

Midterm

low 68 high 94

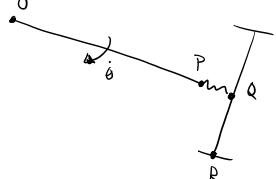
mean 85 median 86

P2 60% correct

P3, P4, P5 80% correct

P1 75% correct

P1



$$\bar{V}_P = \bar{V}_O + \bar{\omega} \times \bar{r}^P \quad \text{Keppler theorem applies to rigid bodies}$$

$$\bar{r}^P = -x \hat{i}$$

$$\bar{V}_Q = \bar{V}_P + \frac{d\bar{r}^P}{dt} \Big|_{\text{initial}} = \bar{V}_P + \frac{d\bar{r}^{QP}}{dt} \Big|_{\text{moving}} + \bar{\omega} \times \bar{r}^P$$

$$\bar{V}_R = \bar{V}_P - \dot{x} \hat{i} - x \dot{\theta} \hat{j}$$

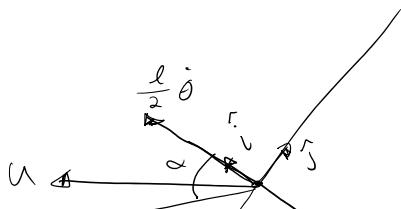
$$\bar{V}_R = \bar{V}_O + \bar{\omega} \times \bar{r}^R \quad \text{+ constant}$$

$$(1) m \ddot{x} + Kx = 0$$

$$(2) m \ddot{\theta} + C \dot{\theta} + C \theta = 0$$

$$M = \begin{bmatrix} I & 0 \\ G & m \end{bmatrix} \quad C = \begin{bmatrix} \frac{C_1 C_{11}}{m} & 0 \\ 0 & 0 \end{bmatrix} \quad K = \begin{bmatrix} \frac{C_1 C_{11}}{m} & 0 \\ 0 & K \end{bmatrix}$$

$$T = \frac{1}{2} m_1 V_{c1}^2 + \frac{1}{2} m_2 V_{c2}^2 + \frac{1}{2} I_1 \dot{\theta}_1^2 + \frac{1}{2} I_2 \dot{\theta}_2^2$$



$$\omega_L = -\dot{\theta} - \frac{(a+b)}{l} \dot{\theta}$$



$$\alpha = -\theta - \phi$$

P3

$$\begin{aligned} F_r + F_\ell &= C_r \alpha_r + C_\ell \alpha_\ell \\ &= C_2 (\alpha_r + \alpha_\ell) \end{aligned}$$

$$F = \underbrace{C_2}_m^2 \alpha$$

$$\underbrace{I_p}_+ \gamma + \underbrace{\cancel{U m h}}_{\gamma} + \underbrace{\left[ k_b - mh \left( g - \frac{u^2}{ac} \right) \right]}_{\gamma} \gamma = 0$$

$U < 0 \Rightarrow$  unstable

$U = 0 \Rightarrow k_b - mh g < 0 \Rightarrow$  unstable

$U > 0 \Rightarrow k_b - mh g + \frac{mh u^2}{ac} < 0$

if  $k_b < mh g$

$$U_{crit} = \sqrt{\left( g - \frac{k_b}{mh} \right) ac}$$

Steady turn

$$S = \underbrace{K \frac{U^2}{R}}_1 + \underbrace{(a+b)}_2 / R$$

$$G_a = \frac{\frac{U^2}{R}}{S} = \frac{U^2}{\underbrace{K U^2 + (a+b)}_2 R}$$

$K = 0$  neutral

$$G_a = \frac{U^2}{a+b}$$

$K > 0$  under shock

Define  $U_{ch}$  so that  $G_{a_{\text{neutral}}} = \frac{G_{a_{\text{under shock}}}}{2}$

$$K U_{ch}^2 = (a+b)$$

$$G_a = \frac{U_{ch}^2}{(a+b)} \left[ \frac{U^2/U_{ch}^2}{1 + U^2/U_{ch}^2} \right]$$

$K < 0$  overshock

$$K U_{crit}^2 = -(a+b)$$

$$G_a = \frac{U_{crit}^2}{a+b} \left[ \frac{U^2/U_{crit}^2}{1 - U^2/U_{crit}^2} \right]$$

