Assembly Kinematics and Dynamics

24-370 - Spring 2011

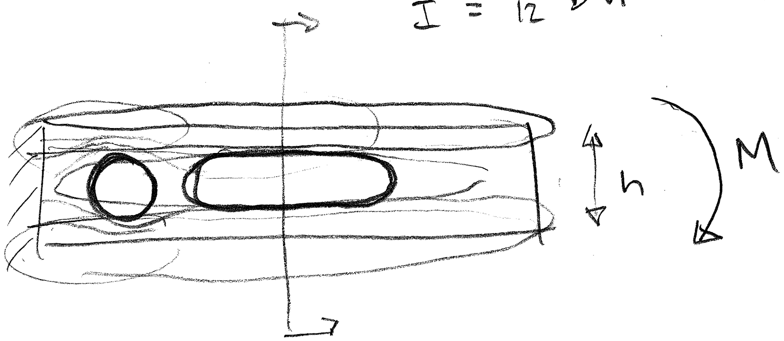
Professor Steve Collins

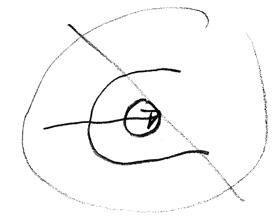
Reminders and Announcements

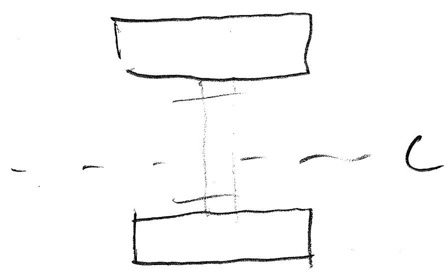
- Graded reports, addenda, and HW3 at front
- HW4 due in folder
- Project 1 Rev 2 Debriefing
  - Thoughts?
  - The good: great progress, great creativity!
  - Still working on: some fundamentals, some details
  - Winner: Bennet Poepping
  - Everyone: great work!
- Project 2 Details

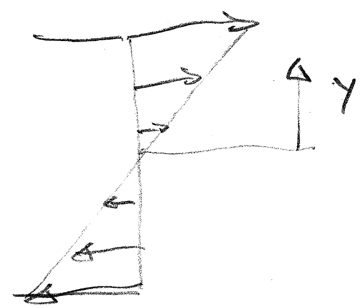
$$I = \frac{1}{12} b h^3$$

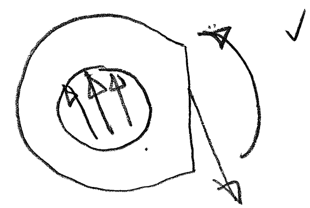
$$\sigma_m = \frac{My}{I}$$





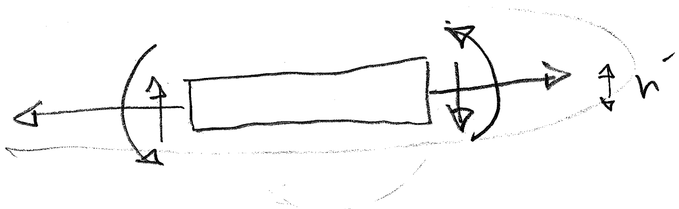






FREE BODY

$$\Sigma F = \Sigma M = 0 \; ?$$

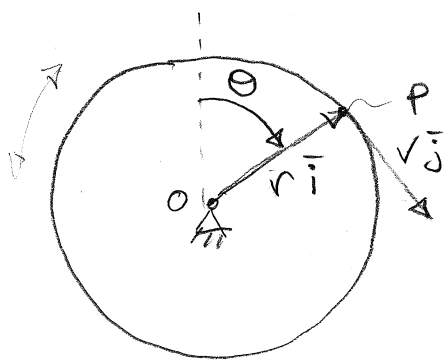


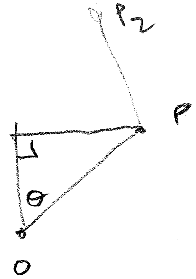
Assembly Kinematics and Dynamics

- Now things have started to move…
  - Where are they?
  - What are they doing?
  - How does this affect the parts?
- Geometry, kinematics, and dynamics
  - Review and synthesis
- Dynamic loading
- Leverage and gearing
- Some common gearing elements

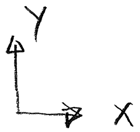
Common Gearing Elements

- Levers
- Gears
- Belts and pulleys
- Cables and capstans
- Linkages





KINEMATICS & DYNAMICS



$$r\bar{i} = r\cdot\sin\theta\cdot\bar{x} + r\cos\theta\,\bar{y}$$

$$\frac{d}{dt}(r\bar{i}) = r\dot{\bar{i}} = r\left(\cos\theta\cdot\dot{\theta}\,\bar{x} - \sin\theta\,\dot{\theta}\,\bar{y}\right) \qquad |r\dot{\bar{i}}| = v = r\cdot\dot{\theta}$$

$$\frac{d^2}{dt^2}(r\bar{i}) = r\ddot{\bar{i}} = r\left(\left(\cos\theta\cdot\ddot{\theta} - \sin\theta\,\dot{\theta}^2\right)\bar{x} + \left(-\sin\theta\,\ddot{\theta} - \cos\theta\,\dot{\theta}^2\right)\bar{y}\right)$$

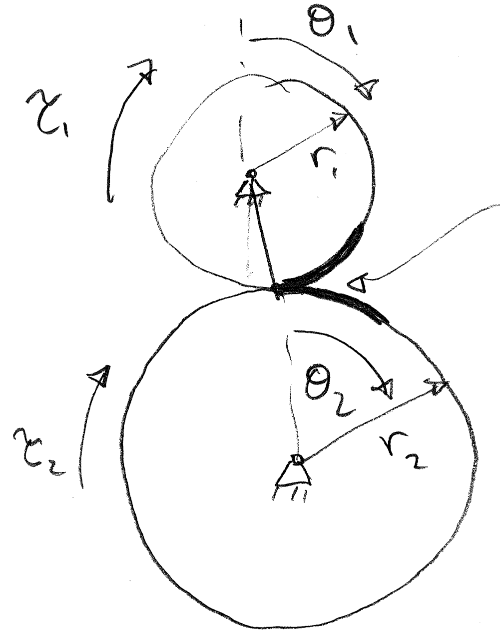
$$|r\ddot{\bar{i}}| = r\left(\ddot{\theta}^2 + \left(\dot{\theta}^2\right)^2\right)^{\frac{1}{2}}$$

① $\dot{\theta} = 0$, $\ddot{\theta} \neq 0$ → $|a| = r\ddot{\theta}$

② $\ddot{\theta} = 0$, $\dot{\theta}$ = CONST. → $|a| = r\dot{\theta}^2 = \frac{v^2}{r}$

$$F_{DYN} = m\cdot a$$

GEARING

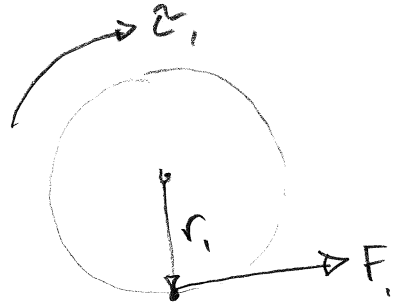


NO SLIPPING

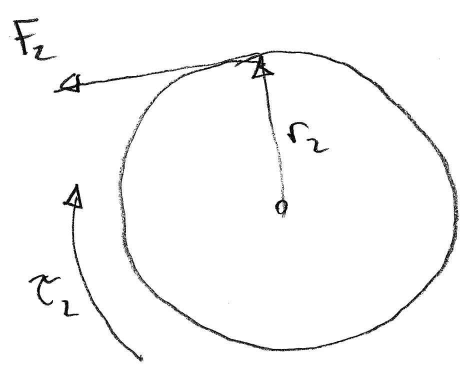
ARC LENGTHS: $l_a = r_1 \theta_1 = r_2 \theta_2$

$$\theta_2 = \frac{r_1}{r_2} \cdot \theta_1$$

$$\dot{\theta}_2 = \frac{r_1}{r_2} \cdot \dot{\theta}_1$$



$$F_1 = \frac{\tau_1}{r_1}$$



$F_2 = F_1$

$$\tau_2 = F_1 \cdot r_2 = \frac{r_2}{r_1} \cdot \tau_1$$