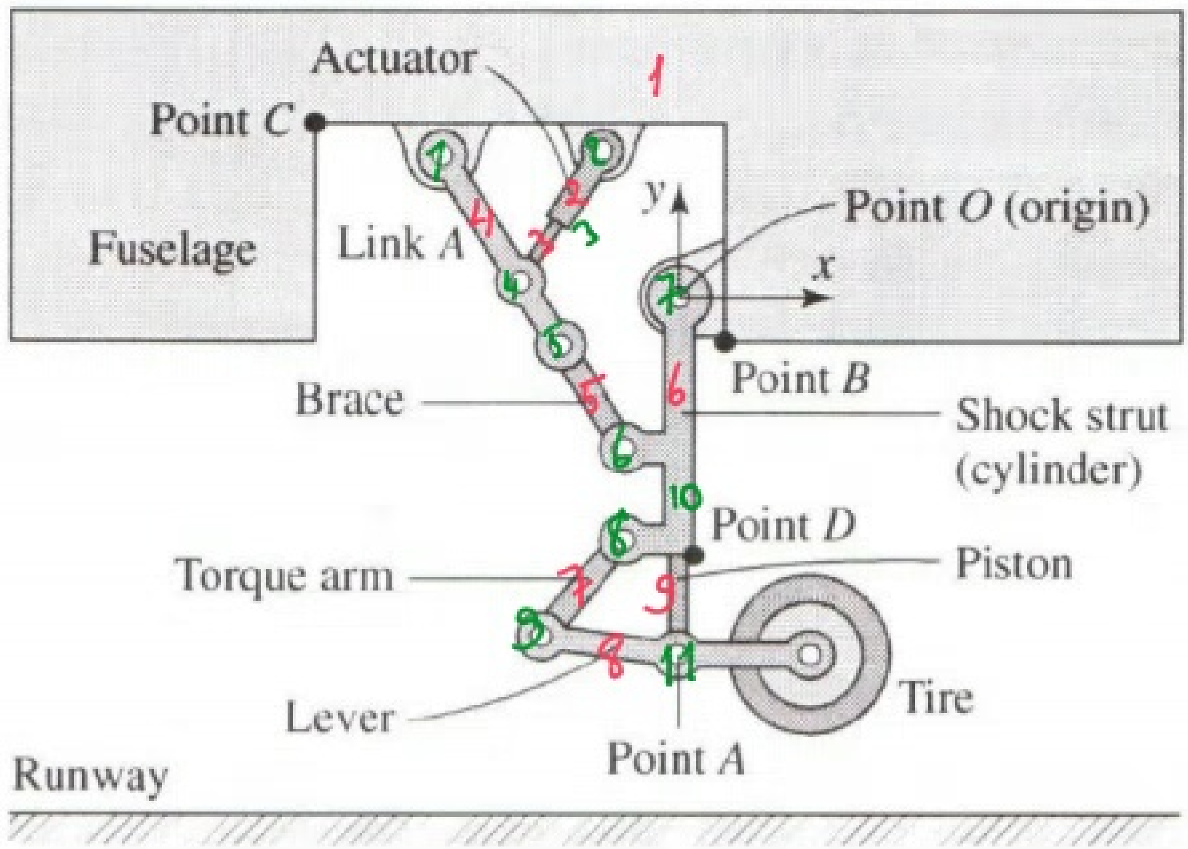
20161 / MT01

1st question



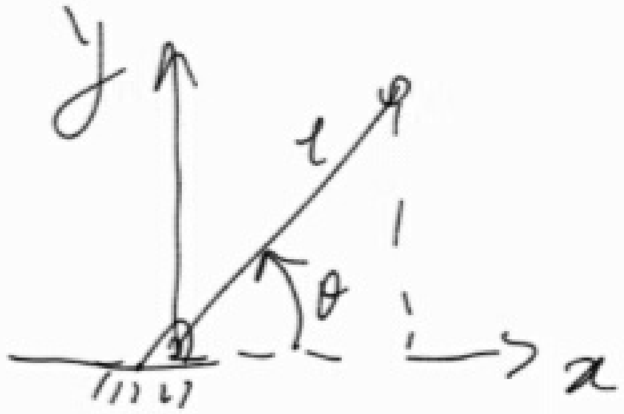
$n = 9$

$j = 11$

$$M = 3(n - j - 1) + \sum f_i = 3(9 - 11 - 1) + 11$$

$$= \underline{\underline{2}}\ \text{DOF}$$

4th question



F.K.

$$x = l\,C_\theta$$

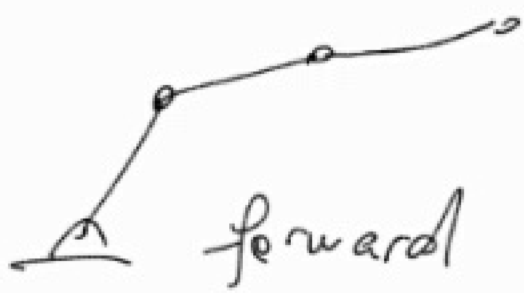
I.K.

$$\theta = C^{-1}\frac{x}{l}$$

If we think of a simple bar rotating around a point, θ is amount of rotation. The position eq. of the tip w.r.t. θ is forward kinematics, the equation calculating needed amount of rotation for required x, y position of the tip is inverse kinematics.

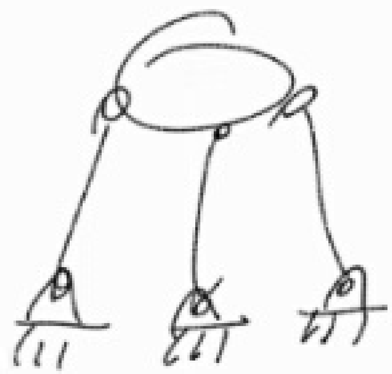
5th question

SERIAL



forward
inverse

PARALLEL



	serial	parallel
F	Easy	Hard
I	Hard	Easy

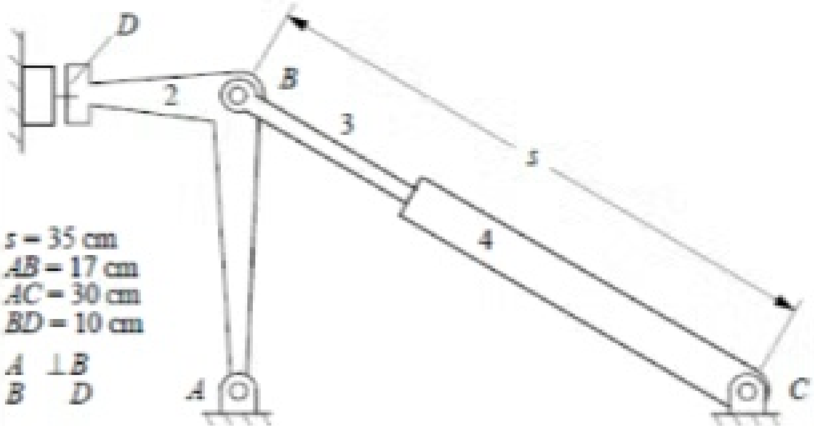
2nd question

Velocity and acceleration polygons of printing mechanism is given below. Input velocity and acceleration of the piston is 5 cm/sec ve 2 cm/sec^2.

a. Velocity and acceleration vectorial eq. are to be written based on the vector polygons.
b. Angular velocity and acceleration of the rotating piece 2 is to be determined.
c. Linear velocity and acceleration point D?

(Aşağıdaki baskı makinesinin hız ve ivme poligonları ölçekleri ile verilmiştir. Pistonun giriş hız ve ivmesi 5 cm/sn ve 2 cm/sn^2 olarak verilmiştir.

a. Sistemin hız ve ivme vektör eşitliklerini, vektör poligonlarından hareketle yazınız.
b. 2 elemanının açısal hız ve açısal ivmesini bulunuz.
c. D noktasının doğrusal hız ve ivmesini bulunuz.)



$^1v_{D_2} = 5.79$ cm/s

$|\omega_2| = \frac{|{}^1v_{B_2/A_2}|}{|r_{B/A}|} = \frac{5.81}{17} = 0.342$ rad/s CCW

$^1v_{B_2} = {}^1v_{B_3} = {}^1v_{B_2/A_2}$

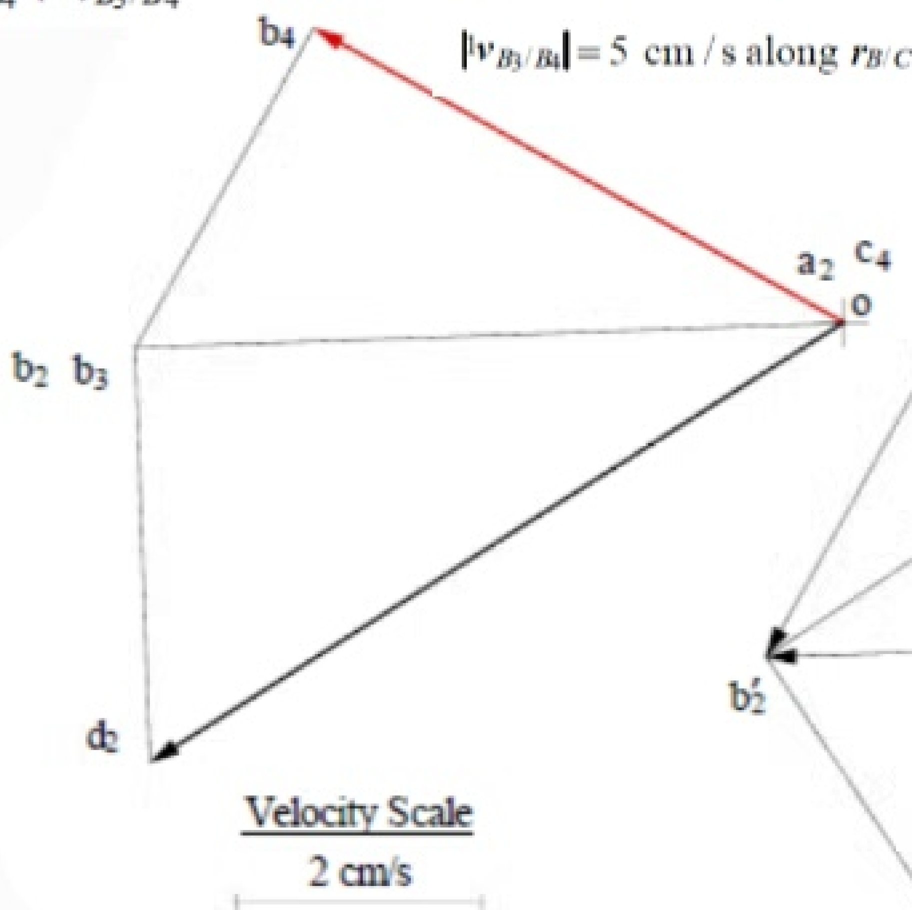
$^1v_{B_2/A_2} = {}^1\omega_2 \times r_{B/A}$ ($\perp$ to $r_{B/A}$)

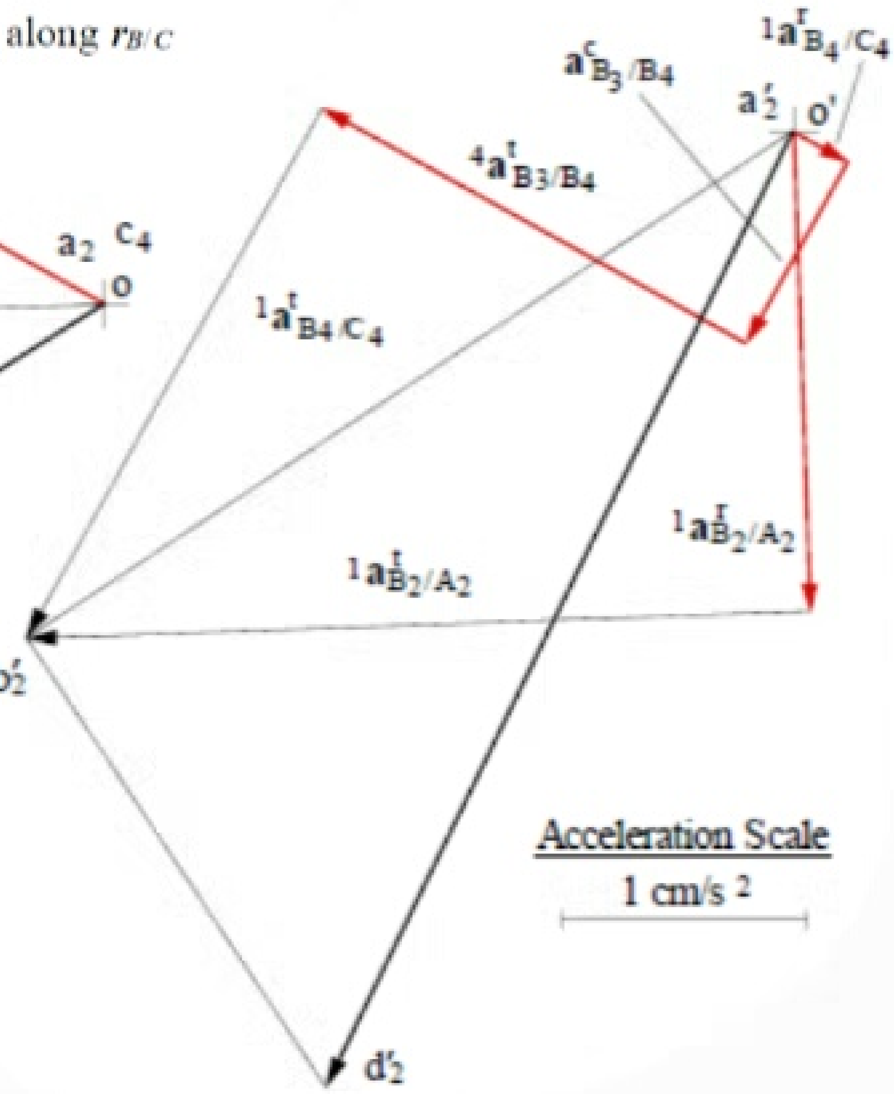
$|\omega_4| = \frac{|{}^1v_{B_4/C_4}|}{|r_{B/C}|} = \frac{3.018}{35} = 0.0862$ rad/s CCW

$^1v_{B_3} = {}^1v_{B_4} + {}^1v_{B_3/B_4}$

$^1v_{B_4} = {}^1v_{B_4/C_4} = {}^1\omega_4 \times r_{B/C}$ ($\perp$ to $r_{B/C}$)

$|{}^1v_{B_3/B_4}| = 5$ cm/s along $r_{B/C}$





$$^1\alpha_{B_2} = {}^1\alpha_{B_3} = {}^1\alpha_{B_2/A_2} = {}^1\alpha^r_{B_2/A_2} + {}^1\alpha^t_{B_2/A_2}$$

$$^1\alpha_{B_3} = {}^1\alpha_{B_4/A_4} + {}^1\alpha_{B_3/B_4} = {}^1\alpha^r_{B_4/A_4} + {}^1\alpha^t_{B_4/A_4} + {}^4\alpha^r_{B_3/B_4} + {}^4\alpha^t_{B_3/B_4} + {}^1\alpha^c_{B_3/B_4}$$

$$^1\alpha^r_{B_2/A_2} + {}^1\alpha^t_{B_2/A_2} = {}^1\alpha^r_{B_4/A_4} + {}^1\alpha^t_{B_4/A_4} + {}^4\alpha^r_{B_3/B_4} + {}^4\alpha^t_{B_3/B_4} + {}^1\alpha^c_{B_3/B_4}$$

$$\left|{}^1\alpha^n_{B_2/A_2}\right| = \left|{}^1\omega_2\right|^2 \left|r_{B/A}\right| = 0.342^2(17) = 1.99 \text{ cm/s}^2 \text{ (opposite to } r_{B/A})$$

$${}^1\alpha^t_{B_2/A_2} = {}^1\alpha_2 \times r_{B/A} \; (\perp \text{ to } r_{B/A})$$

$$\left|{}^1\alpha^r_{B_4/C_4}\right| = \left|{}^1\omega_4\right|^2 \left|r_{B/C}\right| = 0.0862^2(35) = 0.260 \text{ cm/s}^2 \text{ (opposite to } r_{B/C})$$

$${}^1\alpha^t_{B_4/A_4} = {}^1\alpha_4 \times r_{B/C} \; (\perp \text{ to } r_{B/C})$$

$$\left|{}^4\alpha^t_{B_3/B_4}\right| = 10 \text{ cm/s}^2 \text{ (along } r_{B/C})$$

$$\left|{}^4\alpha^n_{B_3/B_4}\right| = \frac{\left|{}^1v_{B_3/B_4}\right|^2}{\infty} = 0$$

$${}^1\alpha^c_{B_3/B_4} = 2 \cdot {}^1\omega_4 \times {}^4v_{B_3/B_4} \Rightarrow \left|{}^1\alpha^c_{B_3/B_4}\right| = 2\left|{}^1\omega_4\right|\left|{}^4v_{B_3/B_4}\right| = 2(0.0862)(5) = 0.862$$

$${}^1a_{D_2} = 4.39 \; cm/s^2$$

$$\left|{}^1\alpha_2\right| = \frac{\left|{}^1\alpha^t_{B_2/A_2}\right|}{\left|r_{B/A}\right|} = \frac{3.23}{17} = 0.190 \text{ rad/s}^2 \text{ CCW}$$