$$A_A = a\alpha_2(\underbrace{i\cos\theta_2 + j\sin\theta_2}_{A_A^t}) - a\omega_2^2(\underbrace{\cos\theta_2 + j\sin\theta_2}_{A_A^t})$$

Example (Ch. 7, Slide 21)

$A = 8\sin 16.5° = 2.271$

$B = 6\sin(-53.1°) = -4.8$

$C = 10(-10)\sin(45°) + 10(-5)\cos(45°) + 6(-4.2\times3)^2\cos(-53.1°) \cdots$
$\cdots - (8)(-6.6)^2\cos(16.5°) = -163.29$

$D = 8\cos(16.5°) = 7.671$

$E = 6\cos(-53.1°) = 3.6$

$F = 10(-10)\cos(45°) - 10(-5)^2\sin(45°) - 6(-4.243)^2\sin(53.1) \cdots$
$\cdots + 8(6.6)^2\sin(16.5°) = 62.145$

$$\alpha_3 = \frac{(-163.29)(7.671) - (2.271)(-62.145)}{(2.271)(3.6) - (-4.8)(7.671)} = -24.7 \text{ rad/s}^2 \text{ (cw)}$$

$$\alpha_4 = \frac{(-163.29)(3.6) - (-4.8)(-62.145)}{(2.271)(3.6) - (-4.8)(7.671)} = -19.7 \text{ rad/s}^2 \text{ (cw)}$$

$\hat{A}_S = \hat{A}_S^t + \hat{A}_S^n = js\alpha_2 e^{j(\theta_2+\delta_2)} - s\omega_2^2 e^{j(\theta_2+\delta_2)}$

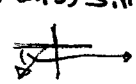
$\hat{A}_P = \hat{A}_A + \hat{A}_{PA} = \hat{A}_A^t + \hat{A}_A^n + \hat{A}_{PA}^t + \hat{A}_{PA}^n$

$\hat{A}_A^t = ja\alpha_2 e^{j\theta_2} = j10(-10)\cos 45° - 10(-10)\sin(45°) = -j70.7 + 70.7$

$\hat{A}_A^n = -a\omega_2 e^{j\theta_2} = -10(-5)^2\cos 45° - j10(-5)^2\sin(45°) = 176.76 - j176.75$

$\hat{A}_{PA}^t = jp\alpha_3 e^{j(\theta_3+\delta_3)} = j10(-24.7)\cos(-53.1+80°) - 10(-24.7)\sin(-53.1+80°)$
$= -j220.3 + 111.75$

$\hat{A}_{PA}^n = -p\omega_3 e^{j(\theta_3+\delta_3)}$
$= (-10)(-4.243)^2\cos(-53.1°+80°) - j(10)(-4.243)^2\sin(-53.1°+80°) = -160.6 - j81.45$

$\hat{A}_P = -154.9 - j549.2 \text{ cm/s}^2$ ←  → this is the angle we're finding

$|\hat{A}_P| = 570.6 \text{ cm/s}^2$ (because it's in the third quadrant)

$\theta = \tan^{-1}\left(\frac{549.2}{-154.9}\right) = 180° + 74.2° = 254.2°$

Given : $a, b, c, \theta_2, \omega_2, \alpha_2$ (slide 24)

Position analysis : θ_3, d

Velocity analysis : $\omega_3, \dot{d}$

$$\hat{A}_A = \hat{A}_B + \hat{A}_{AB} = \hat{A}_B + \hat{A}^t_{BA} + \hat{A}^n_{BA}$$

$$\alpha_3 = \frac{2(5)\cos(60^\circ) - (2)(-2)^2\sin(60^\circ) + 6(0.542)^2\sin(127.9^\circ)}{(6)\cos(127.9^\circ)}$$

$$= 0.146 \text{ rad/s}^2 \quad (\text{ccw})$$

$$\ddot{d} = -2(5)\sin(60^\circ) - 2(-2)^2\cos 60^\circ + 6(0.146)\sin(127.9^\circ) \cdots$$

$$\cdots + 6(0.542)^2\cos(127.9^\circ) = -13.05 \text{ cm/s}^2$$

Coriolis Acceleration : (slide 26)

$$\hat{R}_P = p\, e^{j\theta_2}$$

$$\hat{V}_P = \frac{d\hat{R}_P}{dt} = \frac{dp}{dt} e^{j\theta_2} + p j \frac{d\theta_2}{dt} e^{j\theta_2}$$

$$= \dot{p} e^{j\theta_2} + j p \omega_2 e^{j\theta_2} = \hat{V}_{P_{slip}} + \hat{V}_{P_{trans}}$$

$$\hat{A}_P = \frac{d\hat{V}_P}{dt} = \ddot{p} e^{j\theta_2} + \dot{p} j \omega_2 e^{j\theta_2} + j\omega_2 e^{j\theta_2} + j p \alpha_2 e^{j\theta_2} + j p \omega_2 j \omega_2 e^{j\theta_2}$$

$$= \ddot{p} e^{j\theta_2} + 2j\dot{p}\omega_2 e^{j\theta_2} + j p \alpha_2 e^{j\theta_2} - p\omega_2^2 e^{j\theta_2}$$

$$= \hat{A}_{P,slip} + \hat{A}_{P,coriolis} + \hat{A}^t_P + \hat{A}^n_P$$

$$\hat{A}_{P,slip} = \ddot{p} e^{j\theta_2}$$

$$\hat{A}_{P,coriolis} = 2j\dot{p}\omega_2 e^{j\theta_2} = 2\dot{p}\omega_2 e^{j(\theta_2 + 90^\circ)}$$

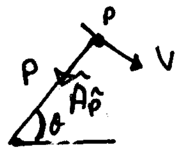
Project : 1st input : From table

2nd input : From table (in degrees)

DOM

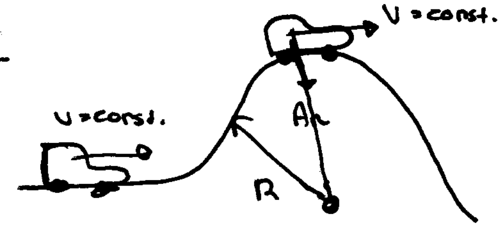
① MAR. 6/19

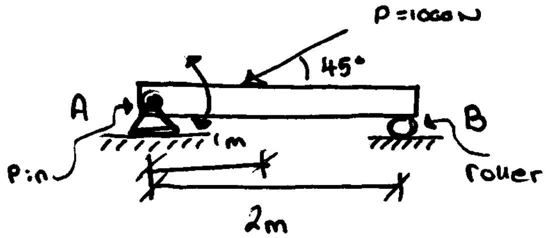
$\hat{A}_p^n = -\rho\left(\frac{V}{\rho}\right)^2 e^{j\theta}$



$\hat{A}_p = A_p^n + A_p^t$

$= j\rho\alpha e^{j\theta} - \rho\omega^2 e^{j\theta}$





1) FBD

2) Apply ... etc.

(statics review material)

2 Objects { Particles (no size) – a point
bodies

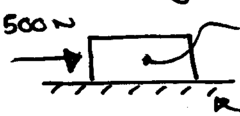
$\sum F = ma$
$\sum M = I_G\alpha$ } Special cases :

Translational motion:
$\sum F = ma$
$\sum M_G = 0$

Pure rotation:
$\sum F = ma_G$
$\sum M_o = I_o\alpha$

① Forward dynamic problem:

P = 500 N, m = 50 kg, (a = ?)

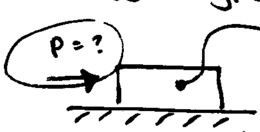


friction coefficient $\mu = 0.1$

(kinetostatic problem)

② Inverse dynamic problem:

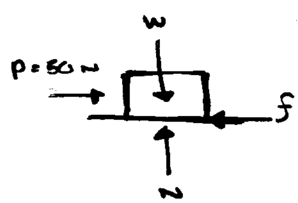
(P = ?), m = 50 kg



a = 5 m/s

friction coefficient $\mu = 0.1$

1) FBD



① : $a = \frac{P - f}{m}$

$a = 9.02$ m/s²

② $N = W$

$f = \mu N = 9.02$ m/s²

Centre of gravity of composite bodies :

$$\overline{X} = \frac{m_A \overline{X}_A + m_B \overline{X}_B}{m_A + m_B}$$

$$\overline{Y} = \frac{m_A \overline{Y}_A + m_B \overline{Y}_B}{m_A + m_B}$$