BENGAL ENGINEERING AND SCIENCE UNIVERSITY, SHIBPUR

B.E. (Mech.) Part III 5th Semester Examination, 2012
Use Separate Answer-script for each Half

Subject: Kinematics of Mechanisms (ME 505)

Duration: 3 hours **F.M. 70**

First Half

Answer **Question No. 1 and any two** from the rest of this half

1. (a) Determine the mobility of the mechanism shown in **Figure 1**. Can you classify the mechanism?

   (b) Discuss with illustrations different types of kinematic pairs.

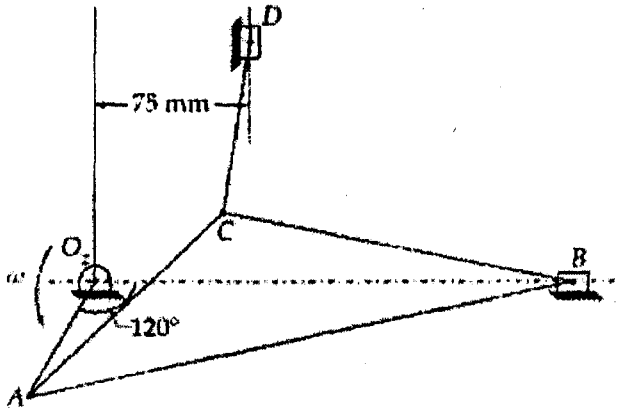

Figure 1.

[2+1+4=7]

2. Dimensions of the links of a four bar mechanism are : Frame- 25 mm, input link - 20 mm, coupler- 67 mm and the output link- 70 mm.
   (a) Is it a Grashof linkage? Determine the type of the mechanism.
   (b) Find the range of motion of the output link.
   (c) Find the time ratio.
   (d) Find the maximum and minimum transmission angles

[2+4+4+4=14]

3. For the mechanism shown in **figure 2**, crank CB oscillates about C through a limited arc, causing the crank OA to oscillate about O. When the linkage passes the position shown in the

figure with CB horizontal and OA vertical, the angular velocity of CB is 5rad/s CCW. Use analytical method to find the angular velocities and accelerations of the links AB and OA.

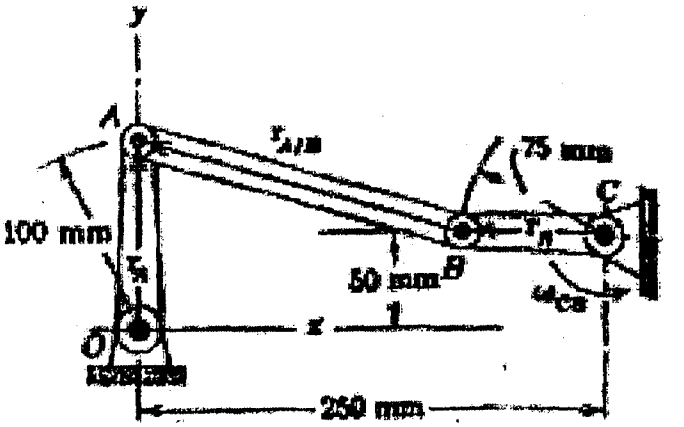

Figure 2. A 4-bar linkage

[8+6 =14]

4. Find the velocities and accelerations of the sliders B and D in the double slider mechanism shown in Fig. 1. The link O_2A rotates at 42 rad/s CCW. AO_2 =50 mm, BA =250 mm, CA = 100 mm, CB =175 mm and DC =200 mm. Use graphical method.

[14]

5. In a slider crank mechanism, the lengths of crank OB and connecting rod AB are 100 mm and 400 mm, respectively. The crank makes an angle 45° to the horizontal and rotates clockwise with uniform angular velocity of 10 rad/s.

   (a) Locate the instantaneous centres of the mechanism.

   (b) Find the velocity of the slider A (use IC method).

   (c) Find angular velocity of the connecting rod AB.

[6+4+4=14]

SECOND HALF

Answer **one** from Questions 6 and 7 and **two** from the rest.

6. (a) Two involute spur gears of module 3 mm and with 18 and 26 teeth have an operating pressure angle of 20^0. Assuming same addendum for both the gears, determine the maximum addendum to avoid interference. Derive any formula used. (4+5)

(b) (i) Why involute tooth profile is most common?

(ii) Why a flat face follower is offset in both the plane of rotation and also in a perpendicular direction?

(iii) Show that involute rack has straight tooth profile. (6)

7. (a) A translating offset roller follower rises and returns with simple harmonic motion without having any dwell period. The rise and return take equal time. The lift of the follower is 50 mm. Write the displacement equation of the follower movement. (2)

(b) For the cam in part (a), the prime circle radius and the offset are chosen so as to limit the maximum pressure angle **during rise** to 30^0. Determine the magnitude of the maximum pressure angle during return. (8)

(c) Determine the parametric equation of the profile of this cam, if the roller radius is 6 mm. (5)

8. In the epicyclic gear train shown in Fig. 3 , the input shaft *A* rotates at 1200 rpm in CCW direction. The internal wheel *E* is fixed, the gear *B* is keyed to the input shaft and the planet carriers *H* and *J* are fixed to the output shaft *K*. The internal gear *D* and gear *G* form a compound gear which revolves about the axis of *A* and *K*. The planet *C* is carried by *H* and the planet *F* is carried by *J*. The number of

teeth on the gears is $N_B = 24$, $N_D = 68$, $N_G = 30$ and $N_E = 64$. Determine the speed of the output shaft K. If the input power is 1 kW, then what torque is needed to keep the internal wheel E fixed? (8+2)

9. Explain clearly how you would design graphically a four-bar linkage so that a coupler point passes through three points C_1, C_2 and C_3 lying on a horizontal straight line with prescribed rotations of the input link as the coupler point moves from C_1 to C_2, and then from C_2 to C_3. (10)

10. Derive the equation for analytically designing a slider-crank linkage for three position synthesis. Hence obtain the link-lengths for satisfying the following three pairs of coordinated crank-angle and distance of the slider (along the direction of the slider movement) from the crankshaft axis:
(128.7^0, 3.95 cm), (90^0, 8.26 cm), (51.3^0, 9.97 cm) (5+5)

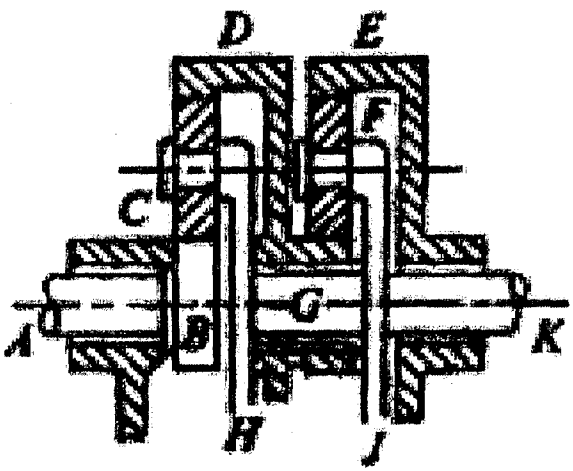

Figure 3