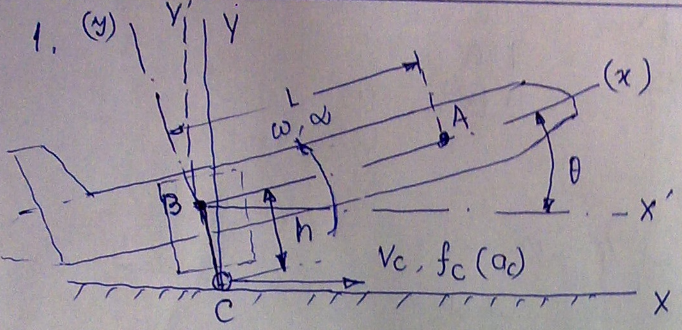
Solution of Problems set for class-test - I on DYNAMICS for 3rd Semester Mechanical, 2011 of I.I.T., Bhubaneswar

1. 

Data Given:

Velocity of C = $V_C \rightarrow$

Acc^n of C = $a_C \rightarrow$

Pitch rate = $\omega = \dot{\theta} k = (\Omega)$

Pitch acc^n = $\alpha = \dot{\omega} k = (\dot{\Omega})$

$[V_A]_{xBy} = v_{rel} = (\dot{L}) i$

$[f_A]_{xBy} = a_{rel} = (\ddot{L}) i$

A is the person moving along BA $\rightarrow$ with V_{rel} & a_{rel}.

To find: $V_A = [V_A]_{XCY}$?

$f_A = [f_A]_{XCY}$?

Since $V_A = [V_A]_{XCY} = \bar{V}_B + \bar{V}_{A/B} = \bar{V}_B + [(\bar{V}_{A/B})_{xby} + (\bar{\Omega} \times \bar{r}_{A/B})]$

$= (\bar{V}_C + \bar{V}_{B/C}) + [(\bar{V}_{A/B})_{xby} + (\dot{\theta} \times \bar{r}_{A/B})] = [(V_C \cos\theta) i + (V_C \sin\theta)(-j)]$

$+ [\dot{\theta} k \times h j] + (\dot{L}) i + [\dot{\theta} k \times L i] = (V_C \cos\theta) i + (V_C \sin\theta)(-j) + (\dot{\theta} h)(-i)$

$+ (\dot{L}) i + (\dot{\theta} L) j = [(V_C \cos\theta - \omega h + \dot{L}) i + (\omega L - V_C \sin\theta) j]$

So $|V_A| = \sqrt{(V_C \cos\theta - \omega h + \dot{L})^2 + (\omega L - V_C \sin\theta)^2}$ **Ans**.

Similarly: $f_A = \bar{f}_B + \bar{f}_{A/B} = \bar{f}_C + \bar{f}_{B/C} + (\dot{\omega} \times r_{A/B}) + \omega \times (\omega \times r_{A/B}) + (\ddot{r}_{A/B})_{xby} + 2\omega \times (\dot{r}_{A/B})_{xby}$

$= [(a_C \cos\theta) i + (a_C \sin\theta)(-j)] + [(\alpha)(k) \times (h)(j)] + [(\omega) k \times (\omega k \times h j)]$

$+ [(\alpha) k \times (L) i] + [(\omega) k \times (\omega k \times L i)] + (\ddot{L}) i + [2 (\omega) k \times (\dot{L}) i]$

$= (a_C \cos\theta) i + (a_C \sin\theta)(-j) + (\alpha h)(-i) + (\omega^2 h)(-j)$

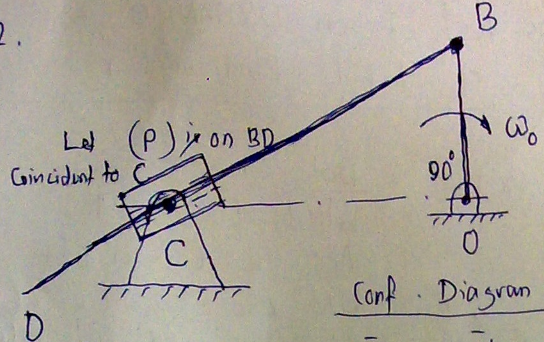
$+ (\alpha L) j + (\omega^2 L)(-i) + (\ddot{L}) i + (2\omega\dot{L})(j)$

$= (a_C \cos\theta - \alpha h - \omega^2 L + \ddot{L}) i + (-a_C \sin\theta - \omega^2 h + \alpha L + 2\omega\dot{L}) j$

So $|f_A| = \sqrt{(a_C \cos\theta - \alpha h - \omega^2 L + \ddot{L})^2 + (-a_C \sin\theta - \omega^2 h + \alpha L + 2\omega\dot{L})^2}$ **Ans**

(P.T.O.)

2.



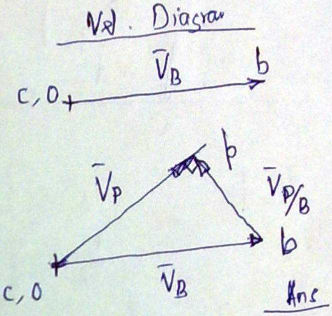
Data Given:

OB = 250 mm | $\omega_0 = 5$ rad/sec (C.W.)
OC = 600 mm
∠BOC = 90°

To find: (1) $\omega_{BD} = ?$
(2) $\alpha_{BD} = ?$

For velocity → $\bar{V}_{P/C} = \bar{V}_{B/O} + \bar{V}_{P/B}$

	$\bar{V}_{P/C}$	$\bar{V}_{B/O}$	$\bar{V}_{P/B}$
Mag	?	$(\omega_0 \times BO)$	?
Dir	// to BD	⊥r to BO	⊥r to BD
Sense	?	C.W.	?



$$\omega_{BD} = \omega_{BP} = \left[\frac{\bar{bp} \times \text{Scale}}{BP}\right] \text{ rad/sec}$$

(C.W.) w.r. to B

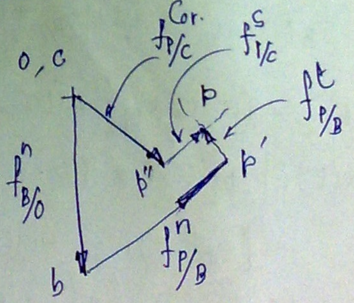
Ans

For acc^n. → $\bar{f}_{P/C} = \bar{f}_{B/O} + \bar{f}_{P/B} = \bar{f}^n_B + \bar{f}^t_B + \bar{f}^n_{P/B} + \bar{f}^t_{P/B}$

$$f^S_{P/C} + f^{Cor}_{P/C} = f^n_{B/O} + 0 + \bar{f}^n_{P/B} + f^t_{P/B}$$

	$f^S_{P/C}$	$f^{Cor}_{P/C}$	$f^n_{B/O}$	$f^n_{P/B}$	$f^t_{P/B}$
Mag	?	$2\,\omega_{BD} \cdot V_{P/C}$	$\omega_0^2 \times OB$	$\omega_{BD}^2 \times BP$	?
Dir	// to BD	⊥r to BD	// to BO	// to BD	⊥r to BD
Sense	?	C.W	fr. B to O	fr. P to B	?

Acc^n. Diagram:



$$\alpha_{BD} = \frac{f^t_{P/B}}{PB} = \frac{\bar{b'p} \times \text{Scale}}{PB} = 6.25 \text{ rad/sec}^2 \text{ (C.W. about B)}$$

Ans