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INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

MODEL QUESTION PAPER - I

B.Tech V Semester End Examinations (Regular),November– 2019

Regulations: R16

MECHANISM AND MACHINE DESIGN

(**AERONAUTICAL ENGINEERING**)

Time: 3 hours **Max. Marks: 70**

Answer ONE Question from each Unit
All Questions Carry Equal Marks
All parts of the question must be answered in one place only

UNIT – I

1.	a)	Explain machine and mechanism with a flow diagram and also discuss contrast between machine and mechanism.	**[7M]**
	b)	The length of the fixed link in a crank and slotted lever quick return mechanism is 300 mm and crank is 110 mm. Determine the inclination of the slotted lever with the vertical in the extreme position.	**[7M]**
2.	a)	Demonstrate different types of constrained motions with examples.	**[7M]**
	b)	In a Whitworth quick return motion mechanism, the distance between the fixed centers is 50 mm and the length of the driving crank is 75 mm. The length of the slotted lever is 150 mm and the length of the connecting rod is 135 mm. Find the ratio of time of cutting and return strokes and also the effective stroke.	**[7M]**

UNIT – II

3.	a)	Derive Arnold Kennedy's theorem and apply to slider crank mechanism.	**[7M]**
	b)	Locate all the Instantaneous centers of slider crank mechanism with crank length of 25mm rotating clockwise at a uniform speed of 100 rpm. The crank makes 45^0 with IDC and the connecting rod is 400 mm long .Determine the velocity of the slider and the angular velocity of connecting rod?	**[7M]**
4.	a)	Derive the velocity of piston using Instantaneous center method.	**[7M]**
	b)	In a four link mechanism, the dimensions of the links are AB=200 mm, BC=400mm, CD=450 mm and AD=600mm. At the instant when DAB=90°, the link AB has angular velocity of 36 rad/s in the clockwise direction. Determine (i) The velocity of point C, (ii) The velocity of point E on the link BC When BE =200 mm (iii) The angular velocities of links BC and CD, (iv) Acceleration of link BC.	**[7M]**
5.	a)	Describe any one mechanism having all turning pairs that generate an exact	**[7M]**

straight line?

b) Derive the condition for generating a straight line in Grasshopper's mechanism. **[7M]**

6. a) Derive an expression for the ratio of shaft velocities in a Hooke's joint. **[7M]**

b) In a Davi's steering gear, the distance between the pivots of the front axle is 1 meter and the wheel base is 2.5 meters. Find the inclination of the track arm to the longitudinal axis of the car when it is moving along a straight path? **[7M]**

UNIT – IV

7. a) Draw and explain the displacement and velocity diagrams for uniform velocity motion. **[7M]**

b) Draw a cam to raise a valve through a distance of 50 mm in 1/3 of revolution with SHM, keep it fully raised through 1/12 of revolution and lower it with harmonic motion in 1/6 of revolution. The valve remains closed during the rest of the revolution. The diameter of the roller is 20 mm and the minimum radius of the cam is 25 mm. The axis of the valve rod passes through the axis of the cam shaft. **[7M]**

8. a) Define angle of action, angle of dwell and pressure angle in a cam with diagrammatic representation. **[7M]**

b) A cam is to give the following motion to a knife edge follower: **[7M]**
(a) Outstroke during 60° of cam rotation
(b) Dwell for the next 45° 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 uniform velocity 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.

UNIT – V

9. a) Derive an expression for the length of path of contact and deduce the number of pairs in contacts in involute case. **[7M]**

b) A pair of gears having 40 and 20 teeth respectively is rotating in mesh. The speed of the smaller is 2000 rpm. Determine the velocity of sliding at the point of engagement, at the pitch point and at the point of disengagement. Assume that the gear teeth are 20^0 involute, addendum is 5 mm and module is 5 mm. **[7M]**

10. a) Explain with a neat sketch the sun and planet wheel and deduce the gear ratio. **[7M]**

b) In a reverted epicyclic train, the arm F carries two wheels A and D and a compound wheel B-C. Wheel A meshes with wheel B and Wheel D meshes with wheel C. The number of teeth on wheel A, D and C is 80, 48, and 72. Find the speed and direction of wheel D, when wheel A is fixed and arm F makes 200 rpm clockwise. **[7M]**

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COURSE OBJECTIVES:

The course should enable the students to:

I	Understand the basic principles of kinematics and the related terminology of machines.
II	Discriminate mobility; enumerate links and joints in the mechanisms.
III	Formulate the concept of analysis of different mechanisms.
IV	Understand the working of various straight line mechanisms, gears, gear trains, steering gear mechanisms, cams and a Hooke's joint.
V	Analyze a mechanism for displacement, velocity and acceleration of links in a machine.

COURSE OUTCOMES (COs):

CO 1	Describe the concept of mechanisms and machines in which all the links and their mechanism studied.
CO 2	Determine the velocity and acceleration diagrams for different mechanisms using graphical methods.
CO 3	Understand the concept of plane motion of body and gyroscopic motion precession in which gyroscopic mechanism is studied.
CO 4	Explore the concept of cams and followers, steering gear mechanism to understand real time applications of mechanisms.
CO 5	Introduction to gears and gear mechanism where different tooth profiles of gear is designed.

COURSE LEARNING OUTCOMES (CLOs):

AAE523.01	Classifications of the kinematic links, kinematic pairs and formation of the kinematic chain.
AAE523.02	Distinguish between mechanism and machine.
AAE523.03	Design and develop inversions of quadratic cycle chain, slider crank mechanism, and double slider crank mechanism and cross slider mechanism.
AAE523.04	Demonstrate type synthesis, number synthesis and dimensional synthesis.
AAE523.05	Construct Graphical methods of velocity polygon and acceleration polygons for a given configuration diagram.
AAE523.06	Understand other methods of acceleration diagrams like Klien's construction.
AAE523.07	Develop secondary acceleration component i.eCorreli's component involving quick return mechanisms
AAE523.08	Alternative approach for determining velocity by using Icentres and centriods methods.
AAE523.09	Significance of exact and approximate straight line mechanisms.
AAE523.10	Application of straight line mechanism in steam engine indicators.
AAE523.11	Applications of Ackerman's and Davi's steering mechanisms in automobiles.
AAE523.12	Develop the condition for exact steering.
AAE523.13	Develop the polar velocity diagram for a single hook joint and double hook joint and develop condition for unity for higher and lower speeds.
AAE523.14	Study different displacement profiles applicable in I.C engines cam shafts.
AAE523.15	Plot the displacement, velocity and acceleration profiles with respect to time.
AAE523.16	Understand the geometry of gears and deduce the expression for arc of contact.
AAE523.17	Derive the expression for minimum number of teeth to avoid interference in case of pinion and gear as well as rack and pinion.
AAE523.18	Application of different gear trains including epicyclic and deduce the train value.
AAE523.19	Significance of differential gear box in an automobile while taking turn on the road.
AAE523.20	Enable the students to understand the importance of theory of machines for lifelong learning, Higher Education and competitive exams.

Mapping of Semester End Examinations to Course Learning Outcomes:

SEE Question No.		Course Learning Outcomes		Course Outcomes	Blooms Taxonomy Level
1	a	AAE523.02	Distinguish between mechanism and machine	CO 1	Understand
	b	AAE523.01	Design and develop inversions of quadratic cycle chain, slider crank mechanism, and double slider crank mechanism and cross slider mechanism.	CO 1	Understand
2	a	AAE523.01	Classifications of the kinematic links, kinematic pairs and formation of the kinematic chain.	CO 1	Understand
	b	AAE523.03	Design and develop inversions of quadratic cycle chain, slider crank mechanism, and double slider crank mechanism and cross slider mechanism.	CO 1	Understand
3	a	AAE523.08	Alternative approach for determining velocity by using I centers and centroid methods.	CO 2	Understand
	b	AAE523.08	Alternative approach for determining velocity by using I centers and centroid methods.	CO 2	Remember
4	a	AAE523.08	Alternative approach for determining velocity by using I centers and centroid methods.	CO 2	Remember
	b	AAE523.05	Construct Graphical methods of velocity polygon and acceleration polygons for a given configuration diagram.	CO 2	Remember
5	a	AAE523.09	Significance of exact and approximate straight line mechanisms.	CO 3	Understand
	b	AAE523.09	Significance of exact and approximate straight line mechanisms.	CO 3	Understand
6	a	AAE523.13	Develop the polar velocity diagram for a single hook joint and double hook joint and develop condition for unity for higher and lower speeds.	CO 3	Understand
	b	AAE523.11	Applications of Ackerman's and Davi's steering mechanisms in automobiles.	CO 3	Understand
7	a	AAE523.15	Plot the displacement, velocity and acceleration profiles with respect to time.	CO 4	Understand
	b	AAE523.14	Study different displacement profiles applicable in I.C engines cam shafts.	CO 4	Remember
8	a	AAE523.15	Plot the displacement, velocity and acceleration profiles with respect to time.	CO 4	Remember
	b	AAE523.14	Study different displacement profiles applicable in I.C engines cam shafts.	CO 4	Remember
9	a	AAE523.16	Understand the geometry of gears and deduce the expression for arc of contact.	CO 5	Remember
	b	AAE523.17	Derive the expression for minimum number of teeth to avoid interference in case of pinion and gear as well as rack and pinion.	CO 5	Understand
10	a	AAE523.15	Plot the displacement, velocity and acceleration profiles with respect to time.	CO 5	Remember
	b	AAE523.15	Plot the displacement, velocity and acceleration profiles with respect to time.	CO 5	Remember

Signature of Course Coordinator **HOD, AE**