B.E. 5th Semester (M.E.) Examination, 2011
Subject: Kinematics of Mechanisms (ME 505)

Time: 3 hrs. Answer Questions of Each half in separate scripts F.M. 70

First Half

Answer *question No. 1, 2* and *any two* from the rest of this half

1. Figure 1 shows the configuration diagram of the Watt's indicator mechanism. Find the
   (a) number of Binary and Ternary links,
   (b) number of first order and second order hinges, and also the number of prismatic pairs.
   (c) Hence compute the mobility of the mechanism.

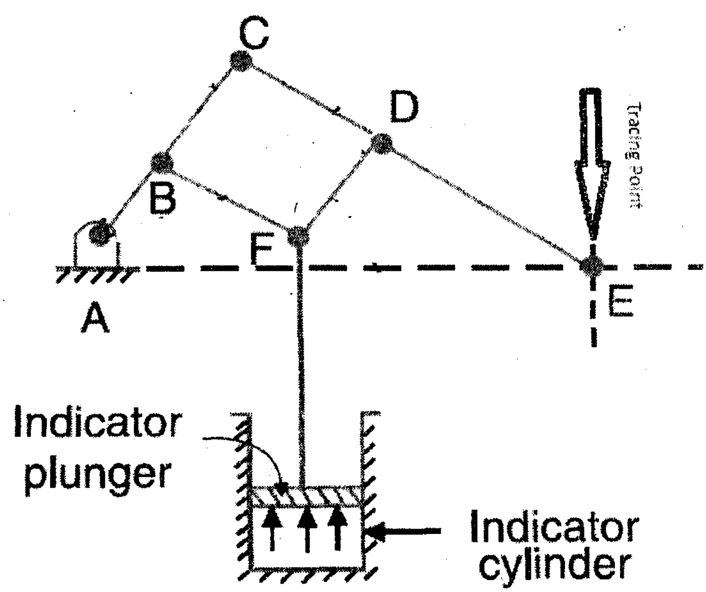

Figure 1

(2+2+2=6)

2. The crank and slotted lever mechanism used in a shaper has a centre distance of 300 mm between the centre of rotation of the crank and that of the slotted lever. If the radius of the crank is 120 mm, find the ratio between the time of cutting and the time of return stroke.

(5)

3. Consider the mechanism shown in Fig. 2. The dimensions of different links are: AB =150 mm, BC = 300 mm, CD = 225 mm, CE = 500 mm. Angular velocity of the link is 240 rpm counterclockwise.
   (a) Locate the instantaneous centers of velocity of the mechanism.
   (b) Find the velocity of the slider E, rotational velocity of the link BC.

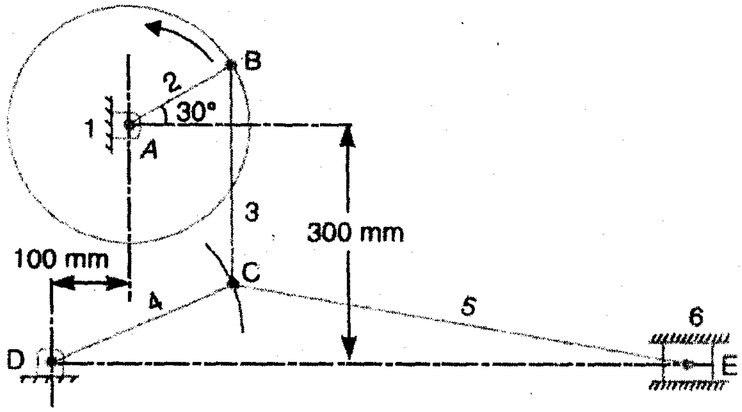

Figure 2

(7+5=12)

4. Consider the mechanism shown in Fig. 3. Link dimensions are: O_1A=100 mm, AC = 700 mm, BC = 200 mm, BD = 150 mm, O_2D = 200 mm, O_2E = 400 mm, O_3C= 300 mm. The angular velocity of the crank O_1A is 100 rad/s. Determine

   (a) the linear velocity of the point E on the bell crank lever,
   (b) acceleration of the points B and E,
   (c) angular acceleration of the bell crank lever.

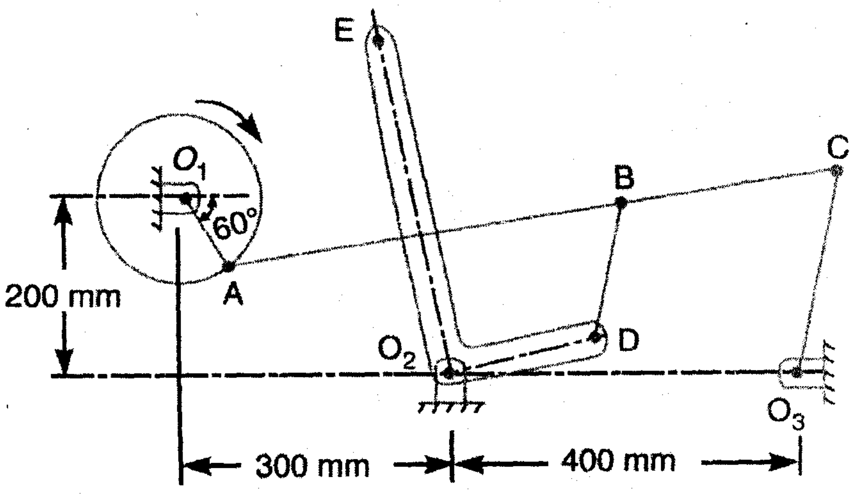

Figure 3

(12)

5. The slider of the offset slider crank mechanism shown in Fig. 4 is moving with a constant velocity of 1m/s towards the right. Using analytical method to determine the angular velocities and accelerations of the crank and the connecting rod for the given configuration (crank angle 45° and AB is horizontal).

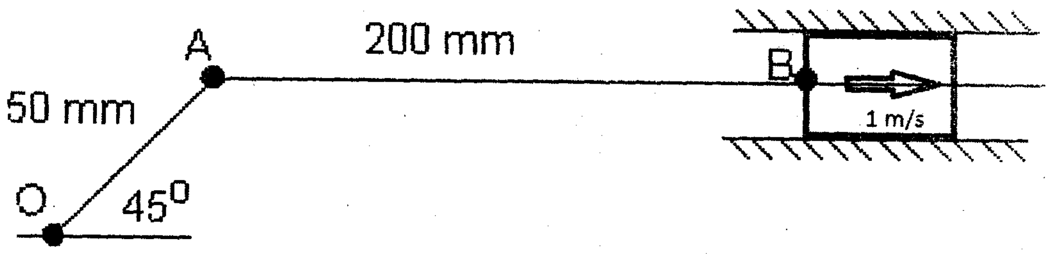

Figure 4

(12)

Second Half

Answer **Question No. 6 and any two** from the rest

6. (a) State and prove the fundamental law of gearing. Give all the reasons due to which the involute tooth profile is most common.

(5 + 2)

(b) Figure 5 shows an epicyclic gear train in which the numbers of teeth on various gears are indicated within the parenthesis. If shaft I rotates at 60 rad/s, determine the speed and the direction of rotation of shaft II. Gear 3 is an internal fixed gear. If the shaft I is driven by a torque of 10 N.m, then also determine what torque is needed to hold gear 3 fixed.

(5 + 3)

7. (a) Derive the expression for the contact ratio for a rack and a pinion in terms of usual parameters.

(6)

(b) A rack is in mesh with a pinion of 52 mm pitch circle radius. The operating pressure angle is 20^0, the addendum for both the rack and the pinion is 5 mm. Determine the contact ratio if the module is given to be 4 mm.

(4)

8. (a) Refer to Figure 6. **With respect to this figure**, obtain the Freudenstein's equation for three position synthesis.

(4)

(b) Determine the link-lengths of the four-bar linkage shown in Figure 6, to generate the following pairs of coordinated movements:

$$\left(\theta_2^{12} = 54^0,\ \theta_4^{12} = 26^0\right),\ \left(\theta_2^{13} = 80^0,\ \theta_4^{13} = 52^0\right)$$

Assume: $\theta_2^1 = -68^0,\ \theta_4^1 = -40^0,\ \ \ell_1 = 5.1$ cm.

(6)

9. Refer to Figure 7, which shows the sketch of a slider-crank mechanism. Locate three Chebyshev's accuracy points in the interval B_i to B_f, which represents the total movement of the slider at B. Now graphically design the slider-crank mechanism O_2AB, so that the slider passes through the three accuracy points B_1 to B_2 and from B_2 to B_3 as the crank rotates through 26^0 (CCW) for each of these movements. Locate the crank-pin at A_1 and hence the crank-length O_2A_1 and the connecting-rod length A_1B_1. Use the locations of O_2, B_i and B_f as indicated in Figure 7. (4 + 6)

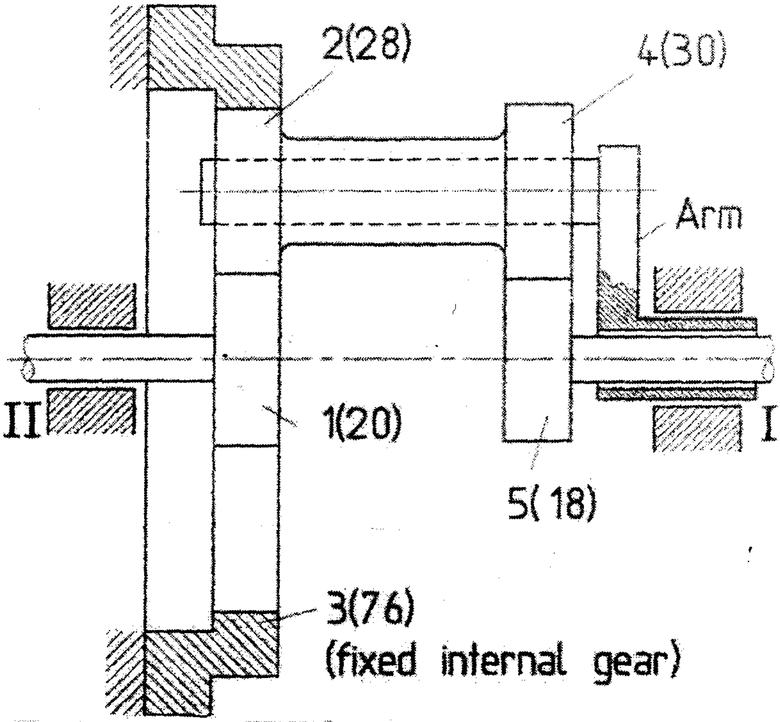

Figure 5

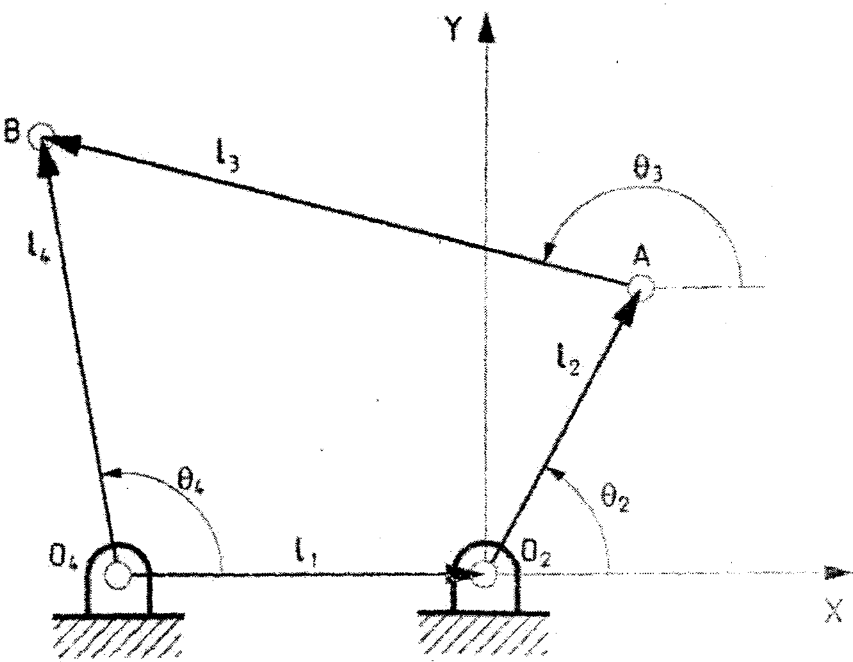

Figure 6

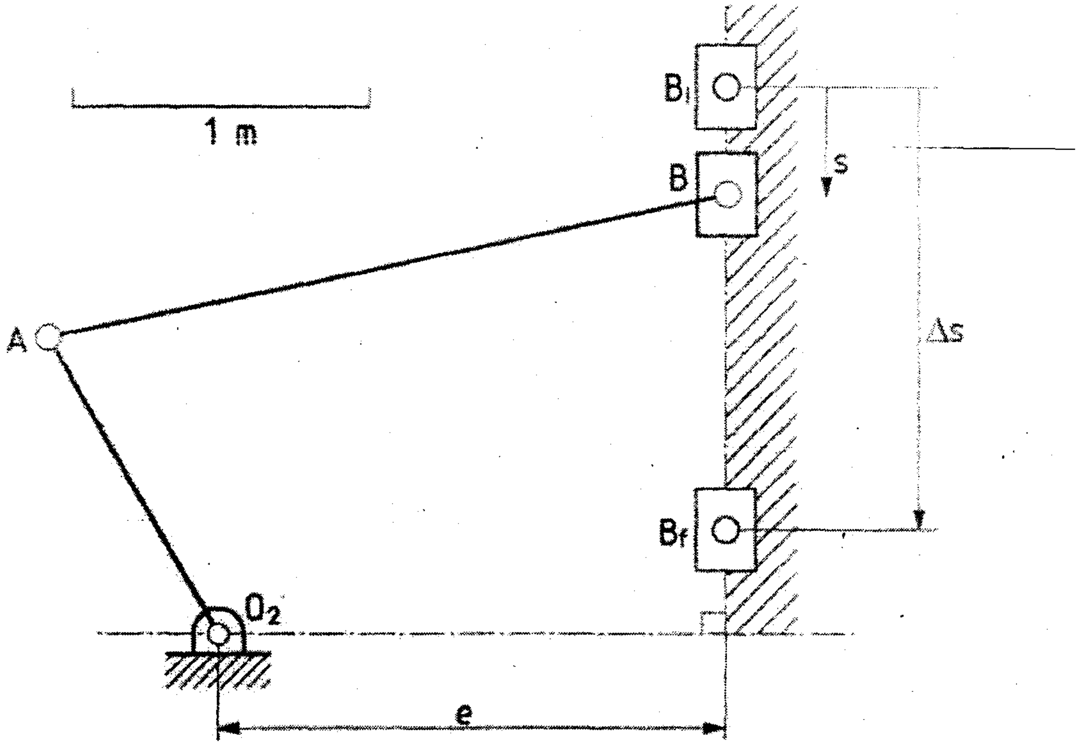

Figure 7