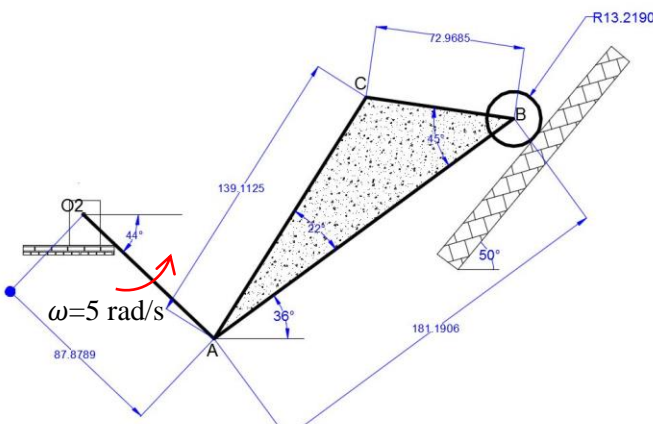
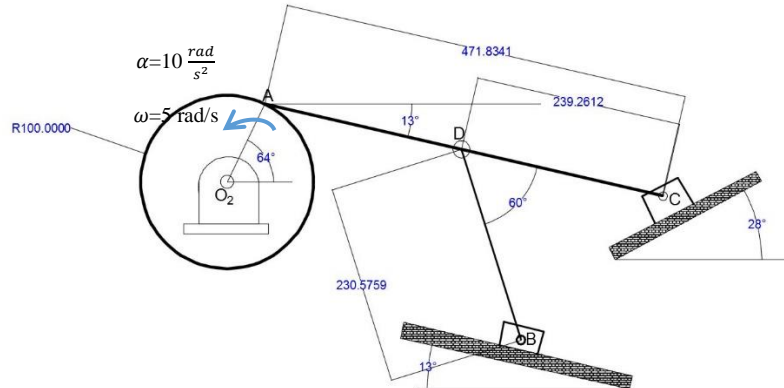
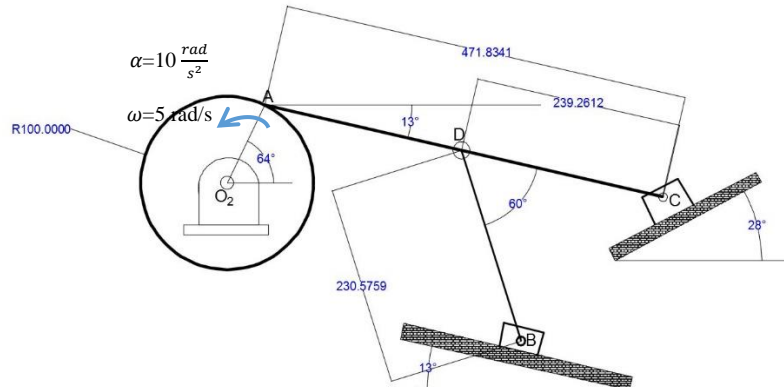


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<p>Time: 120 min</p>		<p>Department of Mechanical Engineering</p>

1.

	<p>۱- اگر سرعت زاویه‌ای و شتاب زاویه‌ای لینک O2A به ترتیب برابر با ۵ رادیان بر ثانیه و صفر باشد با استفاده از روش مؤلفه‌ها سرعت نقاط B و C را به دست آورید.</p> <p>اندازه های روی شکل بر حسب سانتی‌متر است.</p> <p style="text-align: right;">۳۰ نمره</p>
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	<p>۲- اگر سرعت زاویه‌ای و شتاب زاویه‌ای لینک O2A به ترتیب برابر با ۵ رادیان بر ثانیه و ۱۰ رادیان بر مجذور ثانیه باشند با استفاده از روش سرعت‌های نسبی سرعت نقاط B, C, D را به دست آورید.</p> <p>اندازه های روی شکل بر حسب سانتی‌متر است.</p> <p style="text-align: right;">۳۰ نمره</p>
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	<p>۳- اگر سرعت زاویه‌ای و شتاب زاویه‌ای لینک O2A به ترتیب برابر با ۵ رادیان بر ثانیه و ۱۰ رادیان بر مجذور ثانیه باشند با استفاده از روش سرعت‌های نسبی شتاب نقاط B, C, D را به دست آورید.</p> <p>اندازه های روی شکل بر حسب سانتی‌متر است.</p> <p style="text-align: right;">۴۰ نمره</p>
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زمان آزمون ۱۲۰ دقیقه است. ۱۰ دقیقه زمان اضافه برای آپلود پاسخ‌ها در نظر گرفته شده است. در حین حل سوال دوم، پاسخ سوال اول را آپلود کنید. در حین حل سوال سوم، پاسخ سوال دوم را آپلود کنید.

منظم و تمیز بنویسید.

فقط پاسخ‌های که در سامانه ارسال شوند، مورد بررسی قرار خواهند گرفت.

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پاسخ سوال ۱

پایانم دینامیک ماشین ۱۴۰۰-۲-۱۳۵۵

$V_A = r\omega = 0.878789 \times 5 = 4.393945$

$V_A = 4.393945 (\cos 4^\circ \hat{i} + \sin 4^\circ \hat{j}) = 3.0523 \hat{i} + 3.1607 \hat{j}$

$V_B = V_A + V_{B/A} \Rightarrow$

$V_B \cos 50^\circ \hat{i} + V_B \sin 50^\circ \hat{j} = 3.0523 \hat{i} + 3.1607 \hat{j} + V_{B/A} \sin 36^\circ \hat{i} - V_{B/A} \cos 36^\circ \hat{j}$

$\hat{i} \left\{ \begin{array}{l} 0.6428 V_B - 0.5878 V_{B/A} = 3.0523 \\ 0.7660 V_B + 0.8090 V_{B/A} = 3.1607 \end{array} \right.$

$\begin{bmatrix} 0.6428 & -0.5878 \\ 0.766 & +0.8090 \end{bmatrix} \begin{Bmatrix} V_B \\ V_{B/A} \end{Bmatrix} = \begin{Bmatrix} 3.0523 \\ 3.1607 \end{Bmatrix}$

$\begin{Bmatrix} V_B \\ V_{B/A} \end{Bmatrix} = \frac{1}{-0.9704} \begin{bmatrix} -0.809 & -0.5879 \\ -0.766 & 0.6428 \end{bmatrix} \begin{Bmatrix} 3.0523 \\ 3.1607 \end{Bmatrix} = \begin{Bmatrix} 4.4597 \\ 0.3157 \end{Bmatrix}$

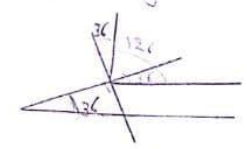

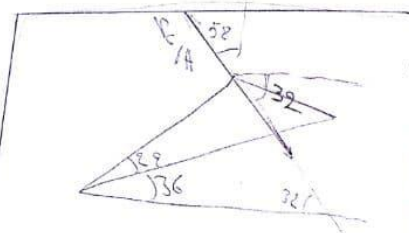
$V_B = 4.4597 \frac{m}{s} \quad V_{B/A} = 0.3157 \frac{m}{s}$

$\omega_3 = \frac{V_{B/A}}{AB} = \frac{0.3157}{1.81906} = 0.17355 \frac{rad}{s}$

$V_C = V_A + V_{C/A}$
 $V_C = V_B + V_{C/B}$

$V_{C/A} = AC \omega_3 = 1.391125 \times 0.17355 = 0.24143 \frac{m}{s}$

$V_C = 3.0523 \hat{i} + 3.1607 \hat{j} + (-0.24143 \cos 32^\circ \hat{i} + 0.24143 \sin 32^\circ \hat{j})$

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$$\vec{v}_C = 2.8476\hat{i} + 3.2886\hat{j}$$

$$\vec{v}_C = \vec{v}_B + \vec{v}_{C/B}$$

$$v_{C/B} = BC \omega_3 = 0.729685 \times 0.17355 = 0.12664 \frac{m}{s}$$

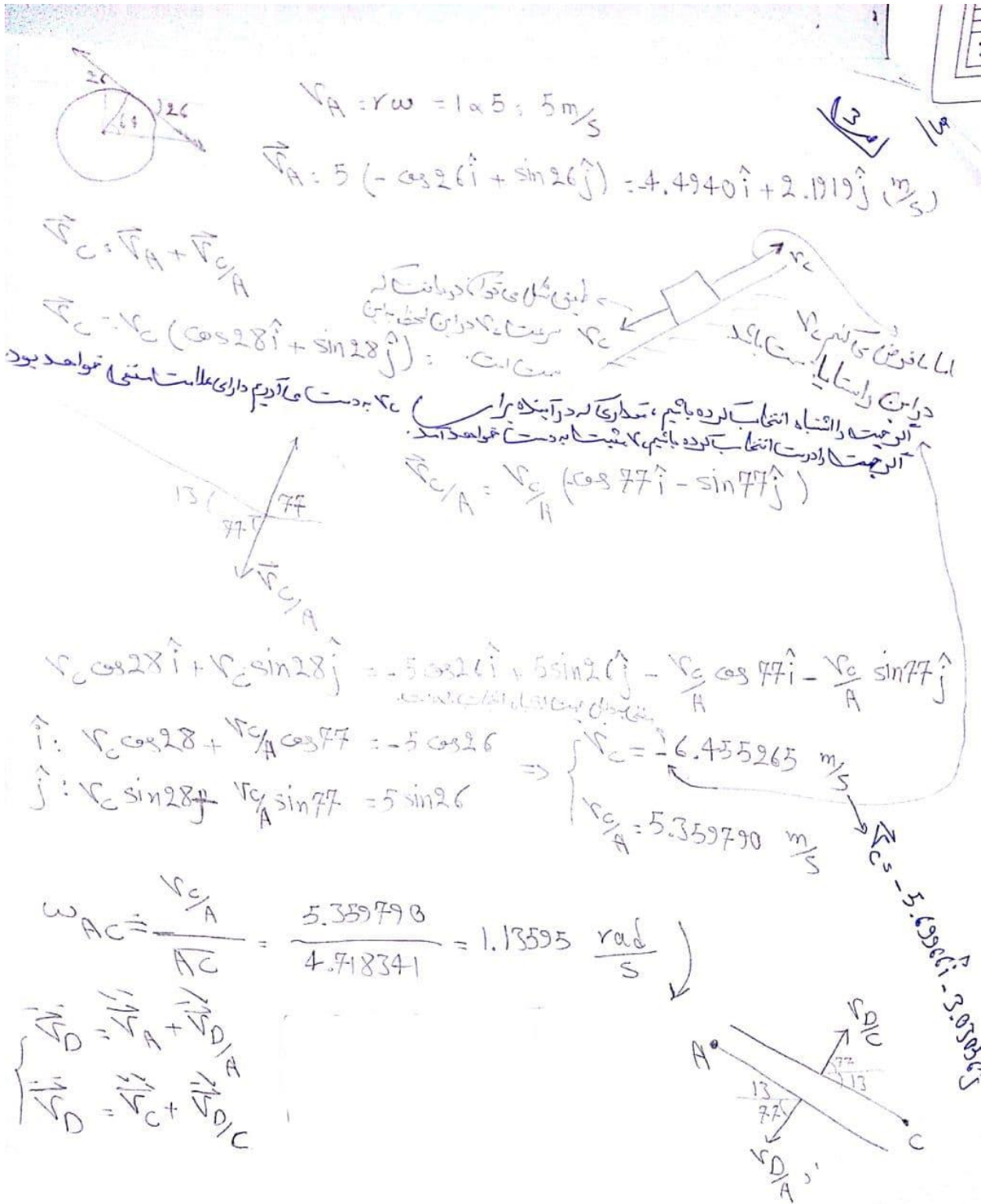
$$\vec{v}_C = 4.4597 \cos 50^\circ \hat{i} + 4.4597 \sin 50^\circ \hat{j} - (0.12664 \cos 81^\circ \hat{i} + 0.12664 \sin 81^\circ \hat{j})$$

$$= 2.8468 \hat{i} + 3.292 \hat{j}$$



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$v_A = r\omega = 1 \times 5 = 5 \text{ m/s}$
 $\vec{v}_A = 5(-\cos 26^\circ \hat{i} + \sin 26^\circ \hat{j}) = -4.4940 \hat{i} + 2.1919 \hat{j} \text{ (m/s)}$

$\vec{v}_C = \vec{v}_A + \vec{v}_{C/A}$
 $\vec{v}_C = v_C(\cos 28^\circ \hat{i} + \sin 28^\circ \hat{j})$

$\vec{v}_{C/A} = \frac{v_C}{H}(\cos 77^\circ \hat{i} - \sin 77^\circ \hat{j})$

$v_C \cos 28^\circ \hat{i} + v_C \sin 28^\circ \hat{j} = -5 \cos 26^\circ \hat{i} + 5 \sin 26^\circ \hat{j} - \frac{v_C}{H} \cos 77^\circ \hat{i} - \frac{v_C}{H} \sin 77^\circ \hat{j}$

$\hat{i}: v_C \cos 28^\circ + \frac{v_C}{H} \cos 77^\circ = -5 \cos 26^\circ$
 $\hat{j}: v_C \sin 28^\circ - \frac{v_C}{H} \sin 77^\circ = 5 \sin 26^\circ$

$\Rightarrow \begin{cases} v_C = -6.455265 \text{ m/s} \\ v_{C/A} = 5.359790 \text{ m/s} \end{cases}$

$\omega_{AC} = \frac{v_{C/A}}{AC} = \frac{5.359790}{4.718341} = 1.13595 \text{ rad/s}$

$\vec{v}_D = \vec{v}_A + \vec{v}_{D/A}$
 $\vec{v}_D = \vec{v}_C + \vec{v}_{D/C}$

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$$\vec{v}_{D/A} = \overline{AD} \omega_{AC} = 2.325729 \times 1.13595 = 2.641912 \text{ m/s}$$

$$\vec{v}_{D/A} = 2.641912 (-\cos 77^\circ \hat{i} - \sin 77^\circ \hat{j}) = -0.5943 \hat{i} - 2.5742 \hat{j}$$

$$\vec{v}_D = (-5 \cos 26^\circ \hat{i} + 5 \sin 26^\circ \hat{j}) + (-0.5943 \hat{i} - 2.5742 \hat{j}) = -5.0883 \hat{i} - 0.3823 \hat{j}$$
 or

$$\vec{v}_{D/C} = 2.392612 \times 1.13595 = 2.7179 \text{ m/s}$$

$$\vec{v}_{D/C} = 2.7179 (\cos 77^\circ \hat{i} + \sin 77^\circ \hat{j}) = 0.6114 \hat{i} + 2.6482 \hat{j} \text{ m/s}$$

$$\vec{v}_D = -6.455265 (\cos 28^\circ \hat{i} + \sin 28^\circ \hat{j}) + (0.6114 \hat{i} + 2.6482 \hat{j}) = -5.0883 \hat{i} - 0.3823 \hat{j}$$

$$\vec{v}_B = \vec{v}_D + \vec{v}_{B/D}$$

$$\vec{v}_B = v_B (\cos 13^\circ \hat{i} + \sin 13^\circ \hat{j})$$

$$\vec{v}_{B/D} = v_{B/D} (-\cos 17^\circ \hat{i} - \sin 17^\circ \hat{j})$$

$$-v_B \cos 13^\circ \hat{i} + v_B \sin 13^\circ \hat{j} = -5.0883 \hat{i} - 0.3823 \hat{j} - v_{B/D} \cos 17^\circ \hat{i} - v_{B/D} \sin 17^\circ \hat{j}$$

$$\hat{i} \left\{ \begin{array}{l} v_B \cos 13 - v_{B/D} \cos 17 = 5.0883 \\ v_B \sin 13 - v_{B/D} \sin 17 = -0.3823 \end{array} \right. \Rightarrow \left\{ \begin{array}{l} v_B = 2.24 \text{ m/s} \\ v_{B/D} = -3.03424 \text{ m/s} \end{array} \right.$$

$$\vec{v}_B = 3.026 (-\cos(17^\circ) \hat{i} + \sin(17^\circ) \hat{j}) = -2.894 \hat{i} + 0.885 \hat{j}$$

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$\vec{A}_C = \vec{A}_A + \vec{A}_{C/A}$
 $\vec{A}_C = (\vec{A}_t)_C + (\vec{A}_n)_C = [(\vec{A}_t)_A + (\vec{A}_n)_A] + [(\vec{A}_t)_{C/A} + (\vec{A}_n)_{C/A}]$

$(A_n)_C = \frac{v_C^2}{R} = 0$, $(\vec{A}_t)_C = (A_t)_C [-\cos 28^\circ \hat{i} - \sin 28^\circ \hat{j}]$

$(A_t)_A = r\alpha = 1 \times 10 = 10 \frac{m}{s^2} \Rightarrow (\vec{A}_t)_A = (A_t)_A [-\cos 26^\circ \hat{i} + \sin 26^\circ \hat{j}] = 10 [-\cos 26^\circ \hat{i} + \sin 26^\circ \hat{j}]$

$(A_n)_A = \frac{v_A^2}{r} = \frac{5^2}{1} = 25 \frac{m}{s^2} \Rightarrow (\vec{A}_n)_A = (A_n)_A [-\cos 64^\circ \hat{i} - \sin 64^\circ \hat{j}] = 25 [-\cos 64^\circ \hat{i} - \sin 64^\circ \hat{j}]$

$(\vec{A}_t)_{C/A} = (A_t)_{C/A} [\cos 77^\circ \hat{i} + \sin 77^\circ \hat{j}]$

$(A_n)_{C/A} = \frac{v_{C/A}^2}{R_C} = \frac{5.3597^2}{4.718341} = 6.0884 \frac{m}{s^2}$

$(\vec{A}_n)_{C/A} = 6.0884 [-\cos 13^\circ \hat{i} + \sin 13^\circ \hat{j}]$

$-(A_t)_C \cos 28^\circ \hat{i} - (A_t)_C \sin 28^\circ \hat{j} = -10 \cos 26^\circ \hat{i} + 10 \sin 26^\circ \hat{j} - 25 \cos 64^\circ \hat{i} - 25 \sin 64^\circ \hat{j}$


$+ (\vec{A}_t)_{C/A} \cos 77^\circ \hat{i} + (\vec{A}_t)_{C/A} \sin 77^\circ \hat{j} - 6.0884 \cos 13^\circ \hat{i} + 6.0884 \sin 13^\circ \hat{j}$

$\hat{i}: (A_t)_C \cos 28 + (\vec{A}_t)_{C/A} \cos 77 = +10 \cos 26 + 25 \cos 64 + 6.0884 \cos 13$

$\hat{j}: (A_t)_C \sin 28 + (\vec{A}_t)_{C/A} \sin 77 = -10 \sin 26 + 25 \sin 64 - 6.0884 \sin 13$

$(A_t)_C = 28.4293 \frac{m}{s^2}$, $(\vec{A}_t)_{C/A} = 3.4584 \frac{m}{s^2}$

$\alpha_{AC} = \frac{(\vec{A}_t)_{C/A}}{R_C} = \frac{3.4584}{4.718341} = 0.7330 \frac{rad}{s^2}$

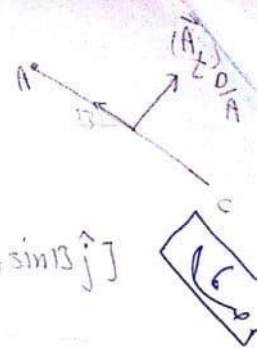


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$$(\vec{A}_t)_{D/A} = \overline{AD} \alpha = \frac{(+.71834 - 2.392612)}{2.325729} \times 0.7330 = 1.7048 \frac{m}{s^2}$$

$$(\vec{A}_t)_{D/A} = (\vec{A}_t)_{D/C} [\cos 77^\circ \hat{i} + \sin 77^\circ \hat{j}] = 1.7048 [\cos 77^\circ \hat{i} + \sin 77^\circ \hat{j}]$$

$$(\vec{A}_n)_{D/A} = \frac{v_{D/A}^2}{AD} = \frac{2.641912^2}{2.325729} = 3.001 \Rightarrow (\vec{A}_n)_{D/A} = 3.001 [-\cos 13^\circ \hat{i} + \sin 13^\circ \hat{j}]$$



$$(\vec{A}_t)_{D/C} = \overline{DC} \alpha = 2.392612 \times 0.733 = 1.7538 \frac{m}{s^2}$$

$$(\vec{A}_t)_{D/C} = (\vec{A}_t)_{D/C} [-\cos 77^\circ \hat{i} - \sin 77^\circ \hat{j}] = 1.7538 [-\cos 77^\circ \hat{i} - \sin 77^\circ \hat{j}]$$

$$(\vec{A}_n)_{D/C} = \frac{v_{D/C}^2}{DC} = \frac{2.717^2}{2.322612} = 3.0874 \frac{m}{s^2} \Rightarrow (\vec{A}_n)_{D/C} = 3.0874 [\cos 85^\circ \hat{i} - \sin 13^\circ \hat{j}] \frac{m}{s^2}$$

$$\text{[I]} \vec{A}_D = \vec{A}_A + \vec{A}_{D/A} = [(\vec{A}_n)_A + (\vec{A}_t)_A] + [(\vec{A}_n)_{D/A} + (\vec{A}_t)_{D/A}]$$

$$= [(-25 \cos 64^\circ \hat{i} - 25 \sin 64^\circ \hat{j}) + (-10 \cos 26^\circ + 10 \sin 26^\circ \hat{j})]$$

$$+ [(-3.001 \cos 13^\circ \hat{i} + 3.001 \sin 13^\circ \hat{j}) + (1.7048 \cos 77^\circ \hat{i} + 1.7048 \sin 77^\circ \hat{j})]$$

$$= -22.4878 \hat{i} - 15.7501 \hat{j}$$

$$\text{[2]} \vec{A}_D = \vec{A}_C + \vec{A}_{D/C} = [(\vec{A}_n)_C + (\vec{A}_t)_C] + [(\vec{A}_n)_{D/C} + (\vec{A}_t)_{D/C}]$$

$$= [0] + (-28.4293 \cos 28^\circ \hat{i} - 28.4293 \sin 28^\circ \hat{j})$$

$$+ [(3.0874 \cos 85^\circ \hat{i} - 3.0874 \sin 13^\circ \hat{j}) + (-1.7538 \cos 77^\circ \hat{i} - 1.7538 \sin 77^\circ \hat{j})]$$

$$= -22.4878 \hat{i} - 15.7501 \hat{j}$$

$$A_D = \sqrt{(-22.4878)^2 + (-15.7501)^2} = 27.45481376 \frac{m}{s^2}$$

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$$\vec{A}_B = (\vec{A}_D) + (\vec{A}_{B/D}) = (\vec{A}_D) + [(\vec{A}_n)_{B/D} + (\vec{A}_t)_{B/D}] = (\vec{A}_n)_B + (\vec{A}_t)_B$$

$$(A_n)_{B/D} = \frac{(v_{B/D})^2}{BD} = \frac{3.034^2}{2.305759} = 3.9933 \text{ m/s}^2$$

$$(\vec{A}_n)_{B/D} = (A_n)_{B/D} [-\cos 73^\circ \hat{i} + \sin 73^\circ \hat{j}] = 3.9933 [-\cos 73^\circ \hat{i} + \sin 73^\circ \hat{j}] \text{ m/s}^2$$

$$(\vec{A}_t)_{B/D} = (A_t)_{B/D} [-\cos 17^\circ \hat{i} - \sin 17^\circ \hat{j}]$$

$$(A_n)_B = \frac{v_B^2}{\infty} = 0$$

$$(\vec{A}_t)_B = (A_t)_B [-\cos 13^\circ \hat{i} + \sin 13^\circ \hat{j}]$$

$$0 + (A_t)_B [-\cos 13^\circ \hat{i} + \sin 13^\circ \hat{j}] = -22.4878 \hat{i} - 15.7501 \hat{j}$$

$$+ [(-3.9933 \cos 73^\circ \hat{i} + 3.9933 \sin 73^\circ \hat{j}) + [(A_t)_{B/D} \cos 17^\circ \hat{i} - (A_t)_{B/D} \sin 17^\circ \hat{j}]]$$

$$\hat{i} \left\{ -(A_t)_B \cos 13^\circ + (A_t)_{B/D} \cos 17^\circ = -22.4878 - 3.9933 \cos 73^\circ \right.$$

$$\hat{j} \left\{ (A_t)_B \sin 13^\circ + (A_t)_{B/D} \sin 17^\circ = -15.7501 + 3.9933 \sin 73^\circ \right.$$

این معادله‌ها را برای انتخاب جهت‌ها و علامت‌ها استفاده کنید.

$$(A_t)_B = -8.9876 \text{ m/s}^2 \Rightarrow (\vec{A}_D)_B = -8.9876 [-\cos 13^\circ \hat{i} + \sin 13^\circ \hat{j}] = \vec{A}_B$$

$$(A_t)_{B/D} = 33.8936 \text{ m/s}^2 \Rightarrow \alpha_{BD} = \frac{(A_t)_{B/D}}{BD} = \frac{-33.8936}{2.305759} = -14.69954$$

$$\Rightarrow (\vec{A}_t)_{B/D} = -33.8936 [-\cos 17^\circ \hat{i} - \sin 17^\circ \hat{j}]$$

