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No. of Printed Pages—6 **ME-402**

B. TECH.

FOURTH SEMESTER EXAMINATION, 2002-2003

KINEMATICS OF MACHINES

Time : 3 Hours *Total Marks : 100*

Note : Attempt **ALL** the questions.

1. Attempt any FOUR of the following :— **(5×4=20)**

   (*a*) Differentiate between the following kinematic pairs with suitable examples :—

   (*i*) Lower pair and higher pair

   (*ii*) Turning pair and sliding pair

   (*b*) What do you mean by constrained motion ? What are the different types of constrained motions ? Explain with examples and neat sketches.

   (*c*) Sketch and describe the working of two different types of quickreturn mechanisms. Give examples of their application. Write an expression for the ratio of times taken in forward and return strokes.

   (*d*) For a plane mechanism, derive an expression for Grubler's equation and find out degrees of freedom for the following planer mechanisms (Figure 1) :—

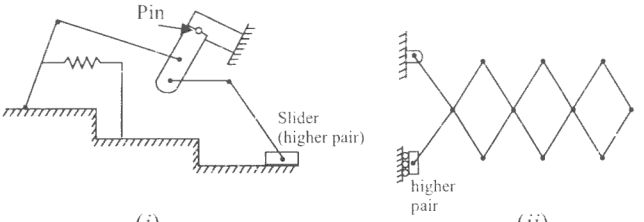


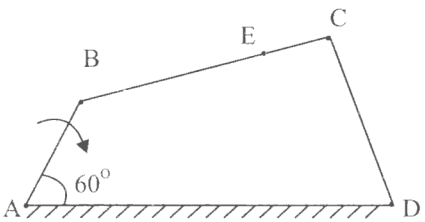
Fig. 1

(*e*) Prove that if three bodies are in relative motion with respect to one another, the three relative instantaneous centres of velocity are collinear.

(*f*) A pin jointed 4 bar mechanism is shown in Fig. 2. The link AB rotates at 20 rpm and angle BAD = 60°. Find :

(*i*) Angular velocities of links CD and BC,

(*ii*) Linear velocity of point E on link BC at a distance of 2·25 m from end B.



AB = 0·5 m
BC = 3·0 m
CD = 1·5 m
AD = 3·5 m
BE = 2·25 m

Fig. 2

2. Attempt any FOUR of the following :— **(5×4=20)**

(*a*) Find an expression for tangential acceleration and for radial acceleration when a body is moving in a circular path. What will happen to these accelerations if :

(*i*) body is rotating with uniform angular velocity, and

(*ii*) body is moving on a straight path ?

(*b*) Explain Klein's construction for finding acceleration of links in four bar mechanism.

(*c*) What do you mean by Coriolis component of acceleration ? When will it exist ? Prove that this component of acceleration is equal to

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$2vw$. How will you find the direction of Coriolis component of acceleration ?

(*d*) An engine mechanism shown in Fig. 3 has a crank length of 0·1 m and connecting rod 0·3 m long with centre of gravity G, 0·1 m from end B. The crankshaft has a speed of 75 rad/sec and an angular acceleration of 1200 rad/sec^2. Find acceleration of point G and angular acceleration of connecting rod.

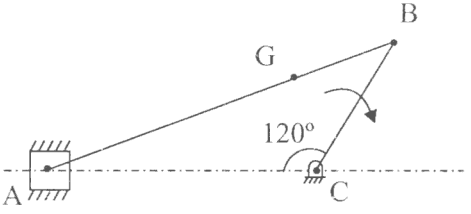

Fig. 3

(*e*) What do you mean by straight line mechanism ? Name different mechanisms which are used for exact straight line motion. Describe the working of one of the exact straight line motion mechanisms with neat sketch.

(*f*) What is a Hooke's joint ? With a neat sketch, describe the working of a Hooke's joint. Also show that for a Hooke's joint,

$$\tan\theta = \cos\alpha \tan\phi$$

where α = angle of inclination of the driven shaft with driving shaft, and ϕ and θ are angles turned by driven and driving shafts at any instant.

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3. Attempt any TWO of the following : — (10×2=20)

(*a*) What do you mean by Grashof's linkage ? Discuss various inversions of Grashof's linkage.

(*b*) Explain synthesis of mechanism with examples. What do you understand by

(*i*) Type Synthesis,

(*ii*) Number Synthesis,

(*iii*) Dimensional Synthesis ?

(*c*) Design a 4 bar mechanism to coordinate the input and output angles as follows :

Input Angles	15°	30°	45°
Output Angles	30°	40°	55°

Also draw the designed mechanism for the above values of input and output.

4. Attempt any TWO of the following :— (10×2=20)

(*a*) Differentiate between the following with neat sketches :—

(*i*) Base circle and Prime circle

(*ii*) Cam angle and Pressure angle

(*iii*) Pitch point and Trace point

(*iv*) Period of ascent and period of descent

(*v*) Disc cams and Cylindrical cams.

(*b*) What are the advantages of cam profiles consisting of circular arcs and straight lines ? Discuss the important cams of specified contours. For the tangent cam with circular

nose and roller follower, derive the expression of the velocity of the follower :

(*i*) when roller is in contact with straight flank,

(*ii*) when roller is in contact with circular nose.

(*c*) Draw a cam profile for a knife edge follower with the following data :—

(*i*) Cam lift 40 mm during 90° cam rotation with simple harmonic motion

(*ii*) Dwell period for next 30°

(*iii*) During next 60° of cam rotation, the follower returns to original position with simple harmonic motion

(*iv*) Dwell period for rest of the rotation of the cam

The radius of base circle is 40 mm and it rotates at 240 rpm in clockwise direction. Also determine the maximum velocity and acceleration of the follower during its ascent and descent.

5. Attempt any TWO of the following :— (10×2=20)

(*a*) State and prove the law of gearing and show how the involute teeth profile satisfies the conditions for correct gearing. Derive an expression for the velocity of sliding between a pair of involute teeth.

(*b*) What are the different forms of a gear tooth ? Discuss the relative advantages of involute and cycloidal gears. Explain the interference and show how it is prevented.

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(c) The annulus A in the gear train shown in Fig. 4 rotates at 300 rpm about the axis of the fixed wheel S which has 80 teeth. The three-arm spider is driven at 180 rpm. Determine the number of teeth required on the wheel P.

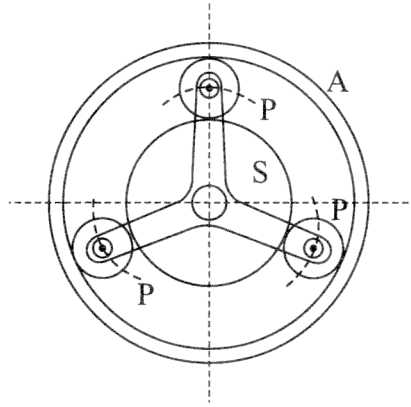

Fig. 4