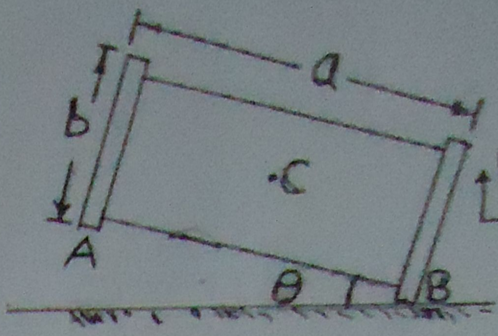
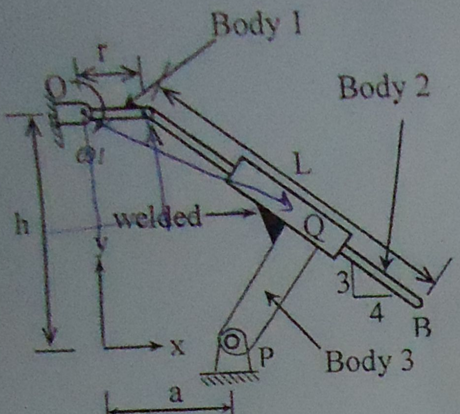
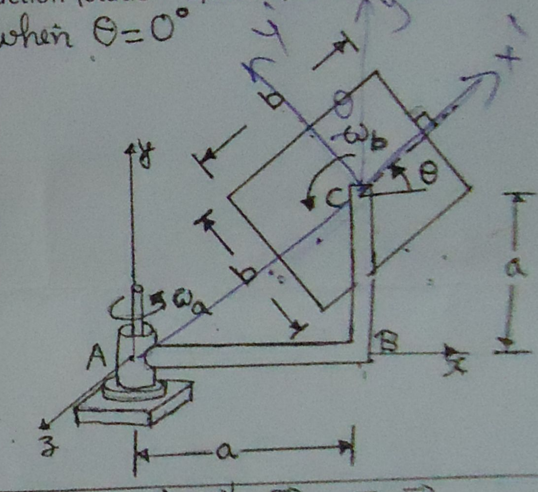
PART B

1. **(30 points)** Member OA rotates with constant angular velocity of $\omega_1 = 2$ rad/s when in position shown in the figure below. Find the (a) angular velocity of body 3, (b) angular acceleration of body 3. h= 14cm, a=6 cm, r=4cm, L=20 cm.





3. **(50 points)** A thin square plate (length of its sides = b) of mass m_b rotates with constant angular velocity ω_b with respect to an L-shaped arm ABC (angle ABC = 90^o, length AB= a, length BC = a), which has mass m_a and rotates with a constant angular velocity ω_a about the y axis. Determine the force-couple system representing the full reaction (static + dynamic) at the support A when $\theta = 0^\circ$



2. **(40 points)** A uniformly loaded cuboidal crate is released from rest in the position shown in the figure below. The floor is sufficiently rough to prevent slipping and the impact at A is perfectly plastic.
   (a) Find the largest value of the ratio of k/a for which the edge B will remain in contact with the floor.
   (b) If this ratio is exceeded, find the angle through which the crate will rotate after A strikes the floor. $k_{zz}^{B} = k_{zz}^{A} = k$

k is the radius of gyration $\Rightarrow I_{33}^{A} = m k_{33}^{2}$

POSSIBLY USEFUL FORMULAE

$\vec{v}_{P/F} = \vec{v}_{A/F} + \vec{\omega}_{m/F} \times \vec{AP} + \vec{v}_{P/m}$ $\quad (\vec{AP} = \vec{r}_{PA})$

$\left(\frac{d\vec{A}}{dt}\right)_{/F} = \left(\frac{d\vec{A}}{dt}\right)_{/m} + \vec{\omega}_{m/F} \times \vec{A}$

$\vec{H}_A = I_A \vec{\omega}$

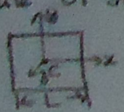
$\vec{a}_{P/F} = \vec{a}_{A/F} + \dot{\vec{\omega}}_{m/F} \times \vec{AP} + \vec{\omega}_{m/F} \times (\vec{\omega}_{m/F} \times \vec{AP}) + 2\vec{\omega}_{m/F} \times \vec{v}_{P/m} + \vec{a}_{P/m}$

$\vec{H}_A = \vec{H}_c + \vec{r}_{CA} \times m\vec{v}_{CA}$

$\vec{v} = \dot{s}\hat{e}_t \; ; \; \vec{a} = \ddot{s}\hat{e}_t + \frac{\dot{s}^2}{\rho}\hat{e}_n \; ; \; \rho = \frac{|1+f'^2|^{3/2}}{|f''|}$ where $y = f(x)$

Moments of inertia about center of mass

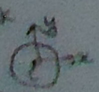
a) Square plate of side L



$I_{xx}^{C} = I_{yy}^{C} = \frac{mL^2}{12}$

$I_{33}^{C} = \frac{mL^2}{6}$

b) Thin Disk



Radius = R

$I_{xx}^{C} = I_{yy}^{C} = \frac{mR^2}{4}$

$I_{33}^{C} = \frac{mR^2}{2}$

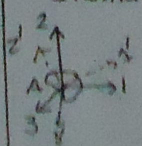
c) Rod

$I_{xx}^{C} = 0$

$I_{yy}^{C} = I_{33}^{C} = \frac{mL^2}{12}$

Length L

Inertia Matrix Transformation



$[I_A'] = R^T [I_A] R$ where

$R_{ij} = \hat{e}_i \cdot \hat{e}_j'$

Euler's Axioms

$\sum \vec{F}^{ext} = m\vec{a}_c$

$\vec{M}_c^{ext} = \dot{\vec{H}}_c$

$\vec{M}_A^{ext} = \dot{\vec{H}}_c + \vec{r}_{CA} \times m\vec{a}_c$

$\vec{M}_A^{ext} - \vec{r}_{CA} \times m\vec{a}_A = \dot{\vec{H}}_A$

All qts w.r.t inertial reference frame