ME 2580 Dynamics – Equation Sheet #4

Newton's Laws of Motion

$$\sum_i \underset{\sim}{F}_i = m\underset{\sim}{a}_G$$

$$\sum_i (\underset{\sim}{M}_G)_i = \sum_i (\underset{\sim}{r}_i \times \underset{\sim}{F}_i) = I_G \underset{\sim}{\alpha}$$

or

$$\sum_i (\underset{\sim}{M}_P)_i = \sum_i (\underset{\sim}{p}_i \times \underset{\sim}{F}_i) = I_G \underset{\sim}{\alpha} + (\underset{\sim}{r}_{G/P} \times m\underset{\sim}{a}_G)$$

Center of Mass

$$\underset{\sim}{r}_G = \frac{\sum_i m_i \underset{\sim}{r}_i}{\sum_i m_i}$$

Parallel Axis Theorem

$$I_O = I_G + Md^2$$

Radius of Gyration

$$I_A = m\,k_A^2$$

Newton's Laws of Motion: Fixed Axis Rotation

$$\sum_i \underset{\sim}{F}_i = m\underset{\sim}{a}_G = m(r\alpha \underset{\sim}{e}_\theta - r\omega^2 \underset{\sim}{e}_r)$$

$$\sum_i (\underset{\sim}{M}_O)_i = \sum_i (\underset{\sim}{r}_i \times \underset{\sim}{F}_i) = I_O \underset{\sim}{\alpha}$$

Work and Energy Principle

$$KE_1 + U_{1\to 2} = KE_2$$

$$KE = \sum_{bodies} (\tfrac{1}{2} m v_G^2 + \tfrac{1}{2} I_G \omega^2)$$

$$KE = \tfrac{1}{2} I_O \omega^2 \quad \text{(fixed axis rotation)}$$

Work Done by a Force

$$U_F = \int_s F\cos(\theta)\,ds$$

Work Done by a Couple

$$U_M = \int_{\theta_1}^{\theta_2} M\,d\theta$$

Conservation of Energy

$$KE_1 + V_1 = KE_2 + V_2 = \text{constant}$$

$$U_{1\to 2} = V_1 - V_2$$

$$V_{\substack{translational \\ spring}} = \tfrac{1}{2} k e^2$$

$$V_{\substack{rotational \\ spring}} = \tfrac{1}{2} k\theta^2$$

$$V_{gravity} = mgh_G$$