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

III B.Tech. I Semester Supplementary Examinations, May -2005
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) In a quick return motion mechanism of crank and slotted lever type, the ratio of maximum velocities is 2. If the length of the stroke is 25 cm, find,
   i. The length of the slotted lever,
   ii. The ratio of times of cutting and return strokes, and
   iii. The maximum cutting velocity per second if the crank rotates at 30 r.p.m.
   (b) What is the difference between analysis and synthesis?

2. Explain how Grass- Hopper mechanism and Watt mechanism generate approximate straight-line motion.

3. In a quick return mechanism, as shown is Figure 1, the driving crank OA is 60 mm long and rotates at a uniform speed of 200r.p.m in clockwise direction. For the positions shown, find
   (a) velocity of the ram R
   (b) acceleration of the ram R; and
   (c) acceleration of the sliding block A along with the slotted bar CD.

4. The lengths of various links of a mechanism as shown in Figure 2 are; OA = 0.3m; AB = 1m; CD = 0.8 m; and AC = CB. Determine, for the given configuration, velocity or slider D if the crank OA rotates at 60 r.p.m in the clockwise direction. Also find the angular velocity of the link CD. Use instantaneous centre method.

5. A Hook's joint is used to connect two shafts whose axes are inclined at 20^0. The driving shaft rotates uniformly at 6000 rpm. What are the extreme angular velocities of the driven shaft? Find the maximum value of retardation or acceleration and state the angle where both will occur.

6. A cam rotating clockwise with a uniform speed is to give the roller follower of 20mm diameter with the following motion.
   (a) Follower to move outwards through a distance of 30mm during 120^0 of cam rotation.
   (b) Follower to dwell for 60^0 of cam rotation.
   (c) Follower to return to its initial position during 90^0 of cam rotation; and
   (d) Follower to dwell for the remaining 90^0 of cam rotation.

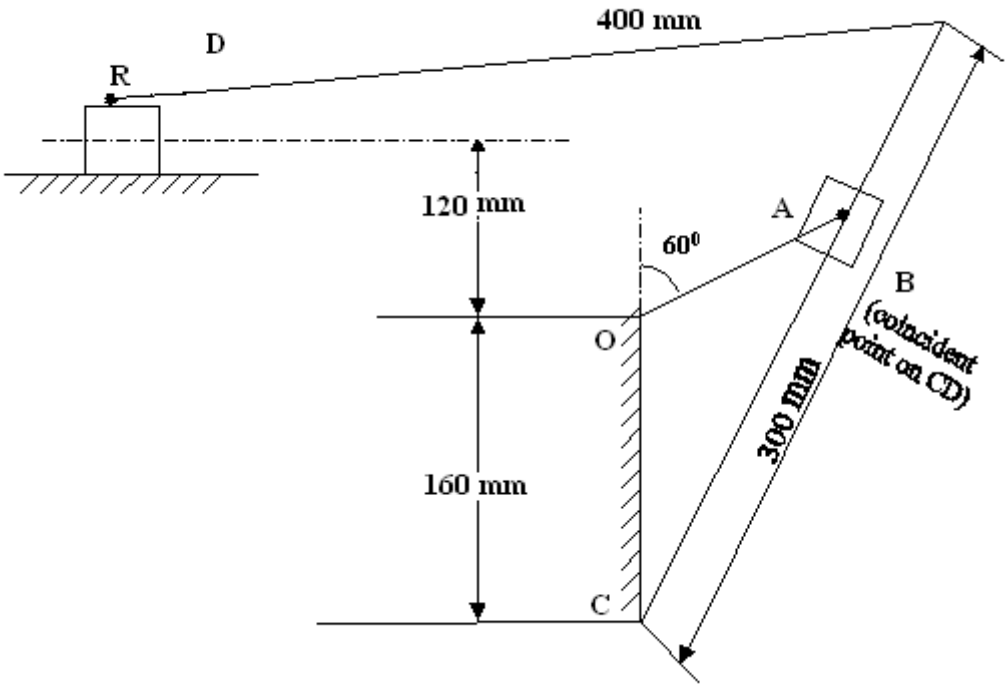

Figure 1:

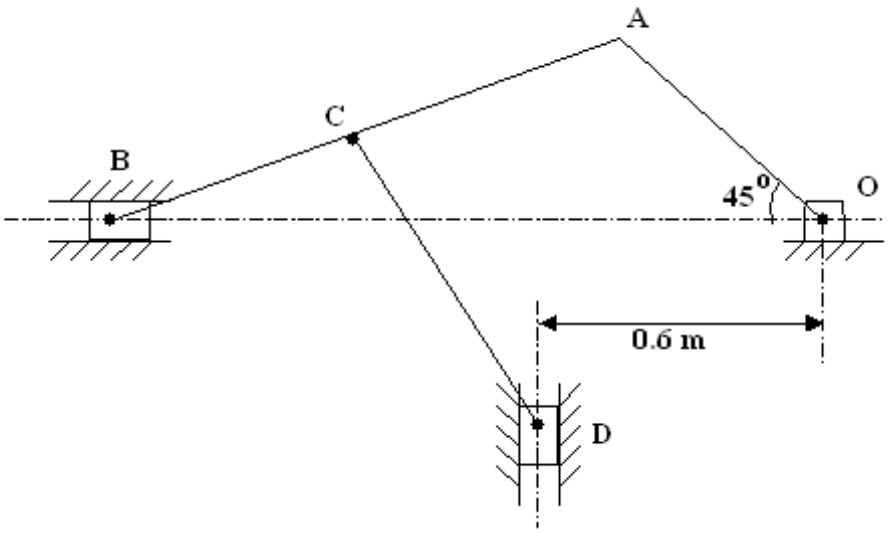

Figure 2:

The minimum radius of the cam is 45mm and the line of stroke of the follower is offset 15mm from the axis of the cam and the displacement of the follower is to take place with simple harmonic motion on both the outward and return strokes. Draw the cam profile.

7. (a) Derive the formula for the length of the path of contact for two meshing spur gear having involute profile.

   (b) Find graphically, the length of the path of contact when pinion with 18 teeth meshes with an internally toothed wheel with 72 teeth, when the pressure angle is 20^0, module pitch is 4 mm and the addenda of pinion and wheel are 8.7 mm and 3.7 mm respectively.

8. An epicyclic train is shown in Figure 3 Internal gear A is keyed to the driving shaft and has
   30 teeth. Compound wheel C and D of 20 and 22 teeth respectively are free to rotate on the pin fixed to the arm P which is rigidly connected to the driven shaft. Internal gear B which has 32 teeth is fixed. If the driving shaft runs at 60 r.p.m. clockwise, determine the speed of the driven shaft. What is the direction of rotation of driven shaft with reference to driving shaft?

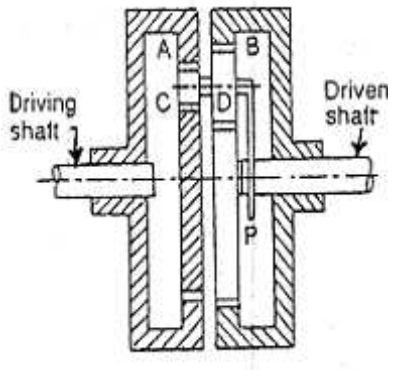

Figure 3:

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

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1. Identify the Kinematic chains to which the following mechanisms belong and explain them with a neat sketch:
   (a) Steam engine mechanism;
   (b) Beam engine;
   (c) Elliptical trammels.
2. Sketch the peaucellier and Hart straight line motion mechanisms. Give dimensions to the links and find in each case what force acting at P penpendicular to O P will be required to balance a force of W kg acting at Q along the locus of P.
3. The mechanism shown in Figure 4 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
4. The crank OA drives the rod AB as shown in Figure 5. A lever CD is pin-jointed to the rod at C and to a block D which moves in the fixed guides; there is a similar arrangement for the rod EF. The speed of block F is 0.72 m/sec for the configuration shown in the figure. Find the speed of crank OA in rpm.
   In figure the dimensions are given as hereunder OA = 18cm, AB = 72cm, AC = 40cm, CD = 36 cm, CE = 24 cm, EF = 30 cm
5. Sketch a pantograph, explain its working and show that it can be used to reproduce to an enlarged scale a given figure.
6. Draw the profile of the cam when the roller follower moves with uniform velocity as give below.
   (a) Outstroke with maximum Displacement of 44 mm during 180^0 of cam rotation.
   (b) Return stroke for the next 150^0 of cam rotation.
   (c) Dwell for the remaining 30^0 of cam rotation.

   The minimum radius of the cam is 20mm and the diameter of the roller is 10mm. The axis of the roller follower passes through the cam shaft axis.

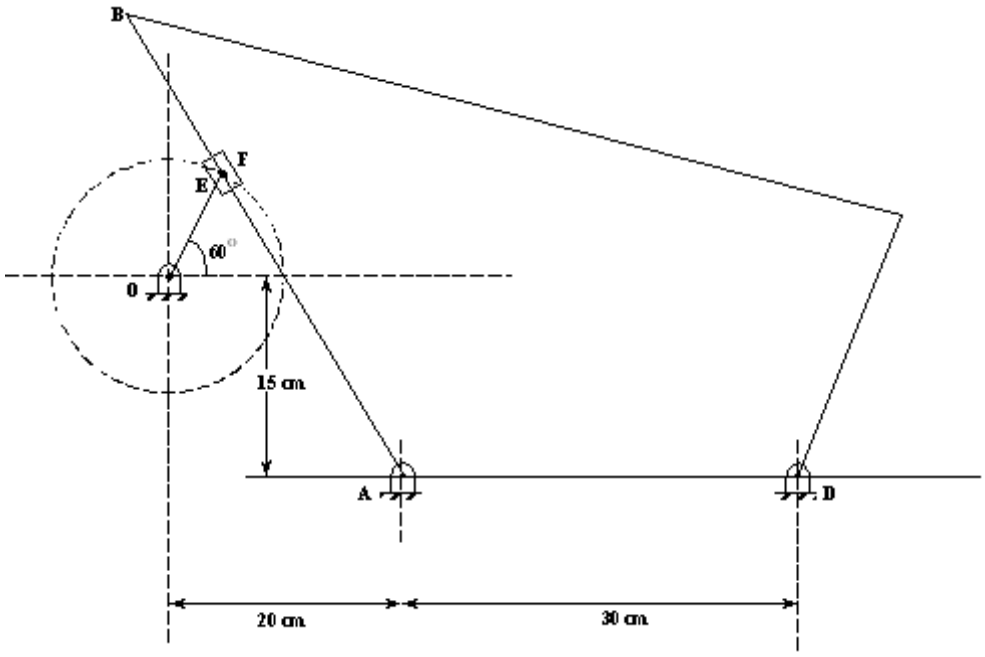

Figure 4:

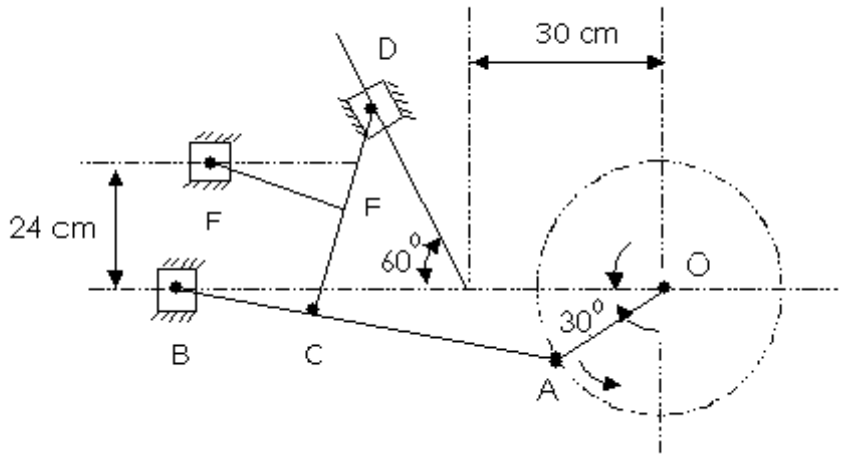

Figure 5:

7. Two mating involute spur gears of 20^0 pressure angle have a gear ratio of 2. The number of teeth on the pinion is 20 and its speed is 250 rpm. The module pitch of the teeth is 12 mm if the addendum on each wheel is such that the path of approach and the path of recess on each side are half the maximum possible length each, find

   (a) the addendum for pinion and gear wheel

   (b) the length of arc of contact

   (c) the maximum velocity of sliding during approach and recess.

   Assume pinion to be driver.

8. Anepicyclic gear consists of bevel wheels as shown in Figure 6. The driving pinion A has 20 teeth and meshes with the wheel B which has 25 teeth. The wheels B and C are fixed together and turn freely on the Shaft F. The shaft F can rotate freely about the main axis XX. The wheel C has 50 teeth and meshes with wheels D and E, each of which has 60 teeth. Find the speed and direction of E when A rotates at 200 r.p.m. if 1. D is fixed and 2. D rotates at 100 r.p.m. in the same direction as A.In both the cases, find the ratio of the torques transmitted by the shafts of the wheels A and E, the friction being neglected.

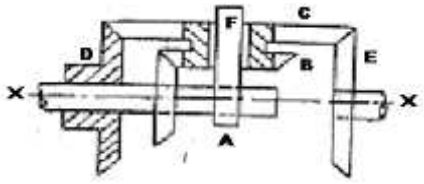

Figure 6:

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

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1. (a) Define motion and state its types. Distinguish between completely constrained, partially constrained and incompletely constrained motions. Where do you find their applications?
   (b) What is meant by degrees of freedom of a mechanism?
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.
3. The following data refer to a quick return motion of crank and slotted lever type shown in Figure 7.
   Distance between fixed centers O and A = 25 cm
   Length of driving Crank AB = 10 cm
   Length of slotted link OC = 40 cm
   Length of rod CD = 15 cm
   Angle O A B = 120^0
   Uniform speed of the crank in clockwise directions = 60 rpm
   Line of stroke of ram is perpendicular to OA
   Determine velocity and acceleration of D.

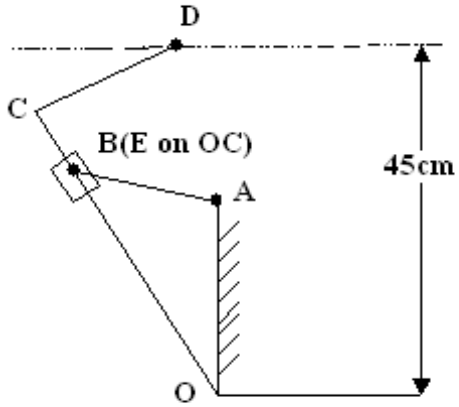

Figure 7:

4. Prove Klein's construction for determining acceleration of a slider in a slider crank mechanism. Hence show that acceleration of the position of an engine at inner and outer dead center positions is given by
   $f_p = \omega^2 r\left[1 + \frac{1}{n}\right]$ *and* $f_p = \omega^2 r\left[1 - \frac{1}{n}\right]$ *respectively*
   Where f_p = acceleration of piston
   ω = angular velocity of crank
   r = crank radius
   L = length of connecting rod,
   and n = $\frac{L}{r}$

5. The driving shaft of a Hooke's joint has a uniform angular speed of 300 r.p.m. Determine the maximum permissible angle between the axes of the shaft to permit a maximum variation in speed of the driven shaft by 6% of the mean speed.

6. (a) Explain a radial cam mechanism and describe the types of cams with sketches.
   (b) Sketch the different types of cam followers.
   (c) Explain angle of Ascent, dwell and angle of descent.
   (d) Briefly explain the different types of follower motions.

7. (a) Derive the formula for the length of the path of contact for two meshing spur gear having involute profile.
   (b) Find graphically, the length of the path of contact when pinion with 18 teeth meshes with an internally toothed wheel with 72 teeth, when the pressure angle is 20^0, module pitch is 4 mm and the addenda of pinion and wheel are 8.7 mm and 3.7 mm respectively.

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.

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

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1. (a) In a quick return motion mechanism of crank and slotted lever type, the ratio of maximum velocities is 2. If the length of the stroke is 25 cm, find,
   i. The length of the slotted lever,
   ii. The ratio of times of cutting and return strokes, and
   iii. The maximum cutting velocity per second if the crank rotates at 30 r.p.m.
   (b) What is the difference between analysis and synthesis?
2. (a) Show the Peaucellier mechanism generates an exact straight line as its path.
   (b) Classify the straight line motion mechanisms with examples.
3. In the mechanism shown in Figure 8 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
4. A mechanism as shown in Figure 9 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.
5. In a Davis steering gear, the distance between the pivots 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.
6. A radial translating flat - face follower has a lift of 3 cm. The rise takes place with SHM for 180^0 of cam rotation, followed by dwell of 30^0 and simple harmonic return for 120^0 followed by another dwell. The base circle radius of the cam is 3 cm. Obtain the cam profile and the minimum length of the follower face with a clearance of 0.3 cm at both the ends. Assume anticlockwise rotation of the cam. What are the maximum velocity and accelerations values during the follower rise when cam rotates at 50 r.p.m.

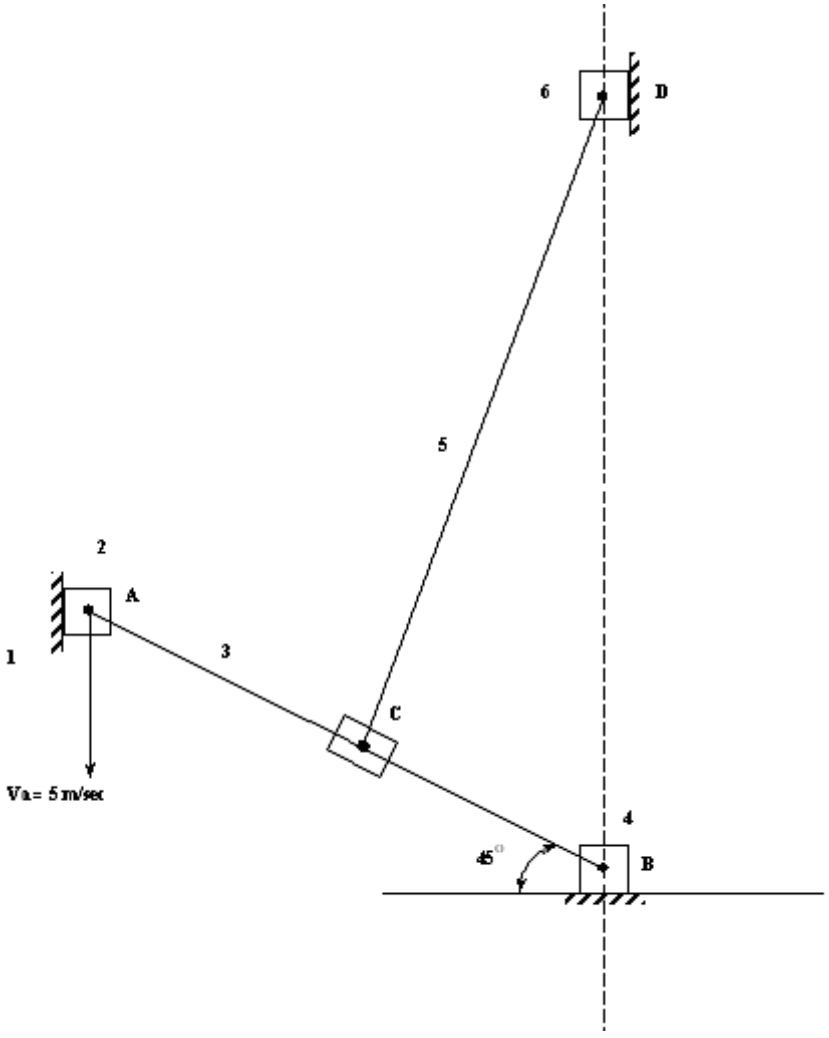

Figure 8:

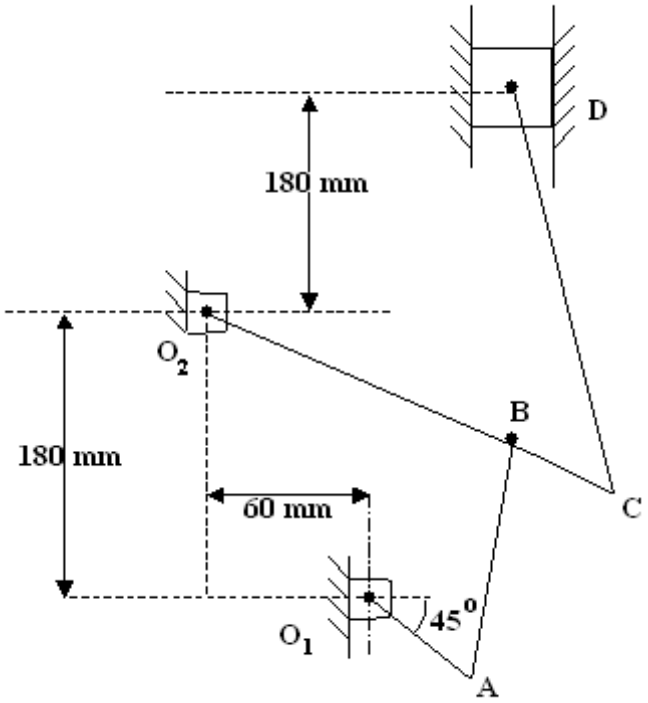

Figure 9:

7. Anepicyclic gear consists of bevel wheels as shown in Figure 10. The driving pinion A has 20 teeth and meshes with the wheel B which has 25 teeth. The wheels B and C are fixed together and turn freely on the Shaft F. The shaft F can rotate freely about the main axis XX. The wheel C has 50 teeth and meshes with wheels D and E, each of which has 60 teeth. Find the speed and direction of E when A rotates at 200 r.p.m. if 1. D is fixed and 2. D rotates at 100 r.p.m. in the same direction as A.In both the cases, find the ratio of the torques transmitted by the shafts of the wheels A and E, the friction being neglected.

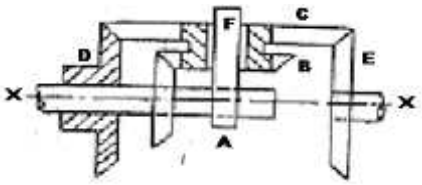

Figure 10:

8. (a) State and prove the law of gearing for constant velocity ratio and show how the involute profile satisfies the condition?
   (b) A pair of spur wheels with involute teeth is to give a gear ratio 3:1. The arc of approach is not being less than the circular pitch and the smaller wheel is the driver. Pressure angle is 20^0. What is the least number of teeth that can be used on each wheel and find the addendum of the wheel in terms of the circular pitch?

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