HW 5 PVA Part1

Student

Shihong Yuan

Total Points

25 / 25 pts

Question 1

PVA Analysis   **25** / 25 pts

1.1   **a**   **5** / 5 pts

✔ **– 0 pts** Correct

     – 0.3 pts Error in position equation

     – 0.3 pts Error in velocity equation

     – 0.3 pts Error in acceleration equation

     – 0.6 pts Missing position eq

     – 1 pt Missing velocity eq

     – 1 pt Missing acceleration eq

     – 2 pts No Answer

     – 1 pt Incomplete

1.2   **b**   **5** / 5 pts

✔ **– 0 pts** Correct

     – 1 pt Incorrect/Missing O2A

     – 1 pt Incorrect/Missing O2O4

     – 1 pt Incorrect/Missing AB

     – 1 pt Incorrect/Missing BO4

     – 1 pt Incorrect/Missing AC

     – 2 pts No Answer

     – 1 pt Incomplete

1.3   **c**   **4** / 4 pts

✔ **– 0 pts** Correct

     – 1 pt Angle 2 incorrect = 53.1301 (0.927 radians)

     – 1 pt Angle 3 incorrect = 22.6199 (0.394 radians)

     – 1 pt Angle 4 incorrect = 118.0725 (2.06 radians)

     – 1 pt Angle 5 incorrect = 135 (2.35 radians)

     – 1 pt Incomplete

     – 2 pts No Answer

1.4 d   **4** / 4 pts

> ✔ **– 0 pts** Correct

     – 1 pt Speed 2 incorrect

     – 1 pt Speed 3 incorrect

     – 1 pt Speed 4 incorrect

     – 1 pt Speed 5 incorrect

     – 4 pts No Answer

1.5 e   **4** / 4 pts

> ✔ **– 0 pts** Correct

     – 1 pt Accel. 2 incorrect

     – 1 pt Accel. 3 incorrect

     – 1 pt Accel. 4 incorrect

     – 1 pt Accel. 5 incorrect

     – 4 pts No Answer

1.6 f   **3** / 3 pts

> ✔ **– 0 pts** Correct

     – 0 pts Correct according to previous answers

     – 0.6 pts Error in velocity

     – 0.6 pts Error in acceleration

     – 1 pt Missing velocity

     – 1 pt Missing acceleration

     – 2 pts No Answer

Question 2

Penalties 0 / 0 pts

✔ **– 0 pts** Correct

    – 3 pts No Pages Assigned

    – 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.

Fall 2025
Homework 5: PVA Part 1

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Hint: This problem may look like one you completed when we studied instant centers, which could be useful for performing a sanity check on your answers

a) Write out the vector loop equations for the position, velocity, and acceleration of C

b) Compute the lengths of O_2A, O_2O_4, AB, BO_4, and AC

c) Compute the angles ϑ_2, ϑ_3, ϑ_4, ϑ_5

d) Compute the angular velocities ω_2, ω_3, ω_4, ω_5

e) Compute the angular accelerations α_2, α_3, α_4, α_5

f) State the linear velocity and acceleration of point C

Show all work for full points
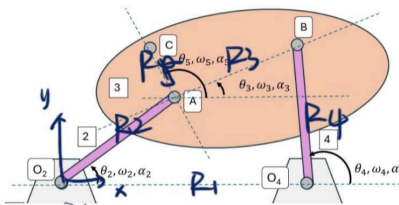
Select one of the following options:

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).

Hint: This problem may look like one you completed when we studied instant centers, which could be useful for performing a sanity check on your answers

$O_2 = (0,0), \quad O_4 = (27.5,0),$
$A = (7.5,10), B = (19.5,15), \quad C = (3.5,14),$
$\omega_4 = 1\,rad/s, \quad \alpha_4 = -2\,rad/s^2$

a) Write out the vector loop equations for the position, velocity, and acceleration of C
b) Compute the lengths of O_2A, O_2O_4, AB, BO_4, and AC
c) Compute the angles $\vartheta_2, \vartheta_3, \vartheta_4, \vartheta_5$
d) Compute the angular velocities $\omega_2, \omega_3, \omega_4, \omega_5$
e) Compute the angular accelerations $\alpha_2, \alpha_3, \alpha_4, \alpha_5$
f) State the linear velocity and acceleration of point C

(1)

$$\vec{R_2} + \vec{R_3} \cdot \vec{R_1} + \vec{R_4} \Rightarrow R_1 e^{j\theta_1} + R_2 e^{j\theta_4} = R_3 e^{j\theta_3} + R_2 e^{j\theta_2} \quad \textcircled{1}$$

$$P_c = \vec{R_2} + \vec{P_5} = R_2 e^{j\theta_2} + R_5 e^{j\theta_5}$$

$$\vec{V_A} + \vec{V_{B|A}} = \vec{V_{B}}|_0 + \vec{V_{O_4}} \Rightarrow j R_2 \omega_2 e^{j\theta_2} + j R_3 \omega_3 e^{j\theta_3} = j R_1 \omega_1 e^{j\theta_1} + j R_4 \omega_4 e^{j\theta_4}$$

$$V_c = \vec{V_A} + \vec{V_{C|A}} = j R_2 \omega_2 e^{j\theta_2} + j R_5 \omega_5 e^{j\theta_5}$$

$$\vec{a_A} + \vec{a_{B|A}} = \vec{a_B} + \vec{a_{O_4}} \Rightarrow j R_1 \alpha_1 e^{j\theta_1} - \omega_1^2 R_1 e^{j\theta_1} + j R_4 \alpha_4 e^{j\theta_4} - \omega_4^2 R_4 e^{j\theta_4} = j R_2 \alpha_2 e^{j\theta_2} - \omega_2^2 R_2 e^{j\theta_2} + j R_3 \alpha_3 e^{j\theta_3} - \omega_3^2 R_3 e^{j\theta_3}$$

$$a_c = \vec{a_A} + \vec{a_{C|A}} \Rightarrow a_c = j R_2 \alpha_2 e^{j\theta_2} - \omega_2^2 R_2 e^{j\theta_2} + j R_5 \alpha_5 e^{j\theta_5} - \omega_5^2 R_5 e^{j\theta_5}$$

(4)

$$\begin{cases} R_2 \omega_2 \cos\theta_2 + R_3 \omega_3 \cos\theta_3 = R_4 \omega_4 \cos\theta_4 \\ R_2 \omega_2 \sin\theta_2 + R_3 \omega_3 \sin\theta_3 = R_4 \omega_4 \sin\theta_4 \end{cases}$$

2 equation 2 variable (ω_2, ω_3) $\omega_1 = 0 \quad \omega_4 = 1$

$$\Rightarrow \begin{cases} \omega_2 = 2.67 \\ \omega_3 = -2.33 \\ \omega_5 = \omega_3 = -2.33 \end{cases}$$

(2)
$O_2 O_4 = R_1 = 27.5$
$O_2 A = R_2 \approx 12.5$
$AB = R_3 = 13$
$B O_4 = R_4 = 17$
$AC = R_5 = 4\sqrt{2} = 5.6327$

(3) $\theta_1 = \operatorname{atan} 0 = 0$
$\theta_2 = \operatorname{atan} \frac{10}{7.5} = 0.927 = 53.13°$
$\theta_3 = \operatorname{atan} \frac{5}{12} = 0.394 = 22.62°$
$\theta_4 = \operatorname{atan} \frac{15}{-8} = -1.08 = 118.07°$
$\theta_5 = \operatorname{atan} \frac{4}{-4} = -0.783 = 135°$

(5)
$$\begin{cases} R_2 \alpha_2 \cos\theta_2 - \omega_2^2 R_2 \sin\theta_2 + R_3 \alpha_3 \cos\theta_3 - \omega_3^2 R_3 \sin\theta_3 = R_4 \alpha_4 \cos\theta_4 - \omega_4^2 R_4 \sin\theta_4 \\ -R_2 \alpha_2 \sin\theta_2 - \omega_2^2 R_2 \cos\theta_2 - R_3 \alpha_3 \sin\theta_3 - \omega_3^2 R_3 \cos\theta_3 = -R_4 \alpha_4 \sin\theta_4 - \omega_4^2 R_4 \cos\theta_4 \end{cases}$$

$$\Rightarrow \begin{cases} \alpha_4 = -2 \quad \alpha_1 = 0 \\ \alpha_2 = -28.8081 \\ \alpha_3 = 26.2828 \\ \alpha_5 = \alpha_3 = 26.2828 \end{cases}$$

6) $V_c = j R_2 \omega_2 e^{j\theta_2} + j R_5 \omega_5 e^{j\theta_5}$
$$= -17.333 + 28.333 j \qquad |V_c| = 34.0718$$

$a_c = a_A + a_{c|A}$
$$= 151.3939 + -414.0808 j \qquad |a_c| = 440.888$$