CLO8	AMEB10.08
12	Describe the application of Hooke's joint?	One very famous application of the Hooke's Joint is in automobiles where it is used to connect shafts that transmit the power from the gearbox to the differential.	Remember	CO 3	CLO8	AMEB10.08
13	What are steering gears?	Steering gears are the collection of components, linkages, etc. which allows any vehicle (car, motorcycle, bicycle) to follow the desired course and provide the steering function. The primary purpose of the steering system is to allow the driver to	Remember	CO 3	CLO8	AMEB10.08

		guide the vehicle.				
14	Explain Davis steering gear?	Davis steering gear mechanism is the one which gives us exact steering alignment. In this mechanism we have two slotted links. These two links are attached with front wheel axle and can move on fixed hinges. On the other hand a horizontal rodis restricted to move along the direction of front wheel axis by sliding members.	Remember	CO 3	CLO8	AMEB10.08
15	Describe the condition of perfect steering?	The condition for perfect steering is that all the four wheels must turn about the same instantaneous centers. While negotiating a curve, the inner wheel makes a larger turning angle θ than the angle φ subtended by the axis of the outer wheel.	Remember	CO 3	CLO8	AMEB10.08

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1	What is a cam?	A cam is a mechanical device used to transmit motion to a follower by direct contact. The driver is called the cam and the driven member is called the follower. In a cam follower pair, the cam normally rotates while the follower may translate or oscillate.	Remember	CO 4	CLO9	AMEB10.09
2	Explain knife follower?	Knife edge follower: It has sharp knife edge which comes into contact with the cam. The motion takes place between the cam and the sharp knife edge. In this follower a considerable side thrust exists between the guide and the followers.	Remember	CO 4	CLO9	AMEB10.09
3	Explain roller follower?	In roller follower the contact surface of cam and follower is in the shape of rollers and the rolling motion takes place between the contacting surfaces so chances of wear are very less. Due to less wear this follower is widely used and is free to rotate about the pin joint.These types of follower are used where space is not any problem like in aircraft engines and in some oil and gas engines etc.	Remember	CO 4	CLO9	AMEB10.09
3	What are the types of cams?	Radial or disc cam, cylindrical cam, spiral cam etc.	Remember	CO 4	CLO9	AMEB10.09
4	Explain the displacement diagram?	In a cam follower system, the motion of the follower is very important. Its displacement can be plotted against the angular displacement θ of the cam and it is called as the displacement diagram. The displacement of the follower is plotted along the y-axis and angular displacement	Remember	CO 4	CLO9	AMEB10.09

		θ of the cam is plotted along x-axis				
5	Define angle of action of cam?	The total angle moved by the cam during its rotation between the beginning of rise and the end of return of the follower. In radial cams the follower reciprocates or oscillates in a direction perpendicular to the cam axis.	Remember	CO 4	CLO9	AMEB10.09
6	Define pressure angle of cam?	The angle between the direction of the follower movement and the normal to the pitch curve at any point is called pressure angle.	Remember	CO 4	CLO9	AMEB10.09
7	What do you mean by dwell?	When the cam turns through one motion cycle, the follower executes a series of events consisting of rise, dwell and return. Dwell is the motion during which the follower is at rest.	Remember	CO 4	CLO9	AMEB10.09
8	What is the principle adopted in the designing of a cam profile?	The fundamental principle in designing the cam profiles is inversion. Normally, the follower oscillates when the cam turns. This means that the relative motion between them is a combination of a relative turning motion and a relative oscillating motion.	Remember	CO 4	CLO9	AMEB10.09
9	Explain the displacement diagram for uniform velocity?	In the displacement diagrams of the follower with uniform velocity, the acceleration of the follower becomes infinite at the beginning and ending of rise and return strokes. To prevent this, the displacement diagrams are slightly modified such that the velocity of the follower changes uniformly during the beginning and end of each stroke.	Remember	CO 4	CLO9	AMEB10.09
10	Define pitch circle of cam?	The smallest circle drawn, tangential to the pitch curve, with its center on the axis of the camshaft.	Remember	CO 4	CLO9	AMEB10.09
11	Explain the displacement diagram for SHM?	The motion executed by point P, which is the projection of point P on the vertical diameter is called simple harmonic motion. P moves with uniform angular velocity ω, along a circle of radius r.	Remember	CO 4	CLO9	AMEB10.09
12	Define base circle of cam?	The smallest circle drawn, tangential to the cam profile, with its center on the axis of the camshaft. The size of the base circle determines the size of the cam.	Remember	CO 4	CLO9	AMEB10.09

13	Explain the displacement diagram for UARM?	The displacement of the follower is parabolic with respect to angular displacement of cam. Accordingly, the velocity of the follower varies uniformly with respect to angular displacement of cam. The acceleration or retardation of the follower becomes constant accordingly.	Remember	CO 4	CLO9	AMEB10.09
14	Name different types of follower motions?	The follower motions are, Uniform velocity, modified uniform velocity, Uniform acceleration and deceleration, Simple harmonic motion and Cycloidal motion	Remember	CO 4	CLO14	AMEB10.14
15	What are the applications of cams?	The applications of cam are specially those of the automatic type, such as printing presses, shoe machinery, textile machinery, gear-cutting machines, and screw machines.	Remember	CO 4	CLO14	AMEB10.14

MODULE-V

1	What are the types of gears?	The different types of gears are spur gear, helical gear, bevel gear and worm and worm gear	Remember	CO 5	CLO15	AMEB10.1 5
2	What is arc of contact in gears?	The arc of contact is the path traced by a point on the pitch circle from the beginning to the end of engagement of a given pair of teeth.	Remember	CO 5	CLO15	AMEB10.1 5
3	Describe path of contact of gears?	It is the path traced by the point of contact of two teeth from the beginning to the end of engagement.	Remember	CO 5	CLO15	AMEB10.1 5
4	What is contact ratio?	The contact ratio is defined as the ratio of the length of arc of contact (from lowest point to the highest point at contact exit) to the circular pitch. In other words, contact ratio is the average number of teeth in mesh during a contact cycle.	Remember	CO 5	CLO15	AMEB10.1 5
5	What is interference in gears?	The phenomenon when the tip of tooth undercuts the root of its mating gear is known as interference.	Understand	CO 5	CLO15	AMEB10.1 5
6	What is a gear train?	When two or more gears are made to mesh with each other to transmit power from one shaft to another then such a combination is called gear train or train of toothed wheels.	Understand	CO 5	CLO15	AMEB10.1 5
7	Mention different types of gear trains?	1. Simple gear train, 2. Compound gear train, 3. Reverted gear train, and 4. Epicyclic gear train	Understand	CO 5	CLO15	AMEB10.1 5
8	What is a reverted gear train?	When the axes of the first gear (i.e. first driver) and the last gear (i.e. last driven or follower) are	Understand	CO 5	CLO15	AMEB10.1 5

		co-axial, then the gear train is known as reverted gear train.				
9	What are epicyclic gear trains/	Gear trains arranged in such a manner that one or more of their members move upon and around another member are known as epicyclic gear trains.	Remember	CO 5	CLO15	AMEB10.15
10	How is the velocity ratio in gear trains determined?	The speed ratio (or velocity ratio) of gear train is the ratio of the speed of the driver to the speed of the driven or follower.	Remember	CO 5	CLO15	AMEB10.15
11	Define train value of a gear train?	The ratio of the speed of the driven or follower to the speed of the driver is known as train value of the gear train.	Remember	CO 5	CLO15	AMEB10.15
12	What is the purpose of an idle gear	To connect gears where a large centre distance is required, and to obtain the desired direction of motion of the driven gear (i.e. clockwise or anticlockwise).	Understand	CO 5	CLO15	AMEB10.15
13	Define a compound gear?	When there are more than one gear on a shaft, it is called a compound train of gear	Understand	CO 5	CLO16	AMEB10.16
14	What are the methods used for calculating velocity ratio in epicyclic gear trains?	The methods used for calculating velocity ratio in epicyclic gear trains are tabular method, and Algebraic method.	Remember	CO 5	CLO15	AMEB10.15
15	Explain the algebraic method of determination of velocity ratio.	In this method, the motion of each element of the epicyclic train relative to the arm is set down in the form of equations. The number of equations depends upon the number of elements in the gear train.	Understand	CO 5	CLO15	AMEB10.15
16	What are sun and planet gears?	The gear at the centre is called the sun gear and the gears whose axes move are called planet gears.	Understand	CO 5	CLO16	AMEB10.16
17	How is speed reduction achieved in gear trains?	The bevel gears are used to make a more compact epicyclic system and they permit a very high speed reduction with few gears.	Remember	CO 5	CLO15	AMEB10.15
18	What is the application of epicyclic gear trains?	The useful application of the epicyclic gear train with bevel gears is found in differential gear of an automobile	Remember	CO 5	CLO15	AMEB10.15
19	Explain the function of a differential?	The function of a differential is to transmit motion from the engine shaft to the rear driving wheels, and to rotate the rear wheels at different speeds while the automobile is taking a turn.	Remember	CO 5	CLO17	AMEB10.17
20	Which gear train is used to connect hour hand to minute hand in clocks?	In a clock mechanism, the gear train used to connect minute hand to hour hand, is a reverted gear train.	Remember	CO 5	CLO17	AMEB10.17

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