Code No: RR310304 **Set No. 1**

III B.Tech I Semester Regular Examinations, November 2006
KINEMATICS OF MACHINERY
(Common to Mechanical Engineering, Mechatronics and Production Engineering)

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

Answer any FIVE Questions
All Questions carry equal marks

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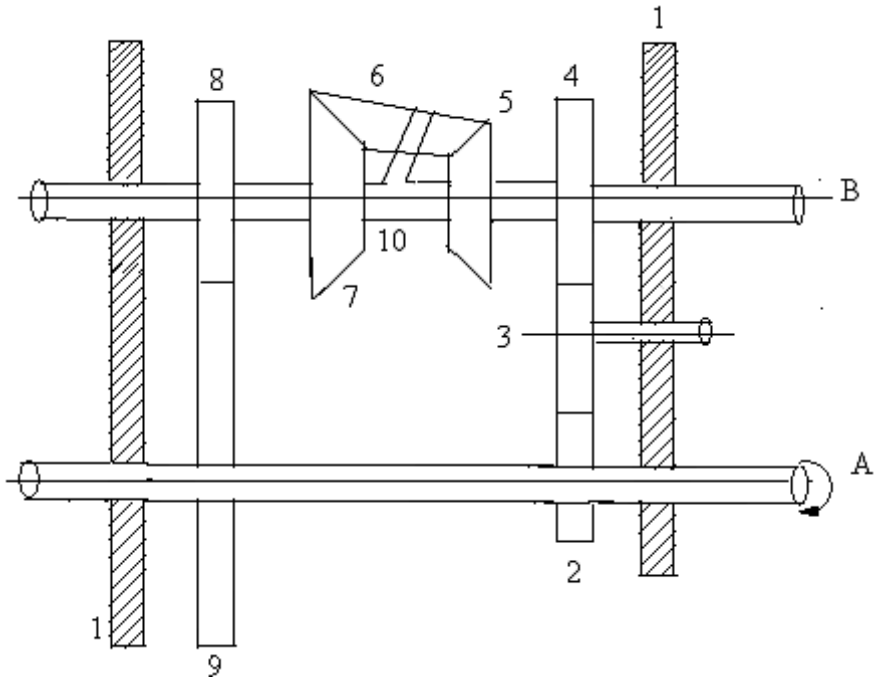
1. (a) Find out the degrees of freedom of the gear system shown in the following Figure 1.
   (b) The distancce between two parallel shafts is 15 mm and they are connected by an Oldham's coupling. The driving shaft revolves at 150 r.p.m.What will be the maximum speed of sliding of the tongue of the intermediate piece along its groove?
   (c) What are resistant bodies? Is it necessary that the resistant bodies be rigid? Give reasons for your answer.



[4+8+4] Figure 1

2. (a) What are straight line motion mechanisms? Name the different types of mechanisms used for straight line motion.
   (b) Sketch the Peaucellier straight line motion and prove that the tracing point 'P' describes a straight line path. [4+12]

3. In the mechanism shown in Figure 3 the slider moves uniformly vertically downloads at 5m/sec. The various dimensions of the link are AB = 15cm, AC = 10cm and CD = 20cm. Determine:

(a) Linear velocity of slides links 4 and 6

(b) Angular velocity of link 5

(c) Linear acceleration of slides 6

(d) Angular acceleration of links 3 and 5. [16]

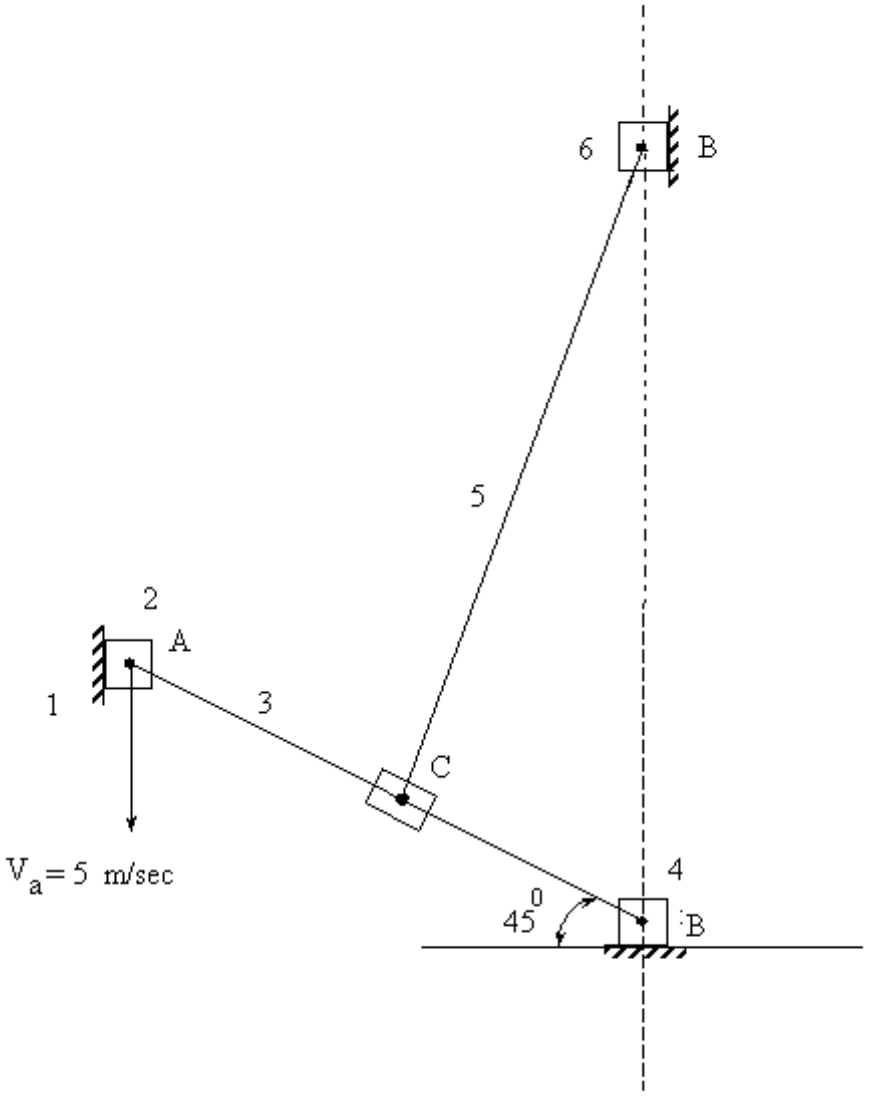


Figure 3

4. A mechanism as shown in Figure 4 has the following dimensions: O_1A = 60 mm; AB 180 mm; O_2B = 100 mm; O_2C = 180 mm and CD = 270 mm. The crank O_1C = 180 mm and CD = 270 mm. The crank O_1A rotates clockwise at a uniform speed of 120 r.p.m. The block D moves in vertical guides. Find by instantaneous centre method, the velocity of D and the angular velocity of CD. [16]

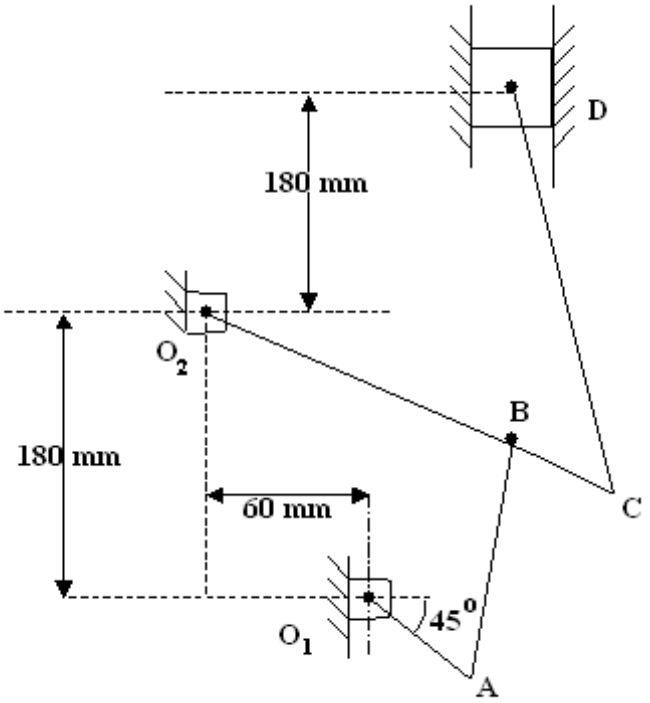


Figure 4

5. Show that the peaucellier mechanism generates an exact straight line as its path. [16]

6. The following data relate to a circular cam operating a flat faced follower
   Least diameter = 40 m.m
   Lift = 12 m.m.
   Angle of action = 160^0
   Speed = 500 r.p.m.
   If the period of acceleration of the follower is 60% of the retardation during the lift determine

   (a) The main dimension of the cam

   (b) The acceleration of the main points

   (c) What is the maximum acceleration and deceleration during the lift? [5+5+6]

7. (a) Define and explain the terms with a neat sketch; Helical gears, helix angle, normal pitch and circular pitch.

   (b) A helical spur gear having 20 teeth has a module pitch in the pane of rotation equal to 3 mm and a face width of 30 mm. The tooth advance is 1.15 times the circular pitch. Calculate

      i. Pitch helix angle
      ii. Normal pitch
      iii. Axial pitch
      iv. Pitch diameter and

v. lead. [8+8]

8. In the epicyclic reduction gear shown in Figure 8 a shaft A is driven by an arm B, which is fixed to it. B has a pin fixed to its outer end, and two pinions, C, E which are cast together in one piece, revolve on this pin. C gears with an annular fixed wheel D and E gears with a pinion F which is driven by a belt pulley G. The number of teeth are as follows:

   D = 80, C=15, E=24, F= 18. The pulley G runs at 240rpm. Find the speed of the shaft A. [16]

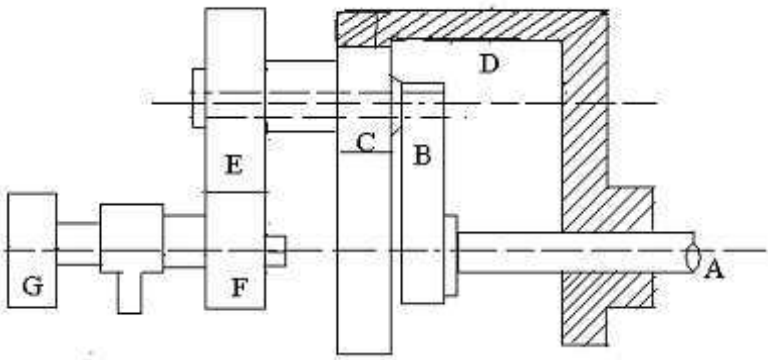


Figure 8

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Code No: RR310304 **Set No. 2**

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

Answer any FIVE Questions
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1. (a) How can the mechanism of higher pair be replaced by the mechanism of lower pair?
   (b) Write notes on complete and incomplete constraints in lower and higher pairs, illustrating your answer with neat sketches. [6+10]

2. Two points P and Q, 4 cm apart are to be connected by a pantograph. The motion of P to the motion of P Q is 13 : 7. Fine the distance of Q from the fixed point O of the pantograph such that the point P moves at least 12.7 cm in either direction of live O Q P when it is horizontal. Find also the main dimensions of the pantograph. [16]

3. A quick return mechanism is shown in Figure 3 below. Link 2 rotates uniformly at 20rad/sec. Draw the acceleration polygon. Find the absolute acceleration of point B. [16]

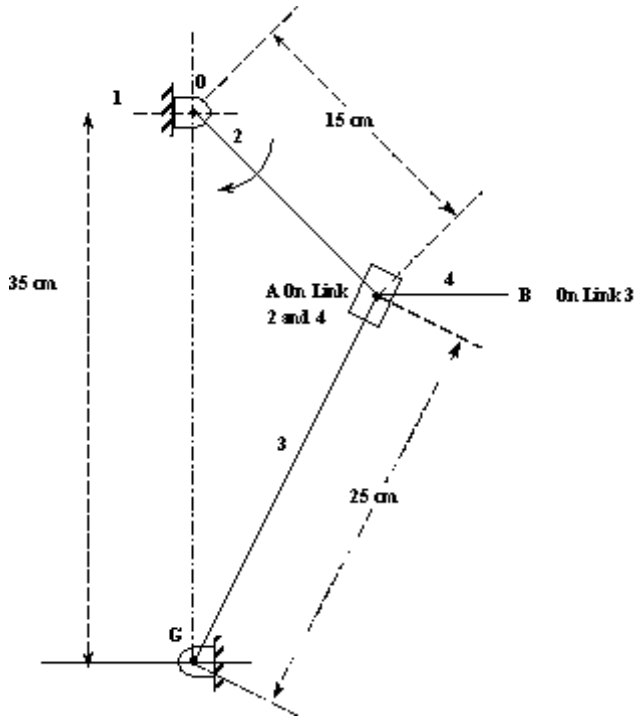

Figure 3

4. An engine mechanism ABC has a crank AB of length 4 cm rotating about A. The connecting rod BC is 12 cm long and the piston C has a mass of 100 gm. C moves

along the line AC. Draw the velocity diagram and the acceleration diagram for a uniform crank speed of 150 rad/sec in clockwise direction when the angle BAC is 45^0. What is torque required at the crank to accelerate the piston C at this position? [16]

5. The angle between the axes of two horizontal shafts to be connected by Hook's joint is 150^0. The speed of driving shaft is 150rpm. The driven shaft carries a flywheel weighing 10 Kg and having a radius of gyration of 10 Cm. If the forked end of the driving shaft rotates 30^0 from horizontal plane, find the torque required to drive the shaft to overcome the inertial of the flywheel. [16]

6. A flat ended valve tappet is operated by a symmetrical cam with circular arcs for flank and nose profiles. The total angle of action is 150^0 base circle diameter 125 mm and the lift 25 mm. During the lift, the period of acceleration is half that of the retardation. Speed of cam shaft is 1250 r.p.m. The straight line path of the tapper passes through the cam axis. Find

   (a) Radii of the nose and flank, and

   (b) Maximum acceleration and retardation during the lift. [16]

7. (a) What do you mea by conjugate gears? Explain how do the involute profile gear teeth satisfy it?

   (b) A pair of gears having 40 and 20 teeth respectively, are rotating in mesh, the speed of the smaller being 2000 rpm. Determine

      i. the speed of sliding between the gear teeth faces at the point of engagement, at the pitch point and at the point of disengagement, if the smaller wheel is the driver. Assume that the gear teeth are of the 20^0 involute forms that the addendum length is 5 mm and module pitch is 5 mm.

      ii. Also find the angle through which pinion turns while any one pair teeth are in contact. [8+8]

8. In an epicyclic train an annular wheel A having 54 teeth meshes with a planet wheel B
which gears with a sun wheel C, the wheels A and C being coaxial. The wheel B is carried on a pin fixed on one end of arm P which rotates about the axis of the wheels A and C. If the wheel A makes 20 rpm in a clockwise direction and the arm P rotates at 100 rpm in the anticlockwise direction and the wheel C has 24 teeth, determine the speed and sense of rotation of arm P. [16]

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Code No: RR310304 **Set No. 3**

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

Answer any FIVE Questions
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1. What is the difference between quick return motion of crank and slotted lever type and that of Whitworth type? What is the ratio of time taken on cutting and return strokes? [16]

2. Explain the Scot-Russel mechanism and show that it generates straight-line motion. [16]

3. Explain how corili's component of acceleration arises. Derive an expression for determining its magnitude. How do you find its direction for any given direction of crank rotation. [16]

4. (a) How the velocity of a point on a link is determined by instantaneous centre method.
   (b) The crank OA of a steam engine is 8 cm and the length of the connecting rod AB is 24 cm. The centre of gravity of the rod is at G, 8 cm from the crank pin. The engine speed is 600 rad/min. For the position when the crank makes 45^0 to the horizontal measured from the inner dead centre, fine the velocity and acceleration of the piston. Also fine the acceleration of the centre of gravity of the connecting rod. Use instantaneous centre method. [6+10]

5. For two shafts connected by a Hooke's joint show that if shaft 1 has uniform angular velocity ω_1, the angular acceleration of shaft 2 is given by:
   $$\frac{\partial\omega_2}{\partial t} = \frac{\omega_1^2 \cos\alpha.\sin^2\alpha.\sin^2\theta_1}{\left(1-\sin^2\alpha.\cos^2\theta_1\right)}$$
   where θ_1 is the angle of rotation of shaft 1 from the position where its forked end in the plane containing the shaft, and α is the angle of deviation of the drive. [16]

6. A flat ended valve tappet is operated by a symmetrical cam with circular arcs for flank and nose profiles. The total angle of action is 150^0 base circle diameter 125 mm and the lift 25 mm. During the lift, the period of acceleration is half that of the retardation. Speed of cam shaft is 1250 r.p.m. The straight line path of the tapper passes through the cam axis. Find
   (a) Radii of the nose and flank, and
   (b) Maximum acceleration and retardation during the lift. [16]

7. (a) Name the curves, which satisfy the condition for, correct gearing and compare them giving atleast six points.

(b) A gear wheel having 20 teeth of involute form of module pitch 6 mm with an angle of obliquity of 20^0, drives another wheel of the same dimensions. Calculate

i. the length of the arc of contact if the addendum is one module.

ii. If the addendum was altered so that the arc of contact was the maximum possible what would be the length of this arc, and the addendum required for this condition. [8+8]

8. In the epicyclic reduction gear as shown in Figure 8 the sunwheel D has 20 teeth and is keyed to the input shaft. The wheels B also mesh with an internal gear C which is fixed. The input shaft rotates at 2100 r.p.m. Determine the speed of the output shaft and the torque required to fix C when the gears are transmitting 30 kW. [16]

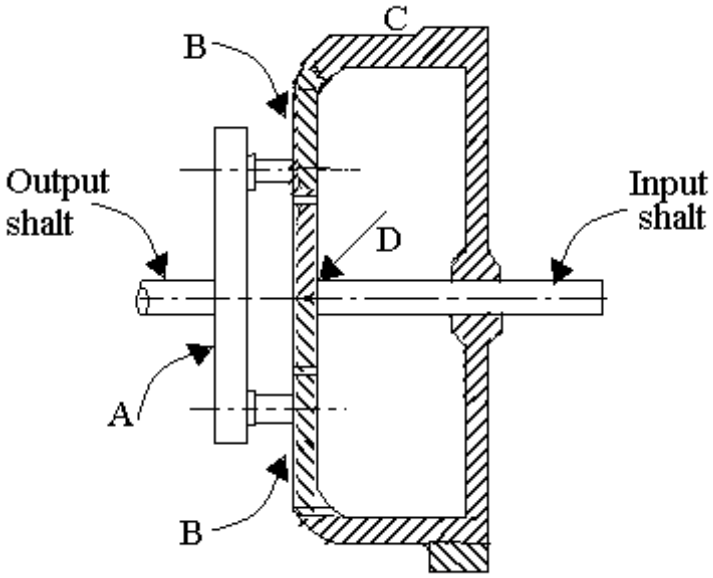

Figure 8

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Code No: RR310304 **Set No. 4**

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

Answer any FIVE Questions
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1. What is the difference between quick return motion of crank and slotted lever type and that of Whitworth type? What is the ratio of time taken on cutting and return strokes? [16]

2. A grass hopper straight line mechanisms gets its motion from a crank OA. The end A of the crank in joined to a long rod PQ such that Q A is 6cm. The end Q is further joined to along vertical link O_1 Q, 24 Cm long moving with centre O_1. The length of rod PQ is also 24 Cm and its end P describes an approximate vertical straight line. Determine the radius of crank OA. Find also the maximum deviation of P from the vertical straight line in a travel of 6 Cm on each side of its mean position. [16]

3. The mechanism shown in Figure 3 the length of the various links are,
OE = 15cm, AB = 40cm, BC = 60cm and CD = 20cm. The crank rotates at 70rpm. Determine
   (a) Coriolis component acceleration of E with respect to F
   (b) Angular acceleration of link BC. [16]

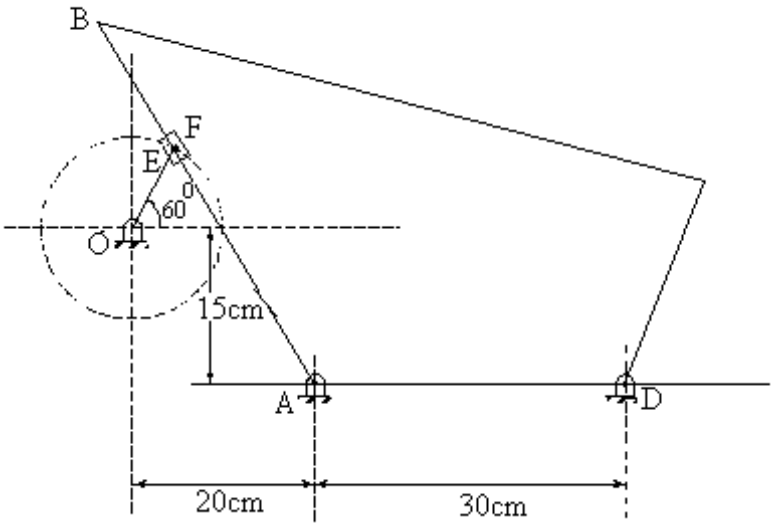

Figure 3

4. In the circuit bracket mechanisms represented in Figure 4 the point P moves in a vertical straight line. In the configuration O_4B is vertical .If the angular velocity

and angular acceleration of link Q_4A is 45 rad/sec and 300 rad/sec^2 respectively, both in clockwise sense, Determine the velocity and acceleration of point P. [16]

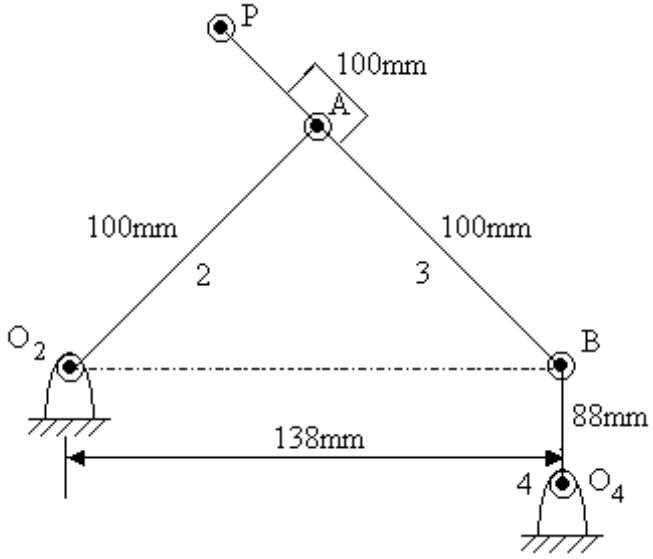

Figure 4

5. (a) What is the function of a steeing gear. What are the mechanisms used in general. Explain any one of them.

   (b) In a Davis Steering gear the distance between the pivot's of the front axle is 1 metre and the wheel base is 2.5 metres. Find the inclination of the track arm to the longitudinal axis of the car when it is moving along a straight path. [8+8]

6. Draw full size profile of a cam which will lift a 2.5 cm diameter knife edged follower through 4 cm. The centre line of the follower passes through the centre of rotation of the cam. Ascent of follower takes place with S.H.M. in 0.1 second, followed by a period of rest of 0.025 sec. The follower then descends with uniform acceleration and retardation in 0.075 second. The cam rotates at a uniform speed of 120 r.p.m. and the least radius of the cam is 10 cm. Also plot velocity and acceleration diagrams of the follower during one revolution of the cam and mark important values thereon. [16]

7. (a) What is the maximum velocity ratio obtained from a spur gear drive.

   (b) The following data relate to two meshing involute gears:
   Number of teeth on the gear wheel = 60, Speed of the gear wheel = 100 rpm, Gear ratio = 1.5, Module = 8 mm and Pressure angle = 20^0. The addendum for each wheel is such tat the path of approach and the path of recess on each side are 40% of the maximum possible length each. Determine the addendum for the pinion and the gear and the length of the arc of contact. [8+8]

8. Figure 8 shows an epicyclic gear train with the following details:
   A has 40 teeth external (fixed gear); B has 80 teeth interna; C-D is a compound wheel having 20 and 50 teeth (external) respectively, E-F is a compound wheel

having 20 and 40 teeth (external) respectively, and G has 90 teeth (external). The arm runs at 100 r.p.m. in clockwise direction. Determine the speeds for gears C,E, and B. [16]

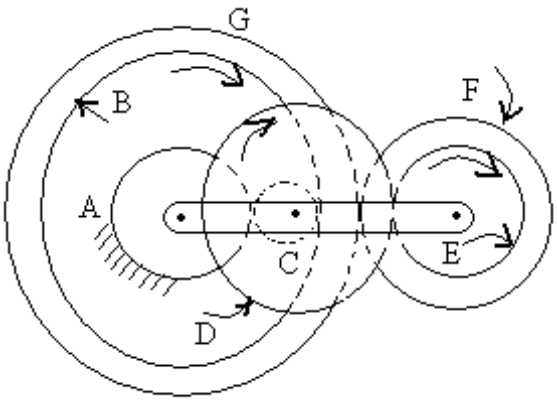

Figure 8

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