

14 Energy methods for rigid bodies

14.1 Extension to rotations

This lecture doesn't cover any real new material in all honesty. Energy methods for rigid bodies are identical to energy methods for particles and point masses with the only difference being that now rotations are also considered. Thus:

$$T_1 + V_1 + \Sigma U = T_2 + V_2 \quad (1)$$

Where T = Kinetic energy and V = potential energy. The new terms for potential and kinetic energy when considering translations and rotations will be as follows:

$$T = \frac{1}{2}mv^2 + \frac{1}{2}I_G\omega^2 \quad (2)$$

$$V = mgh + \frac{1}{2}ks^2 + \frac{1}{2}k_r\theta^2 \quad (3)$$

$$U = \int_{s_1}^{s_2} F ds + \int_{\theta_1}^{\theta_2} M d\theta \quad (4)$$

Equation (1) in its most general form then becomes:

$$\frac{1}{2}mv_1^2 + \frac{1}{2}I_G\omega_1^2 + mgh_1 + \frac{1}{2}ks_1^2 + \frac{1}{2}k_r\theta_1^2 + \int_{s_1}^{s_2} F ds + \int_{\theta_1}^{\theta_2} M d\theta = \frac{1}{2}mv_2^2 + \frac{1}{2}I_G\omega_2^2 + mgh_2 + \frac{1}{2}ks_2^2 + \frac{1}{2}k_r\theta_2^2 \quad (5)$$