ME 274: Basic Mechanics II – Spring 2024 ***Name*** _____

Final Exam – April 29

Equation sheet

$$\begin{aligned}\vec{v}_P &= \dot{x}\hat{\imath} + \dot{y}\hat{\jmath} \\ &= v_P\hat{e}_t \\ &= \dot{r}\hat{e}_r + r\dot{\theta}\hat{e}_\theta \\ &= \vec{v}_B + \vec{\omega}\times\vec{r}_{P/B} \\ &= \vec{v}_B + \left(\vec{v}_{P/B}\right)_{rel} + \vec{\omega}\times\vec{r}_{P/B} \\ &= \vec{v}_B + \vec{v}_{P/B}\end{aligned}$$

$$\begin{aligned}\vec{a}_P &= \ddot{x}\hat{\imath} + \ddot{y}\hat{\jmath} \\ &= \dot{v}_P\hat{e}_t + \frac{v^2}{\rho}\hat{e}_n \\ &= \left(\ddot{r} - r\dot{\theta}^2\right)\hat{e}_r + \left(r\ddot{\theta} + 2\dot{r}\dot{\theta}\right)\hat{e}_\theta \\ &= \vec{a}_B + \vec{\alpha}\times\vec{r}_{P/B} - \omega^2\vec{r}_{P/B} \\ &= \vec{a}_B + \left(\vec{a}_{P/B}\right)_{rel} + \vec{\alpha}\times\vec{r}_{P/B} + 2\vec{\omega}\times\left(\vec{v}_{P/B}\right)_{rel} + \vec{\omega}\times\left(\vec{\omega}\times\vec{r}_{P/B}\right) \\ &= \vec{a}_B + \vec{a}_{P/B}\end{aligned}$$

$$\sum\vec{F} = m\vec{a}_G$$

$$\sum\vec{M}_A = I_A\vec{\alpha} + m\vec{r}_{G/A}\times\vec{a}_A \quad ; \quad I_A = I_G + md^2$$

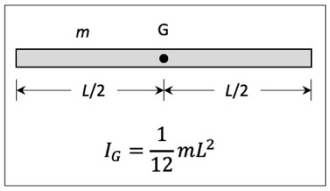
$$T_1 + V_1 + U_{1\to2}^{(nc)} = T_2 + V_2$$

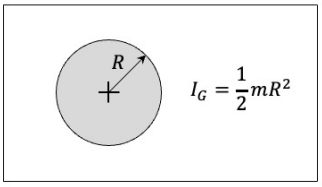
$$T = \frac{1}{2}mv_A^2 + \frac{1}{2}I_A\omega^2 + m\vec{v}_A \bullet (\vec{\omega}\times\vec{r}_{G/A})$$

$$V_{gr} = mgh_G$$

$$V_{sp} = \frac{1}{2}k\Delta^2$$

$$U_{1\to2}^{(nc)} = \int_1^2 (\vec{F}\bullet\hat{e}_t)ds$$





$$\int_1^2 \sum\vec{F}dt = m\vec{v}_{G2} - m\vec{v}_{G1} \quad ; \quad e = -\left[\frac{v_{Bn2} - v_{An2}}{v_{Bn1} - v_{An1}}\right]$$

$$\int_1^2 \vec{M}_A dt = \vec{H}_{A2} - \vec{H}_{A1} \quad ; \quad \vec{H}_A = \vec{r}_{P/A}\times(m\vec{v}_A) \quad ; \quad \vec{H}_A = I_A\vec{\omega}$$

$$M\ddot{x} + C\dot{x} + Kx = F_0 sin\omega t \quad \Rightarrow \quad \ddot{x} + 2\zeta\omega_n\dot{x} + \omega_n^2 x = (F_0\ /\ M)\ sin\omega t$$

$$x_C(t) = e^{-\zeta\omega_n t}(C\ cos\omega_d t + S sin\omega_d t) \quad ; \quad \omega_d = \omega_n\sqrt{1-\zeta^2} \quad [\text{for } 0 \le \zeta < 1\ ]$$

$$x_P(t) = A\ sin\omega t + B\ cos\omega t$$