II B.Tech II Semester Supplementary Examinations, Nov/Dec 2005
KINEMATICS OF MACHINERY
(Aeronautical 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? [12+4]

2. Explain how Grass- Hopper mechanism and Watt mechanism generate approximate straight-line motion. [16]

3. The dimensions of the various links of a pneumatic riveter, as shown in Figure 1, are as follows:
   OA = 175 mm; AB = 180 mm; AD = 500 mm and BC = 325 mm;
   Find the velocity ratio between C and ram D when OB is vertical. What will be efficiency of the machine if a load of 2.5kN on piston C causes a thrust of 4kN at the ram D.

4. An oscillating engine mechanism is shown in Figure 2 With 2 as the input link, carry out the kinematic analysis, using an analytical method.

5. Two shafts are to be connected by a Hooki's joint. The driving shaft rotates at a uniform speed of 500 rpm and the speed of the driven shaft must lie between 475 and 525 rpm. Determine the maximum permissible angle between the shafts. [16]

6. A cam is to be designed for a knife edged follower with the following data.
   (a) Cam lift = 40mm during 90^0 of cam rotation with S.H.M
   (b) Dwell for the next 30^0
   (c) During the next 60^0 of cam rotation the follower returns to its original position with simple harmonic motion.
   (d) Dwell during the remaining 180^0

   Draw the profile of the cam when the line of stroke is offset by 20 mm from the axis of the cam shaft.
   The radius of the base circle of the cam is 40mm. Determine the maximum velocity and acceleration of the follower during its ascent and descent if the cam rotates at 240 R.P.M. [16]

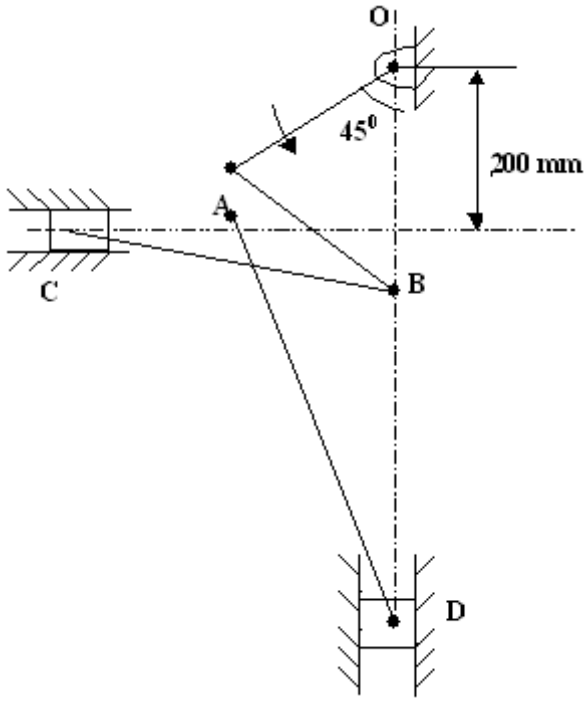

Figure 1:

[16]

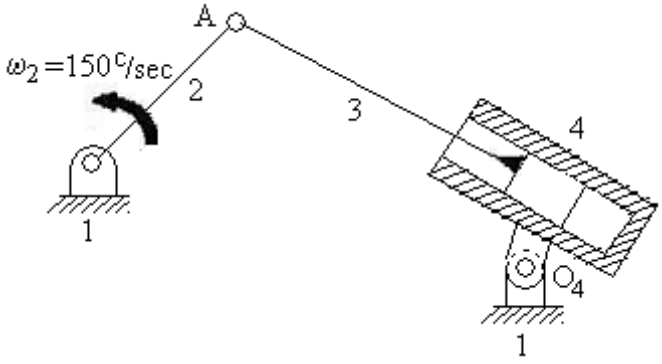

Figure 2:

[16]

7. Two 20^0 gears have a module pitch of 4 mm. The number of teeth on gear 1 is 40 and on gear 2 is 24. If the gear 2 rotates at 600 rpm, determine the velocity of sliding when the contact is at the tip of the tooth of gear 2. Take addendum equal to one module. Also find maximum length of path of contact and the maximum velocity of sliding. Take Cases:

   (a) pinion as driver and Case:

   (b) gear wheel as driver. [16]

8. An epicyclic reduction gear, as shown in Figure 3 has a shaft A fixed to arm B. The arm B has a pin fixed to its outer end and two gears C and E which are rigidly fixed, revolve on this pin. Gear C meshes with annualr wheel D and gear E with pinion F, G is the driver pulley and D is kept stationary.
   The number of teeth are: D = 80; C=10; E=24 and F=18
   If the pulley G runs at 200 r.p.m. find the speed of shaft A.

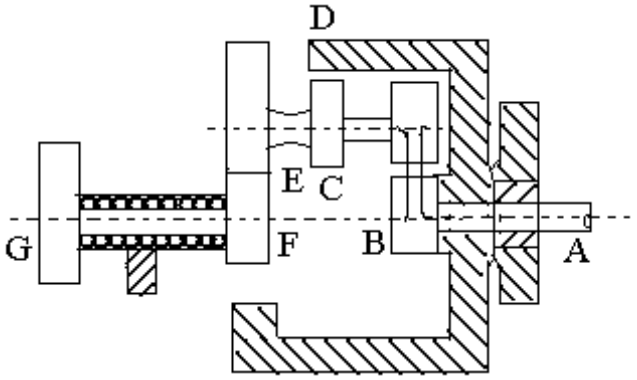

Figure 3:

[16]

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Code No: RR222105 **Set No. 2**

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1. (a) Show that the locus of the mid-point of the link connecting to the two slides in an elliptical trammel is a circle.
   (b) Define frame of a machine? Which link of the machine is known as frame? [10+6]

2. Derive the necessary equations for Hart's straight-line mechanism to prove that the mechanism traces mathematically correct straight line motion. [16]

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. 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 = $\frac{L}{r}$ [16]

5. A Hookes joint connects a shaft running at a uniform speed of 1000 rpm to a second shaft. The angle between their axes is 15 degrees. Find the velocity and acceleration of the driven shaft at the instant when the fork of the driving shaft has turned through an angle of 10^0 from the plane containing the shaft axes.
   At what other positions of the driving shaft during a revolution, the angular velocity of the driven shafts be the same as that arrived above? [16]

6. From the following data, draw the profile of a cam in which the follower moves with simple harmonic motion during ascent while it moves with uniform velocity motion during descent :
   Least radius of cam = 50mm; Angle of ascent = 48^0; Angle of dwell between ascent and descent = 42^0; Angle of descent = 60^0; Lift of follower = 40mm; Diameter

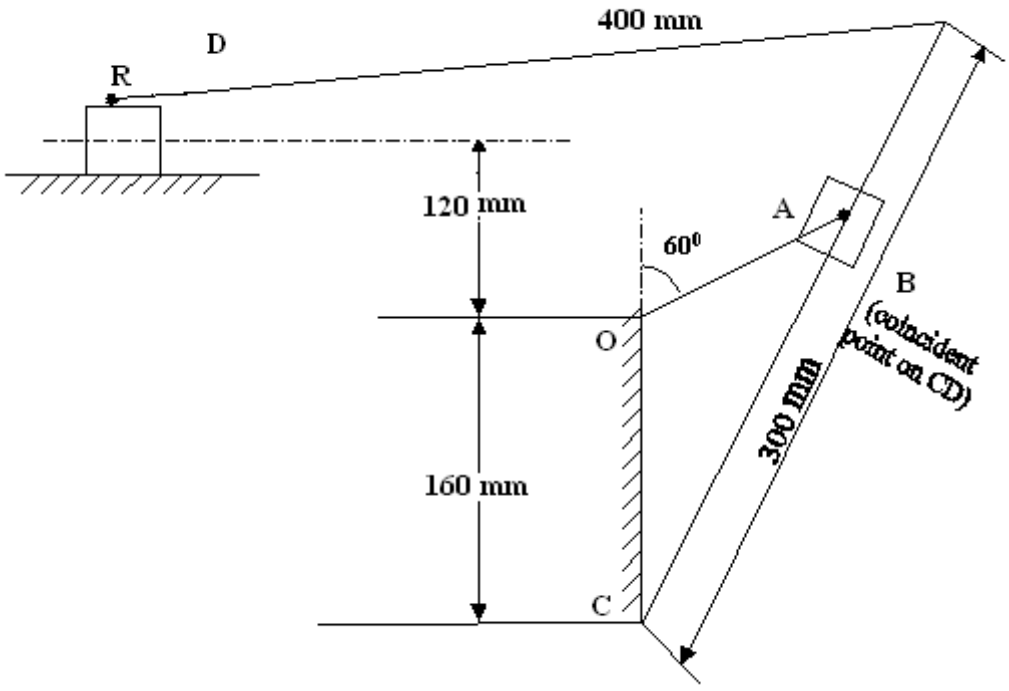

Figure 1:

[16]

of roller = 30mm; Distance between the line of action of follower and the axis of cam = 20mm. If the cam rotates at 360 r.p.m. anticlockwise, find the maximum velocity and acceleration of the follower during descent. [16]

7. (a) Define and explain the term (with the help of a neat sketch) path of approach, path of recess and path of contact between two mating gears.

   (b) Two mating involute spur gears have 28 and 45 teeth and a standard addendum of one module. Find the length of path of contact and length of arc of contact in terms of module when pressure angle is 20^0. [6+10]

8. An epicyclic gear consists of bevel wheels as shown in Figure 2. 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.

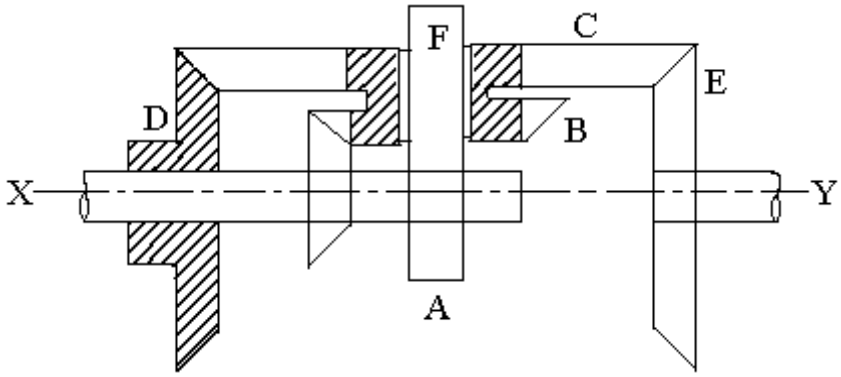

Figure 2:

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1. (a) Explain the terms :
   i. Lower pair,
   ii. Higher pair,
   iii. Kinematic chain, and
   (b) In what way a mechanism differ from a machine?
   (c) Giving a neak sketch explain any one inversion of a simple slider mechanism. [6+4+6]

2. Describe any approximate straight-line motion mechanism with necessary equations. [16]

3. In a mechanism shown in Figure 1, D is constrained, to move on a horizontal path. Find, for the given configuration the velocity and acceleration of D and the angular velocity and angular acceleration of BD

   when OC is rotating in a counter clockwise direction at a speed of 210 r.p.m.

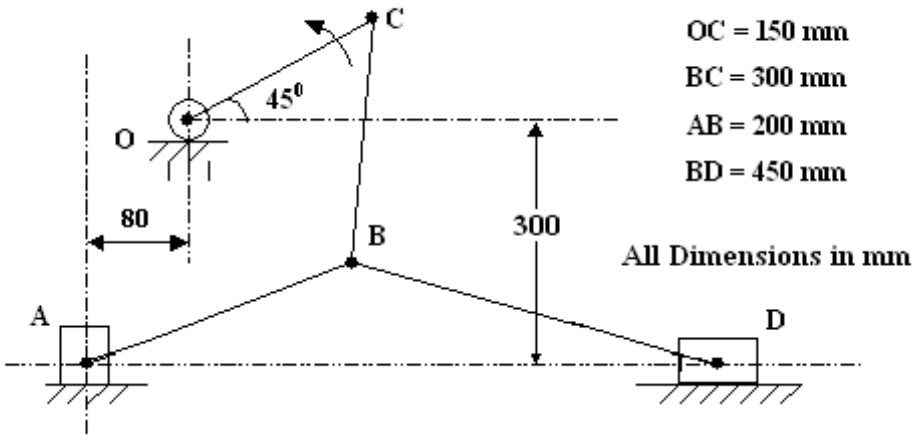

Figure 1:

[16]

4. The crank OA of a mechanism, as shown in Figure 2 rotates clockwise at 120 r.p.m. The lengths of various links are: OA = 100 mm; AB = 500 mm; AC = 100 mm and CD = 750 mm. Find by instantaneous centre method:

(a) velocity of point C;

(b) velocity of slider D;

(c) Angular velocities of the links AB and CD.

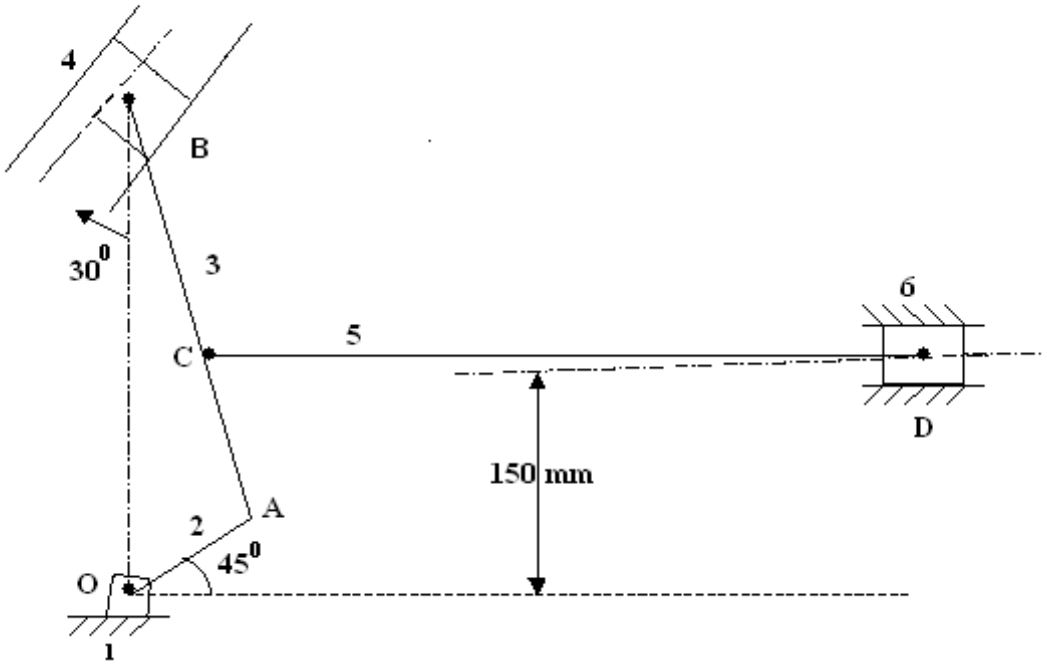

Figure 2:

[16]

5. Two shafts are to be connected by a Hooki's joint. The driving shaft rotates at a uniform speed of 500 rpm and the speed of the driven shaft must lie between 475 and 525 rpm. Determine the maximum permissible angle between the shafts. [16]

6. The following data relate to a cam operating an oscillating roller follower minimum diameter of the cam 44 m.m.
   Diameter of the Roller 10 m.m.
   Length of the follower arm 40 m.m.
   Distance of fulcrum centre from cam centre 50 m.m.
   Angle of Ascent : 75^0
   Angle of Descent : 105^0
   Angle of dwell for the follower in the highest position 60^0.
   Angle of oscillation of follower 28^0
   Draw the profile of the cam if the ascent and descent take place with 5 H.M. [16]

7. (a) Derive an expression for the length of the arc of contact for two meshing gears having involute profile.

(b) Two gear wheels of 100 mm and 150 mm PCD have involute teeth of 1.6-diametral pitch and pressure angle 200. The addenda are 3 mm. Find the contact ratio and angle turned by pinion and gear, while any pair of teeth is in contact. [8+8]

8. In the epicyclic reduction gear shown in Figure 3 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.

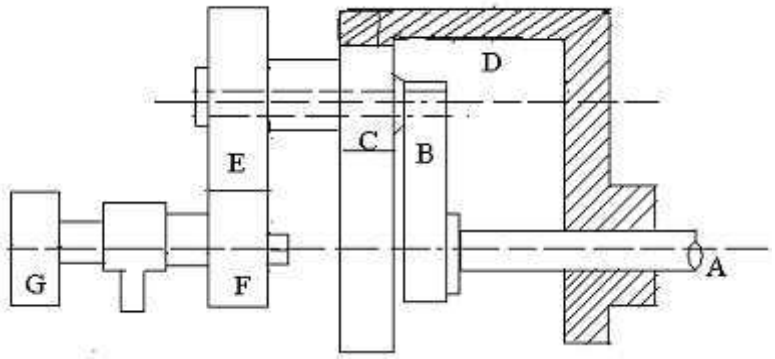

Figure 3:

[16]

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   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? [12+4]

2. Classify the straight-line motion mechanisms. Describe "a copied straight-line mechanism". [16]

3. Figure 1 shows a worth whit quick return motion mechanism. The various dimensions in the mechanism are as follows:
   OQ = 100 mm; OA = 200 mm; QC = 150 mm and CD = 500 mm.
   The crank OA makes an angle of 60^0 with vertical and rotates at 120 rpm in the clockwise direction.
   Locate all the instantaneous centers and find the velocity of ram D.

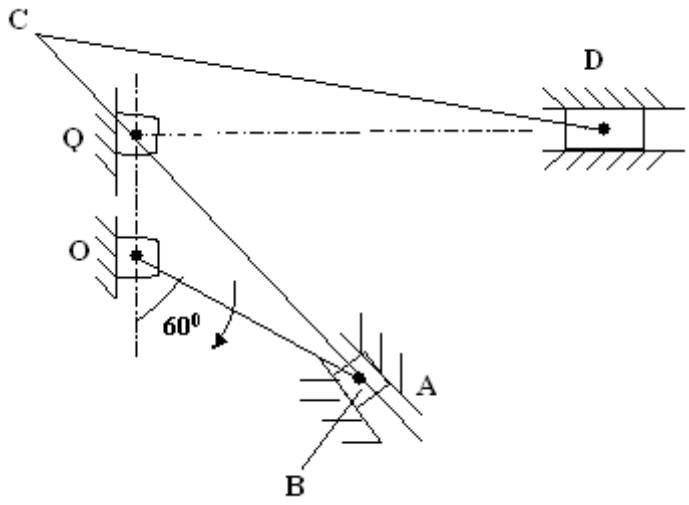

Figure 1:

[16]

4. A mechanism as shown in Figure 2 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.

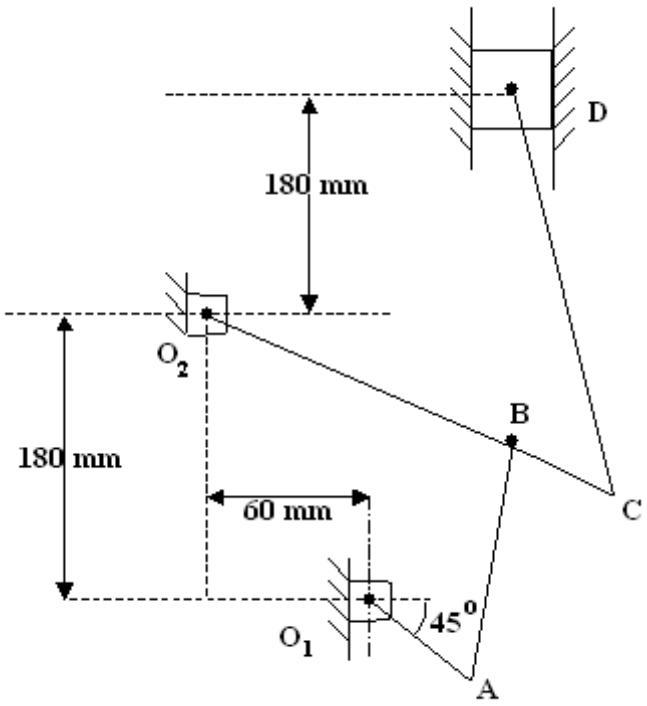

Figure 2:

[16]

5. Two shafts are to be connected by a Hooki's joint. The driving shaft rotates at a uniform speed of 500 rpm and the speed of the driven shaft must lie between 475 and 525 rpm. Determine the maximum permissible angle between the shafts. [16]

6. A cam with 30mm as minimum diameter is rotating closewise at a uniform speed of 1200 r.p.m. and has to give the following motion to a roller follower 10 mm in diameter.

   (a) Follower to complete outward stroke of 25mm during 120^0 of cam rotation with equal uniform acceleration and retardation.

   (b) Follower to dwell for 60^0 of cam rotation.

   (c) Follower to return to its initial position during 90^0 of cam rotation with equal uniform acceleration and retardation.

   (d) Follower to dwell for the remaining 90^0 of cam rotation.

   Draw the cam profile if the axis of the roller follower passes through the axis of the cam.
   Determine the maximum velocity of the follower during the outstroke and return

stroke and also the uniform acceleration of the follower on the outstroke and the return stroke. [16]

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. (a) What are the different types in an epicyclic gear trains.

   (b) A pinion A has 15 teeth and is rigidly fixed to a motor shaft. The wheel B has 20 teeth and gears with A and also with the fixed annular wheel D. The pinion C has 15 teeth and is fixed to the wheel B and gears with annular wheel E which is keyed to a machine shaft. B and C can rotate together on a pin carried by an arm, which rotates about the shaft on which A is fixed. If the motor runs at 1000 rpm, find the speed of the machine. [16]

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