## Common errors on Prelim II

### Problem 1

I) FBDs

A) system of cart + robot

1) The complete FBD should include gravitational forces and normal forces @ wheels of the cart.

2) Inertial forces (e.g. $m\underline{a}$) and internal forces (e.g. forces @ wheels of the robot) do not belong on the FBD.

B) robot

1) If you put 3 forces @ each wheel, you must say that $A_y = C_y = B_x = 0$.

2) Saying $A_x = C_x = B_y = 0$ is an entirely different problem.

3) The friction force at wheel B is not $\mu N$ (no motion relative to cart).

4) Again, inertial forces do not belong on the FBD.

5) The force F is not applied directly to the robot and shouldn't be on the FBD.

II) LMB of system

A) $\Sigma \underline{F} = \dot{\underline{L}} = m\underline{a}$ where $m = m_{TOTAL} = 2m$, not just m

B) F is the only force acting in the $\hat{\jmath}$-direction. (no friction @ wheels of the cart)

C) $\underline{a}$ has no component in the $\hat{\imath}$ OR $\hat{k}$-direction

III. AMB/axis BC - MANY problems here

A) There were many errors in finding moment arms by geometry. ← UNNECESSARY

B) AMB/axis BC : $\{\Sigma \underline{M}_{/B} = \dot{\underline{H}}_{/B}\} \cdot \hat{\lambda}_{BC}$ (B or C)

NOT $\{\Sigma \underline{M}_{/BC} = \dot{\underline{H}}_{/BC}\} \cdot \hat{\imath}$ or $\hat{\jmath}$ or $\hat{k}$

This means nothing!

C) $\underline{H}$ ← not always $\underline{0}$! - You don't need to have a rotating body to have angular momentum about a pt.



Comments:

1) FBD wasn't drawn at all. Draw FBDs whenever you are using LMB or AMB.

2) when using $\Sigma\vec{F} = m\vec{a}$ for a rigid body, it is $\Sigma\vec{F} = m_{total}\,\vec{a}_{cm}$ so when you apply it to the disc $\vec{a}_{cm} = 0$ (since it is not translating)

3) The moment of $\vec{F}$ about the CM of the disc is just $F\sin 30° \cdot R\,\hat{k}$. It is independent of $\phi$, even though you have used the routine $\vec{r}\times\vec{F}$ the net expression can be finally reduced using $\sin(A+B) = \sin A\cos B + \cos A \sin B$. (anyway it is not a mistake if you get to the final step).

4) In the FBD, specify clearly which FBD are you drawing. When you draw the combined FBD of the mass and coin and disc, don't show the internal forces like friction.

5) Friction doesn't gives $\mu N\,\hat{e}_r$ & $\mu N\,\hat{e}_\theta$ components. It acts in a direction so that it provides for the net acceleration of the coin, so friction acts in say $\hat{\lambda}$ direction, then $\mu N\,\hat{\lambda}$ = direction of net acceleration

6) It would be nice to show what quantities you are neglecting.



Question 3:

Common mistakes:

1. Many students treat the angular velocity of the cone $\vec{\omega}_{cone}$ as same as the plate one $\vec{\omega}$, which is wrong. They're not same of the magnitude neither the direction. (Since it's not a rigid body, $\vec{\omega}$ of two parts are different

2. When representing the $\vec{\omega}_{cone}$ with $\vec{e}_r, \vec{e}_\theta$ some students fail to express $\vec{e}_r$ correctly. some sign errors. So be careful for the geometry

3. The final answer is not easy to follow. You should simplify it as possible as you can. Say, merge the terms like $\sin^2\theta + \cos^2\theta \longrightarrow 1$.