Machine theory - ME 306

Project 1

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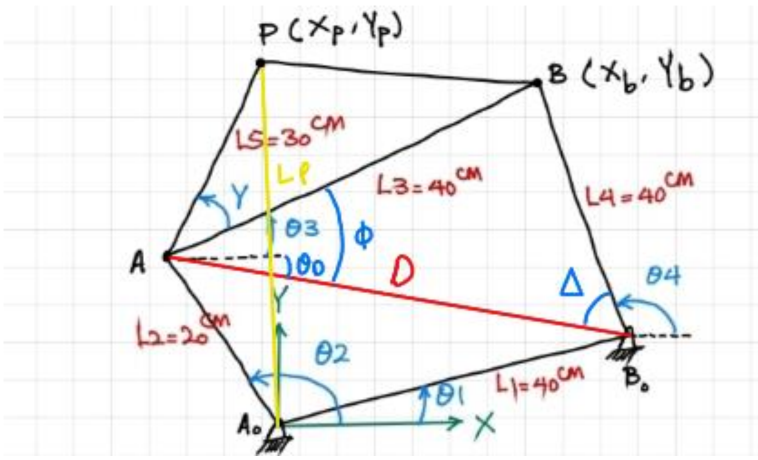
Question No.1:

Manual solution (typed)

Position Analysis:



- In this system s = 20 cm, l = 40 cm, p = 40 cm and q = 40 cm. S + l ≤ p + q thus, the system provides Grashoff's criterion which means the system can turn 360°. $\vartheta_2 \ = \ 0 \ to \ 360$.
- ϑ_2 starts from 0° and goes to 360°.

Matlab solution

- Firstly, the length of line D must be found, after that D_x and D_y must be found.

$$\sqrt{(L_1^2 + L_2^2 - 2 \cdot L_1 \cdot L_2 \cdot \cos(\vartheta_2))}$$
$$D_x \ = \ L_1 \cdot \cos(\vartheta_1) - L_2 \cdot \cos(\vartheta_2)$$
$$D_y \ = \ L_1 \cdot \sin(\vartheta_1) - L_2 \cdot \sin(\vartheta_2)$$

- Now we can find ϑ_D.

$$\vartheta_D \ = \ \tan^{-1}\left(\frac{D_y}{D_x}\right)$$

- To find the ϑ_3 and ϑ_4, we should find Φ and $\triangle$.

$$\Phi = \ \left|\cos^{-1}\left(\frac{L_3^2 + D^2 - L_4^2}{2 \cdot L_3 \cdot D}\right)\right|$$
$$\triangle = \ \left|\cos^{-1}\left(\frac{L_4^2 + D^2 - L_3^2}{2 \cdot L_4 \cdot D}\right)\right|$$
$$\vartheta_3 = phi + \vartheta_D$$
$$\vartheta_4 = \vartheta_D + (\pi - delta)$$

- We have determined all the variables that we need for calculation of position of point P and point B.

$$x_p = L_2 \cdot \cos(\vartheta_2) + L_5 \cdot \cos(\vartheta_3 + Y)$$
$$y_p = L_2 \cdot \sin(\vartheta_2) + L_5 \cdot \sin(\vartheta_3 + Y)$$

$$x_B = L_1 \cdot \cos(\vartheta_1) + L_4 \cdot \cos(180 - \vartheta_4)$$
$$y_B = L_1 \cdot \sin(\vartheta_1) + L_4 \cdot \sin(180 - \vartheta_4)$$

- You can see the results in figure 1 for part 1 and figure 3 for part 2.
- Now we can calculate the angular velocity values and angular acceleration values.

$$w_3 = -w_2 \cdot \left(\frac{L_2 \cdot \sin(\vartheta_4 - \vartheta_2)}{L_3 \cdot \sin(\vartheta_4 - \vartheta_3)}\right)$$
$$w_4 = -w_2 \cdot \left(\frac{L_2 \cdot \sin(\vartheta_3 - \vartheta_2)}{L_3 \cdot \sin(\vartheta_3 - \vartheta_4)}\right)$$

$$\alpha_3 \frac{-L_2 \cdot \alpha_2 \cdot \sin(\vartheta_4 - \vartheta_2) + L_2 \cdot w_2^2 \cdot \cos(\vartheta_4 - \vartheta_2) + L_4 \cdot w_4^2 \cdot \cos(\vartheta_3 - \vartheta_4) - L_3 \cdot w_3^2}{L_3 \cdot \sin(\vartheta_4 - \vartheta_3)}$$

$$\alpha_4 = \frac{L_2 \cdot \alpha_2 \cdot \sin(\vartheta_4 - \vartheta_2) + L_2 \cdot w_2^2 \cdot \cos(\vartheta_4 - \vartheta_2) + L_4 \cdot w_4^2 \cdot \cos(\vartheta_3 - \vartheta_4) - L_3 \cdot w_3^2}{L_3 \cdot \sin(\vartheta_4 - \vartheta_3)}$$

- You can see the results in figure 2 for part 1 and figure 4 for part 2.

Discussion:

- In part 1 the system is Grashof, but in part 2 the system is not Grashof. When the system is Grashof, the equations used give correct results. But the equations used when the system is not Grashof are incorrect. We can see this error best if we compare the angular velocity and angular acceleration graphs.

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Part 1)

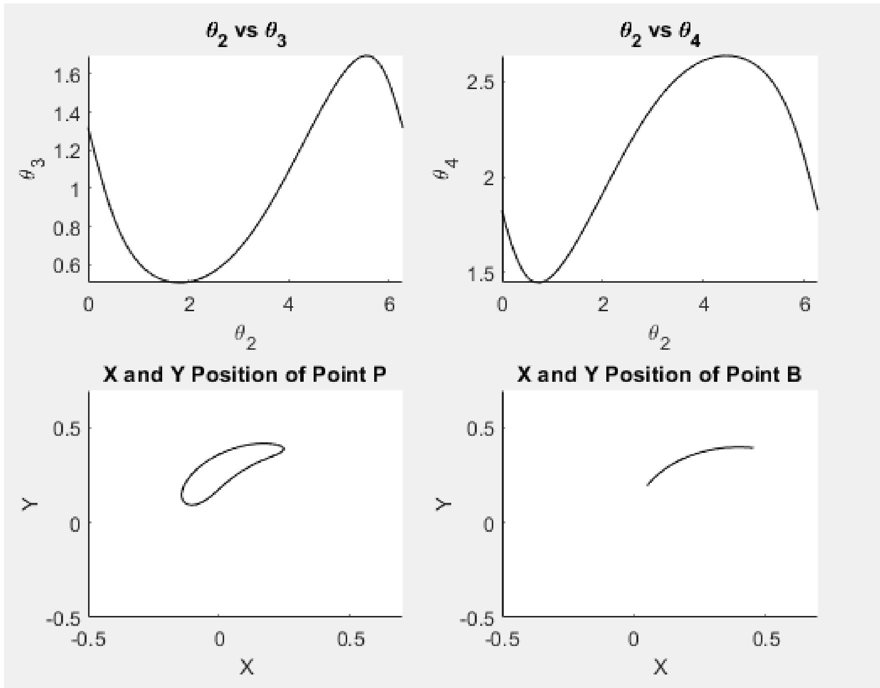

Figure 1

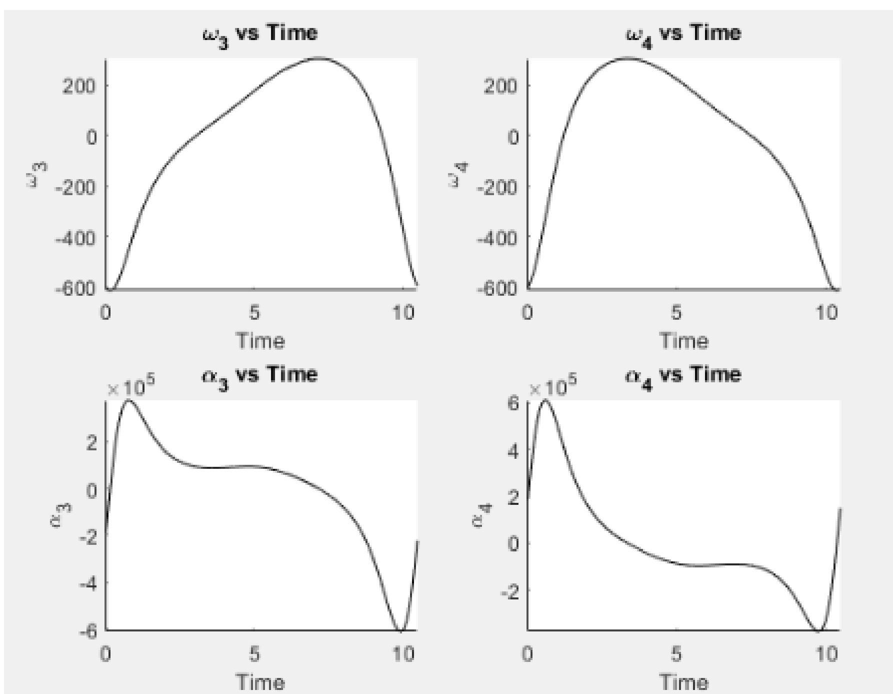

Figure 2

Part 2)

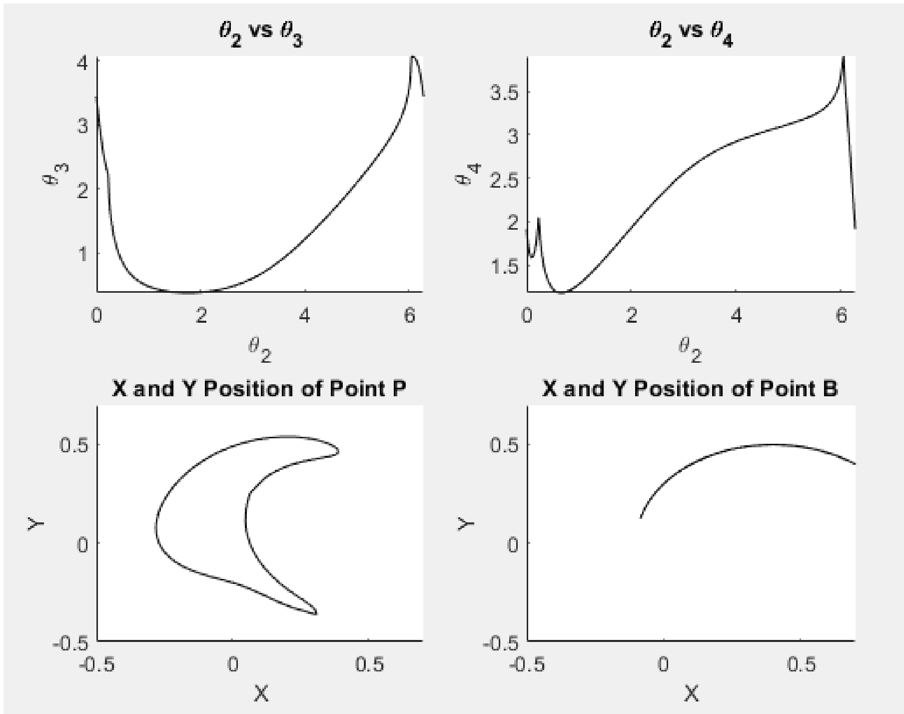

Figure 3

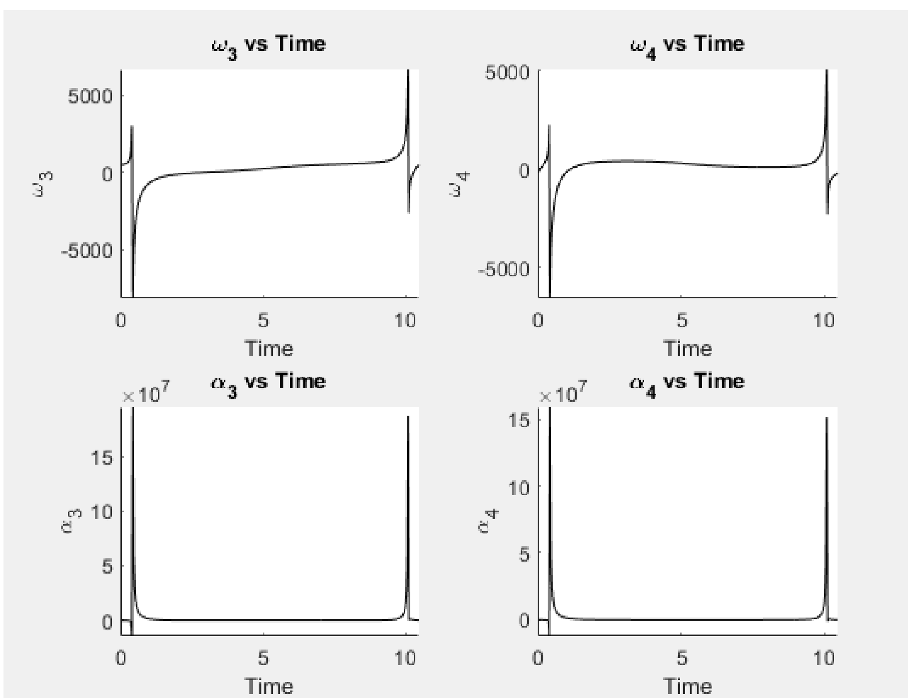

Figure 4