HW 6 PVA Part 2

Graded

Student

Shihong Yuan

Total Points

25 / 25 pts

Question 1

Practical application of PVA analysis

10 / 10 pts

- ✔ **– 0 pts** Correct
- **– 0.5 pts** Error in equation
- **– 1 pt** Incorrect/missing speed of balloon
- **– 1 pt** Incorrect/missing acceleration of balloon
- **– 0.5 pts** Missing magnitude for speed and acceleration

Question 2

6 Bar mechanism PVA

15 / 15 pts

- ✔ **– 0 pts** Correct
- **– 0.5 pts** Error in equation
- **– 1 pt** Incorrect/missing angle
- **– 1 pt** incorrect/missing velocity
- **– 1 pt** Incorrect/missing acceleration
- **– 2 pts** Incorrect/missing ballon velocity
- **– 2 pts** Incorrect/missing ballon acceleration

Question 3

Penalties

0 / 0 pts

- ✔ **– 0 pts** Correct
- **– 2.5 pts** Less than 1 day late
- **– 5 pts** 1-2 days late
- **– 7.5 pts** 2-3 days late
- **– 10 pts** 3-4 days late
- **– 12.5 pts** 4+ days late

No questions assigned to the following page.

ME 370

Fall 2025

Homework 8: PVA Part 2

NAME: shihong Yuan UIN: 665249431

Problem 1 [10 pts]: Practical applications of PVA analysis

Professor Wandke is designing a mechanism to launch a water balloon using linkage.

In Figure 1, the linkage has:

A=1m B= 0.6m C= 2.5m

Assume Professor Wandke accelerates at $1m/s^2$, his slider moves at 3m/s and the slider is 1.2m away from point O4.

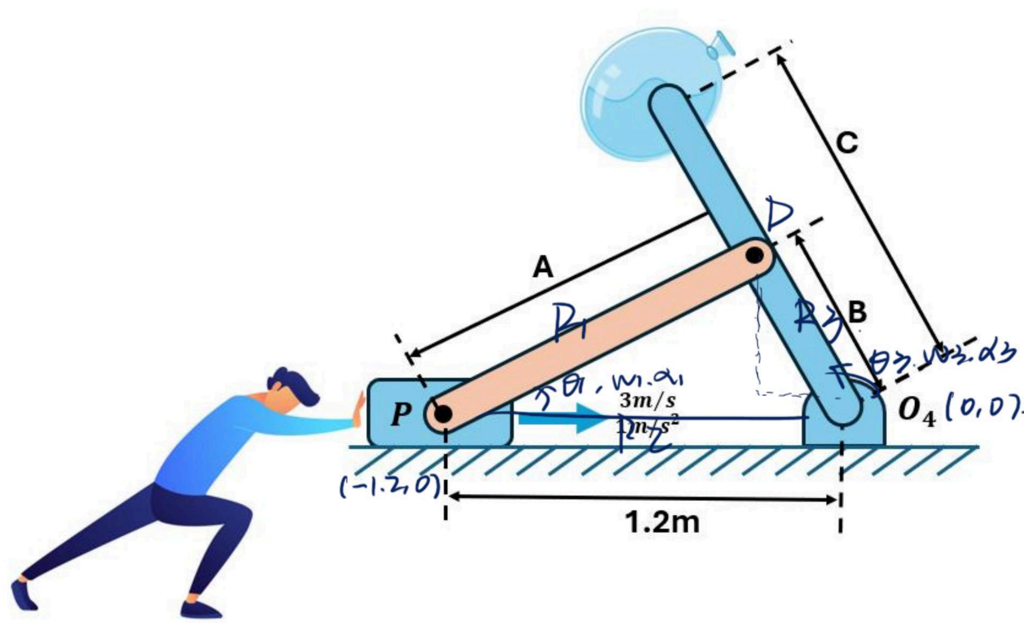


Figure 1. First Iteration Design

Perform a PVA analysis on Professor Wandke's mechanism. Write out the vector loop equations for the position, velocity, and acceleration of the balloon. Compute

Question assigned to the following page: 1

Set $O_4(0,0)$. $P(-1.2,0)$, $R_1=1$ $R_2=1.2$ $R_3=0.6$, $\omega_2=\theta_2=\alpha_2=0$.

$v_p=3$ $a_p=1$

$$\begin{cases} x_p + R_1 e^{j\theta_1} = R_3 e^{j\theta_3} & ① \\ v_p + j\omega_1 R_1 e^{j\theta_1} = j\omega_3 R_3 e^{j\theta_3} & ② \\ a_p + j\alpha_1 R_1 e^{j\theta_1} - \omega_1^2 R_1 e^{j\theta_1} = j\alpha_3 R_3 e^{j\theta_3} - \omega_3^2 R_3 e^{j\theta_3} & ③ \end{cases}$$

① $\Rightarrow$ $\theta_1 = 29.93°$

$\theta_2 = 123.75°$

② $\Rightarrow$ $\begin{cases} 3 - R_1\omega_1 \sin\theta_1 = -R_3\omega_3 \sin\theta_3 \\ 0 + R_1\omega_1\cos\theta_1 = R_3\omega_3 \sin\theta_3 \end{cases} \Rightarrow \begin{cases} \omega_1 = 1.6704 \text{ rad/s} \\ \omega_3 = -4.343 \text{ rad/s} \end{cases}$

③ $\Rightarrow$ $\begin{cases} 1 - \alpha_1 R_1 \sin\theta_1 - \omega_1^2 R_1 \cos\theta_1 = -\alpha_3 R_3 \sin\theta_3 - \omega_3^2 R_3 \cos\theta_3 \\ \alpha_1 R_1 \cos\theta_1 - \omega_1^2 R_1 \sin\theta_1 = \alpha_3 R_3 \cos\theta_3 - \omega_3^2 R_3 \sin\theta_3 \end{cases} \Rightarrow \begin{cases} \alpha_1 = -10.9718 \text{ rad/s}^2 \\ \alpha_3 = 4.4732 \text{ rad/s}^2 \end{cases}$

$r_s = R_4 e^{j\theta_3} = (-1.389, 2.079)$

$v_s = j\omega_3 R_4 e^{j\theta_3} = (9.028, 6.032) \Rightarrow |v| = 10.857$ m/s

$a_s = \alpha_3 \cdot R_4 e^{j\theta_4} - \omega_3^2 R_4 e^{j\theta_4} = (16.898, -45.42) \Rightarrow |a| = 48.462$ m/s²

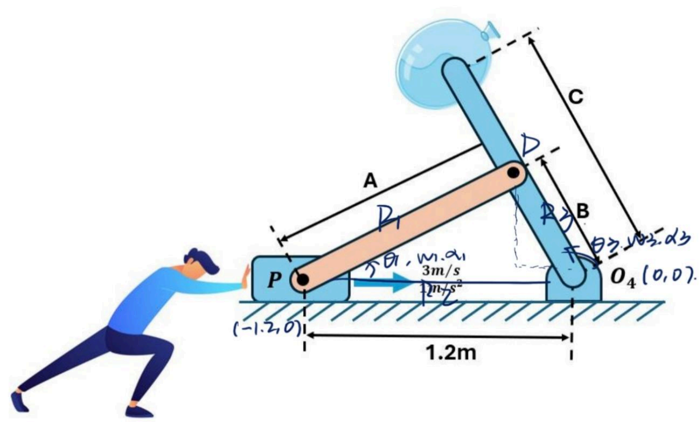


Figure 1. First Iteration Design

No questions assigned to the following page.

NAME: _______________ UIN: ______________

the related link length, angles, angular velocities, and angular accelerations. State the linear velocity and acceleration of the balloon.

Problem 2 [15 pts]: 6 Bar mechanism PVA.

Professor Wandke decides to improve his design by adding another set of linkages onto it. What will the speed and acceleration of the balloon be now?

In Figure 2, the linkage has:

A= 1m B= 0.6m C=2.5m D=2.0m E= 2.5m F = 3.0m

G=1.5m

No questions assigned to the following page.

ME 370

Fall 2025

Homework 8: PVA Part 2

NAME: ______________ UIN: ______________

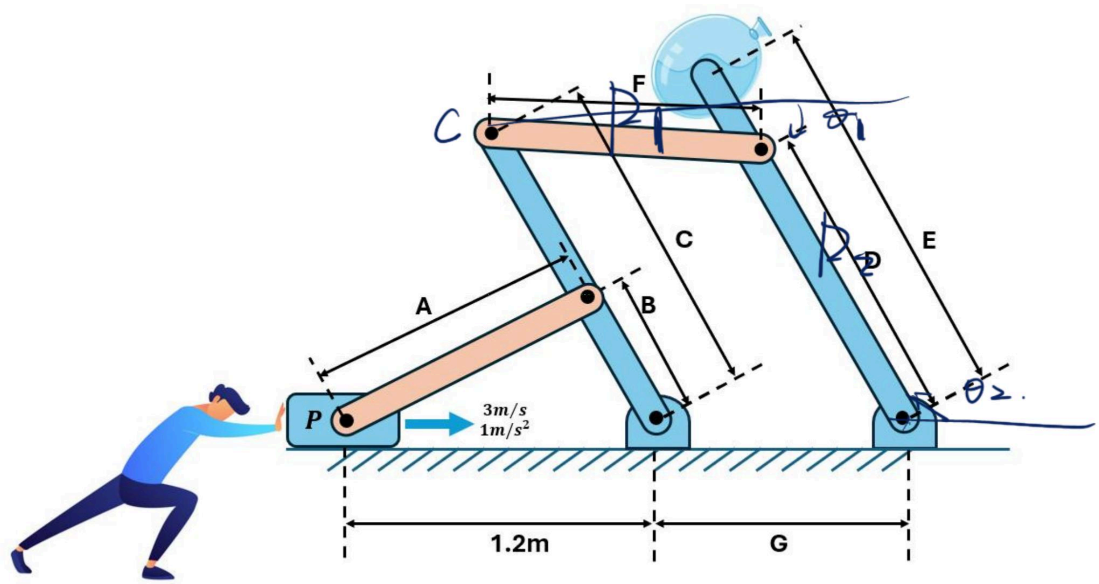
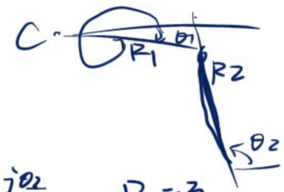


Figure 2. Second Iteration Design

Perform a PVA analysis on Professor Wandke's mechanism. Write out the vector loop equations for the position, velocity, and acceleration of the balloon. Compute the related link length, angles, angular velocities, and angular accelerations. State the linear velocity and acceleration of the balloon.

Question assigned to the following page: 2

$$
\begin{cases}
x_C + R_1 e^{j\theta_1} = G + R_2 e^{j\theta_2} & ① \\
v_C + j\omega_1 R_1 e^{j\theta_1} = 0 + j\omega_2 R_2 e^{j\theta_2} & ② \\
a_C + j\alpha_1 R_1 e^{j\theta_1} - \omega_1^2 R_1 e^{j\theta_1} = 0 + j\alpha_2 R_2 e^{j\theta_2} - \omega_2^2 R_2 e^{j\theta_2}
\end{cases}
$$



$R_1 = 3$

$R_2 = 2$

$G = 1.5$

$R_3 = 2.5$

$$① \Rightarrow \begin{cases} \theta_1 = -1.57^\circ \\ \theta_2 = 86.85^\circ \end{cases}$$

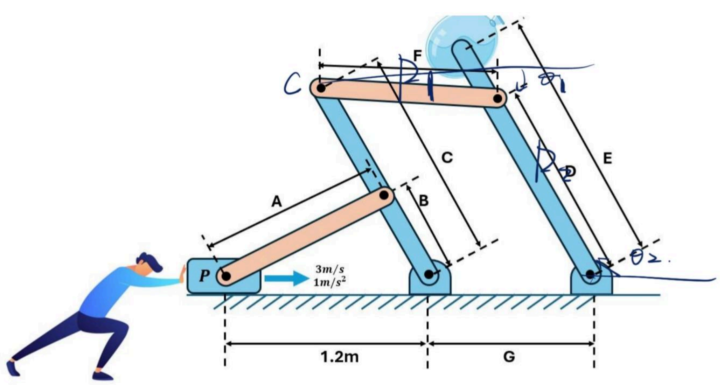
$$② \Rightarrow \begin{cases} v_{c1} - \omega_1 R_1 \sin\theta_1 = -\omega_2 R_2 \sin\theta_2 \\ v_{c2} + \omega_1 R_1 \cos\theta_1 = \omega_2 R_2 \cos\theta_2 \end{cases} \Rightarrow \begin{cases} \omega_1 = -2.1738 \text{ rad/s} \\ \omega_2 = -4.4315 \text{ rad/s} \end{cases}$$

$$③ \Rightarrow \begin{cases} a_{c1} - \alpha_1 R_1 \sin\theta_1 - \omega_1^2 R_1 \cos\theta_1 = -\alpha_2 R_2 \sin\theta_2 - \omega_2^2 R_2 \cos\theta_2 \\ a_{c2} + \alpha_1 R_1 \cos\theta_1 - \omega_1^2 R_1 \sin\theta_1 = \alpha_2 R_2 \cos\theta_2 - \omega_2^2 R_2 \sin\theta_2 \end{cases} \Rightarrow \begin{cases} \alpha_1 = 1.8465 \\ \alpha_2 = -2.5221 \end{cases}$$

$$r_s = G + R_3 \cdot e^{j\theta_2} = (0.1373,\ 3.9962) \text{ m}$$

$$v_s = R_3 j\omega e^{j\theta_2} = (11.0621,\ -0.6807) \text{ m/s} = 11.08 \text{ m/s}$$

$$a_s = j\alpha_3 R_3 e^{j\theta_2} - \omega_2^2 R_3 e^{j\theta_2} = (3.5983,\ -49.3687) = 49.5 \text{ rad/s}$$



Question assigned to the following page: 3

ME 370

Fall 2025

Homework 8: PVA Part 2

NAME: _______________ UIN: ______________

Select one of the following options:

a) My answer was created by a Gen AI algorithm, and I have not modified it
b) My answer was created by a Gen AI algorithm, and I have made some minor changes.
c) My answer was created by a Gen AI algorithm, and I have made major changes.
d) My answer was created solely by myself.
e) If I used Gen AI, I used ___ (name of program).