Code No: 07A51404 **R07** **Set No. 2**

III B.Tech I Semester Examinations,November 2010
KINEMATICS OF MACHINERY
Mechatronics

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) State and explain Kennedy's theorem as applicable to instantaneous center of rotation of three bodies.
   (b) In the mechanism shown in Figure 1. the crank OA makes 400rpm in the counter clockwise direction. Find
      i. angular velocity of the link BA and
      ii. velocity of the slider at A. The lengths of the links are OA= 60mm, OB= 220 mm and BC= 300mm. [6+10]

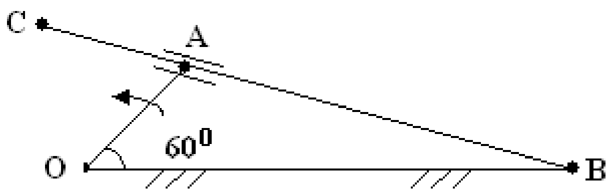

Figure 1

2. a) Explain about types of materials used in belt drive.
   b) A 100mm wide and 10mm thick belt transmits 5 kW between two parallel shafts. The distance between the shaft centers is 1.5m and the diameter of the smaller pulley is 440mm. The driving and driven shafts rotate at 60rpm and 150rpm respectively. Find the stress in the belt if the two pulleys re connected by
      i) an open belt, and
      ii) A cross belt. The coefficient of friction is 0.22 [16]

3. (a) What is path of contact?
   (b) A pair of spur gears have 16 and 18 teeth, a module of 13mm, addendum of 13mm, and pressure angle of 14.5^0. Show that the gears have interference. Determine the amount by which the addendum must be reduced to eliminate the interference. [4+12]

4. (a) Define the following terms with reference to cam.
      i. Base circle.
      ii. Offset.
      iii. Pitch angle.

(b) A cam profile consists of two circular arcs of radii 30mm and 15 mm, joined by straight lines giving the follower a lift of 15mm. The follower is roller of 25mm radius and its line of action is a straight line passing through the cam shaft axis. When the cam shaft has a uniform speed of 600rpm, find the maximum velocity and acceleration of the follower while in contact with the straight flank of the cam. [16]

5. (a) Sketch Ackermann steering gear and explain its advantages.
   (b) For an Ackermann steering gear, derive the expression for the angle of inclination of the track arms to longitudinal axis of the vehicle.
   (c) The driving shaft of a Hooke's joint rotates at a uniform speed of 300 rpm. If the total maximum variation in speed of the driven shaft is 8 percent of the mean speed, determine the greatest permissible angle between the axes of the shaft. Also find the maximum and minimum speeds of the driven shaft. [4+7+5]

6. (a) Explain about "selection of automotive transmission gear trains".
   (b) Figure 6b shows a port indicator for a twin-screw ship. It is found that the pointer P remains stationary if the propellers run at the same speed and drive the gears C and D in the same direction through equal gears A and B. If the number of teeth on G and F are 24 and 50 respectively, find the ratio of the number of teeth on C to that on D.
   What will be the speed of the pointer if B runs at 5% faster than A and if the speed of C is 100rpm? [16]

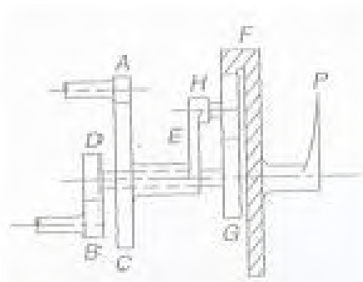

Figure 6b

7. In figure 7 shown, the dimensions of the various links are such that $\frac{OA}{OB} = \frac{OE}{OF} = \frac{AC}{BD} = \frac{EC}{FD}$. Show that if C traces any path, then D will describe a similar path and vice-versa.

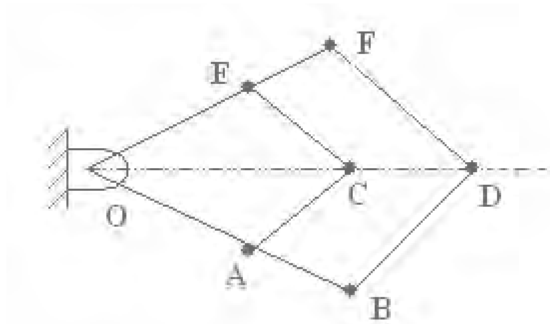

Figure 7

8. (a) What is Kutzback's criterion for degree of freedom of plane mechanisms? In what way Grubler's criterion is different from it?
   (b) How are Whitworth-quick- return mechanism and crank and slotted-lever quick return mechanism are different from each other?
   (c) Describe briefly the functions of elliptical trammel and scotch yoke. [5+5+6]

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Code No: 07A51404 **R07** **Set No. 4**

III B.Tech I Semester Examinations,November 2010
KINEMATICS OF MACHINERY
Mechatronics

Time: 3 hours Max Marks: 80

Answer any FIVE Questions
All Questions carry equal marks
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1. A motor shaft drives a main shaft of workshop by means of a flat belt, the diameters of the pulleys being 500mm and 800mm respectively. Another pulley of diameter 600mm on the main shaft drives counter-shaft having a 750mm diameter pulley. If the speed of the motor is 1600rpm, find the speed of the counter shaft neglecting the thickness of the belt and considering a slip of 4% on each drive. [16]

2. (a) What is pantograph? What are its uses?
   (b) Show that the pantograph can produce paths exactly similar to the ones traced out by a point on a link on an enlarged or a reduced scale. [6+10]

3. In a slider-crank mechanism, the crank is 450 mm long and rotates at 30 rad/s in the counter-clockwise direction. The length of the connecting rod is 1.5 m. When the crank turns 30^o from the inner-dead center, determine,
   (a) the velocity of the slider
   (b) the velocity of a point E located at a distance 450 mm on the connecting rod extended
   (c) the position and velocity of a point F on the connecting rod having the least absolute velocity
   (d) the angular velocity of the connecting rod. [16]

4. (a) How can cams classified according to motions of the followers.
   (b) Set out the profile of a cam to give the following motion to a flat mushroom contact face follower:
   Follower to rise through 24mm during 150^0 of cam rotation with SHM.
   Follower to dwell for 30^0 of the cam rotation.
   Follower to return to the initial position during 90^0 of the cam rotation with SHM.
   Follower to dwell for the remaining 90^0 of cam rotation. Take minimum radius of the cam as 30mm. [16]

5. (a) The angle between the axes of the two shafts connected by a Hooke's joint is 12 degrees. Find the angles turned by the driving shaft when the velocity of the driven shaft is maximum, minimum and equal to that of the driving shaft. Also determine the angles at which the driven shaft will have the maximum acceleration and retardation.
   (b) Describe an Ackermann steering gear with a neat sketch. Explain why it is widely used.

(c) The track arm of a Davis steering gear is at a distance of 190 mm from the front main axle whereas the difference between their lengths is 92 mm. If the distance between steering pivots of the main axle is 1.4 m, determine the length of the chassis between the front and the rear wheels. Also find the inclination of the track arms to the longitudinal axis of the vehicle. [6+4+6]

6. An epicyclic gear train, as shown in figure 6, is composed of a fixed annular wheel A having 150 teeth. The wheel A is meshing with wheel B which drives wheel D through an idler wheel C, D being concentric with A. The wheels B and C are carried on an arm which revolves clockwise at 100rpm about the axis of A and D. If the wheels B and D have 25 teeth and 40 teeth respectively, find the number of teeth on C and the speed and sense of rotation of C. [16]

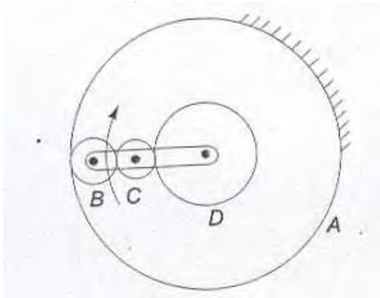

Figure 6

7. (a) Show that for the scotch yoke mechanism shown in figure 7 uniform rotation of the crank 'b' will produce simple harmonic motion of the slider 'd'.

(b) Name the inversion obtained by fixing link 'b' of the scotch yoke mechanism shown in figure 7. Describe the inversion with neat sketch. [8+8]

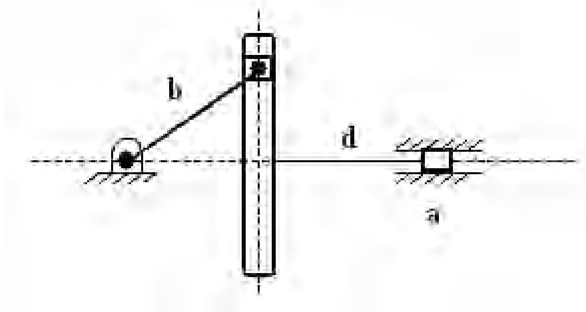

Figure 7

8. (a) How do you find the number of teeth in contact of two mating gears?

(b) Two gears in mesh have a module of 8mm and a pressure angle of 20^0. The larger gear has 57 while the pinion has 23 teeth. If the addendum on pinion and gear wheels are equal to one module, find

i. the number of pairs of teeth in contact

ii. the angle of action of the pinion and the gear wheel

iii. the ratio of the sliding to rolling velocity at

A. the beginning of contact

B. the pitch point

C. the end of contact [16]

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Code No: 07A51404 **R07** **Set No. 1**

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Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
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1. (a) Derive the expression to determine the magnitude of the coriolis component of acceleration.

   (b) Explain the procedure to determine the velocity and acceleration of a four-bar mechanism by Klein's construction. [6+10]

2. Two pulleys on two shafts are connected by a flat belt. The driving pulley is 250mm in diameter and runs at 150rpm. The speed of the driven pulley is to be 90 rpm. The belt is 120mm wide, 5mm thick and weighs 1000 kg/m^3. Assuming a slip of 2% between the belt and each pulley. Determine the diameter of the driven pulley. Also find the total effective tension. [16]

3. (a) What is a Kinematic chain? What is the relation between the number of links and number of pairs in a kinematic chain?

   (b) Give diagrammatic sketches of the following mechanisms and state on which Kinematic chain each mechanism is based:

      i. Oscillating cylinder engine
      ii. Oldham shaft coupling
      iii. Pendulum pump
      iv. Scotch yoke mechanism
      v. Watt's indicator. [6+10]

4. (a) For an Ackermann steering gear, derive the expression for the angle of inclination of the track arms to longitudinal axis of the vehicle.

   (b) A Hooke's joint connects two shafts whose axes intersect at 150^0. The driving shaft rotates uniformly at 120rpm. The driven shaft operates against a steady torque of 150 Nm and carries a flywheel whose mass is 45 Kg and radius of gyration 150mm. Find the maximum torque which will be exerted by the driving shaft. [8+8]

5. The epicyclic gear train known as Ferguson's paradox is shown in figure 5. Gear 1 is fixed to the frame. The arm A and gears 2 and 3 are free to rotate on the shaft S. Gears 1, 2 and 3 have 100, 101, and 99 teeth respectively. The planet gear has 20 teeth. The pitch circle diameter of all the gears is the same so that the plant gear P meshes with all of them. Determine the revolutions of gears 2 and 3 for one revolution of the arm A. [16]

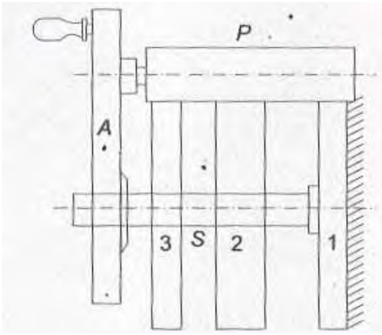

Figure 5

6. (a) What is a pantograph? What are its uses?
   (b) What are the limitations of Scott-Russell mechanism?
   (c) Under what conditions scott-Russel mechanism traces out a straight line and an ellipse? [6+4+6]

7. (a) Define the terms related to worm gear: axial pitch, lead and lead angle.
   (b) Two 20^0 involute spur gears have a module of 6mm. The larger wheel has 36 teeth and the pinion 16 teeth. If the addendum be equal to one module, will interference occur? What will be the effect, if the number of teeth on the pinion is reduced to 14? [16]

8. (a) Write short notes on the following pertaining to cams
      i. Base circle
      ii. Dwell.
      iii. Prime circle.
   (b) The following data refers to a circular arc cam working with a flat faced reciprocating follower.
   Minimum radius of cam = 30mm, total angle of cam action = 120^0, radius of circular arc = 80mm, and nose radius = 10mm. Find
      i. the distance of the centre of the nose circle from the cam axis,
      ii. the angle through which the cam turns when the point of contact moves from the junction of minimum radius arc and circular arc to the junction of nose arc and circular arc, and
      iii. velocity and acceleration of the follower when the cam has turned through an angle of 20^0. The angular velocity of the cam is 10 rad/s.

[6+10]

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Code No: 07A51404 **R07** **Set No. 3**

III B.Tech I Semester Examinations,November 2010
KINEMATICS OF MACHINERY
Mechatronics

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
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1. (a) What is coriolis component of acceleration? How is it determined?
   (b) Explain the procedure to determine the velocity and acceleration of a slider-crank mechanism by Klein's construction. [6+10]

2. Describe any one mechanism having all turning pairs that generate an exact straight-line motion and show that the mechanism generates the straight-line motion. [16]

3. (a) Discuss various types of cams and followers.
   (b) Draw the profile of a cam that gives a lift of 40 mm to rod carrying a 20 mm diameter roller. The axis of the roller passes through the centre of the cam. The least radius of the cam is 50 mm. The rod is to be lifted with simple harmonic motion in a quarter revolution and is to be dropped suddenly at half revolution. Determine the maximum velocity and maximum acceleration during the lifting. The cam rotates at 60 rpm. [16]

4. (a) Define arc of contact of two gear wheels.
   (b) A pinion of 20^0 involute teeth and 120mm pitch circle diameter drives a rack. The addendum of both pinion and rack is 6mm. Determine the least pressure angle which can be used to avoid interference. With this pressure angle find the contact ratio. [16]

5. A leather belt transmits 10 kW from a motor running at 600rpm by an open-belt drive. The diameter of the driving pulley of the motor is 350mm, centre distance between the pulleys 4m and speed of the driven pulley 180rpm. The belt weighs 1100 kg/m^3 and the maximum allowable tension in the belt is 2.5 N/mm^2. $\mu =$ 0.25. Find the width of the belt assuming the thickness to be 10mm. Neglect the belt thickness to calculate the velocities. [16]

6. (a) What is a double Hooke's joint? What is the maximum variation in the speed of the driven shaft if the axes of the driving and driven shafts are connected to the double Hooke's joint in planes that are perpendicular to one another?
   (b) Deduce the condition for the equal speeds of two shafts connected by a Hooke's joint from the expression for the ratio of their angular velocities. Also deduce the expression for the angular acceleration of the driven shaft.
   (c) The track arm of a Davis steering gear is at a distance of 185 mm from the front main axle whereas the difference between their lengths is 90 mm. If the distance between steering pivots of the main axle is 1.2 m, determine the length of the chassis between the front and the rear wheels. Also find the inclination of the track arms to the longitudinal axis of the vehicle. [5+5+6]

7. Figure 7. shows an epicyclic gear train. Pinion A has 15 teeth and is rigidly fixed to the motor shaft. The wheel B has 20 teeth and gears with A, and also with annular fixed, wheel D. Pinion C has 15 teeth and is integral with B (C, B being a compound gear wheel). Gear C meshes with annual wheel E, which is keyed to the machine shaft. The arm rotates about the same shaft on which A is fixed and carries the compound wheel B, C. If the motor runs at 1000rpm, find the speed of the machine shaft. Find the torque exerted on the machine shaft if the motor develops a torque of 100 N-m. [16]

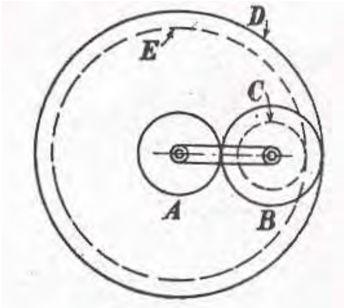

Figure 7

8. (a) What is the difference between quick return motion of crank and slotted lever type and that of whitworth type?

   (b) Find the distance between the fixed centres of a Whitworth quick return motion mechanism if the length of driving link is 40mm, return stroke is 150mm and time ratio of cutting to return stroke is 2. [6+10]

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