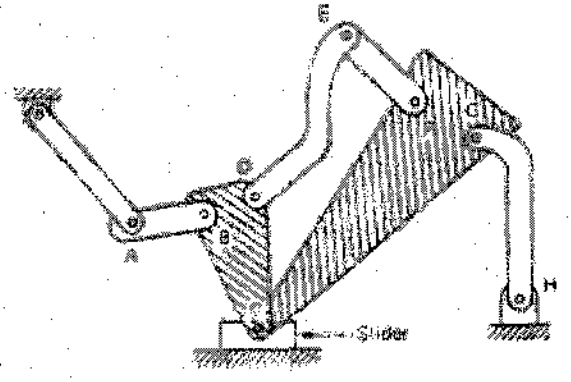
Kafrelsheikh University
Faculty of Engineering
Dept. of Mech. Engineering
Year: second Year
Subject: Theory of Machines

1st Semester
Final Examination
Date: Jan. 16th, 2020
Time allowed: 3 hours
Full Mark: 100

1. a. **(8 Marks) (ILO a.4.1)** For the linkage shown in the figures, determine the number of degrees of freedom of the mechanisms.



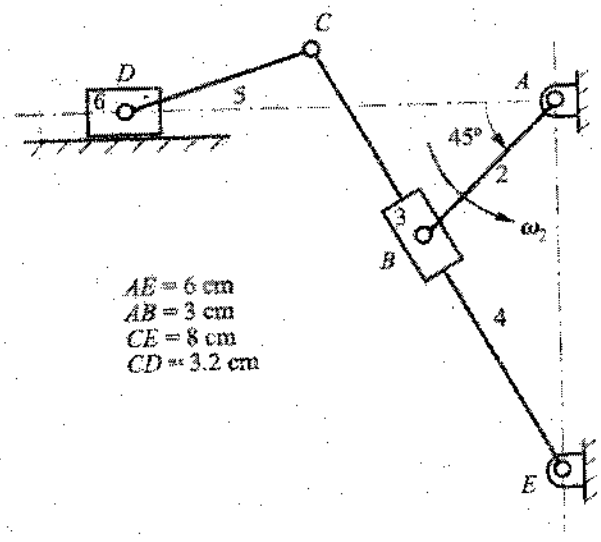
b. **(8 Marks) (ILO a.4.3)** You are given the following sets of links.

a) $L_1 = 5$ *in*, $L_2 = 8$ *in*, $L_3 = 15$ *in*, $L_4 = 19$ *in*, and $L_5 = 28$ *in*.

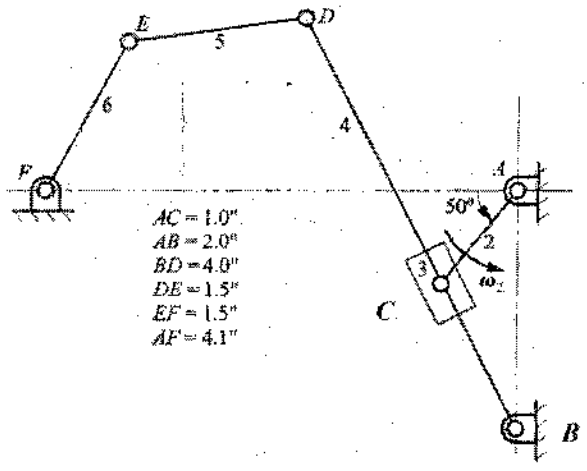
b) $L_1 = 5$ *in*, $L_2 = 2$ *in*, $L_3 = 4$ *in*, $L_4 = 3.5$ *in*, and $L_5 = 2.5$ *in*.

Select four links from each set such that the coupler can rotate fully with respect to other links. Sketch the linkage and identify the type of the four-bar mechanism in each case.

2. **(16 Marks) (ILO c.13.2)** In the mechanism shown, $\omega_2 = 10$ rad/s CCW (constant). Using the analytical method, determine (a) the angular velocity and angular acceleration of link 4, ω_4, and (b) the velocity and acceleration of the slider v_D.



3. **(18 Marks) (ILO c.13.2)** If $\omega_2 = 8\ rad/s$ CCW and constant, write the appropriate vector equations and construct the velocity diagram. Then, find the angular velocities ω_4, ω_5 and ω_6. **Take the velocity scale 1 cm : 4 in/s.**

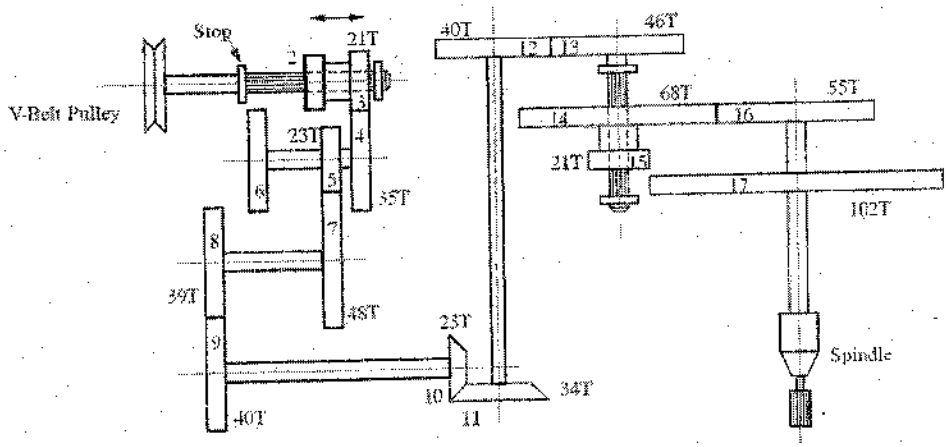


O_v

4. **(16 Marks) (ILO c.13.2)** Draw the displacement schedule for a follower that rises through a total displacement of 40 mm with constant acceleration for 1/8 revolution, constant velocity of 1/4 revolution, and constant deceleration for 1/8 revolution of the cam. The cam then dwells for 1/4 revolution and returns with simple harmonic motion in 1/4 revolution of the cam. Determine the maximum velocity and acceleration of the follower.

5. **(12 Marks) (ILO c.13.1)** Construct the cam profile using the displacement diagram from Questio The cam is to have a radial roller follower with 20 mm diameter. The cam will rotate clockwise, the base circle diameter is 80 mm. determine the maximum pressure angle.

6. **(16 Marks) (ILO b.2.2)** Part of the gear train for a machine tool is shown. Compound gears 2 and 3 slide on a splined shaft so that gear 3 can mesh with gear 4 or gear 2 can mesh with gear 6. Also, compound gears 14 and 15 slide on a splined shaft so that gear 14 can mesh with gear 16 or gear 15 can mesh with gear 17. (a) If gear 3 meshes with gear 4, what are the two possible spindle speeds for a motor speed of 1800 rpm? (b) Now assume that gear 14 meshes with gear 16, and gear 2 meshes with gear 6. Gears 2, 3, 4, and 6 are standard and have the same diametral pitch. What are the tooth numbers on gears 2 and 6 if the spindle speed is 130±3 rpm?



7. **(16 Marks) (ILO b.2.1)** For the linkage shown in the figure, find the torque T_{12} required for the mechanism equilibrium if $\boldsymbol{P} = 100$ lb in the direction shown. The linkage dimensions are as follows: $AB = 6$ in, $EC = 12$ in, $AE = 8$ in, $BC = 18$ in, $ED = 5$ in.