EQUATIONS[1]

Chapter 2

$$\underline{R} = \underline{A} + \underline{B} = \underline{B} + \underline{A}$$
$$\underline{R} = \underline{A} + \underline{B} + \underline{C} = \underline{B} + \underline{C} + \underline{A}$$
$$= \underline{C} + \underline{A} + \underline{B} = \ldots$$
$$A_x = A\cos\theta$$
$$A_y = A\sin\theta$$
$$A = \sqrt{A_x^2 + A_y^2}$$
$$\theta = \tan^{-1}\frac{A_y}{A_x}$$
$$\overline{AB} = (B_x - A_x, B_y - A_y)$$

Chapter 3

$$\text{weight} = mg$$
$$\underline{W} = -(mg)\,\underline{j}$$
$$\underline{F} = (F_x, F_y)$$
$$F_x = F\cos\theta$$
$$F_y = F\sin\theta$$
$$\underline{F} = F_x\,\underline{i} + F_y\,\underline{j}$$

$$\underline{F} = \underline{F}_1 + \underline{F}_2 + \underline{F}_3 + \ldots$$
$$= (F_x, F_y, F_z)$$
$$F_x = F_{1_x} + F_{2_x} + F_{3_x} + \ldots$$
$$F_y = F_{1_y} + F_{2_y} + F_{3_y} + \ldots$$
$$F_z = F_{1_z} + F_{2_z} + F_{3_z} + \ldots$$

$$M = Fd$$
$$= rF\sin\theta$$
$$= [\underline{r} \times \underline{F}]_z$$
$$= r_xF_y - r_yF_x$$
$$\underline{R} = \Sigma\,\underline{F} = \underline{0}$$
$$M_R = \Sigma M = 0$$

or

$$\Sigma F_x = 0$$
$$\Sigma F_y = 0$$
$$\Sigma M_z = 0$$

Chapter 4

$$F_{static} = \mu_{static}F_{normal}$$
$$F_{kinetic} = \mu_{kinetic}F_{normal}$$
$$\mu_{static} = \tan\theta_{static}$$
$$\mu_{kinetic} = \tan\theta_{kinetic}$$
$$\mu_{static} = \frac{F_{x_{maximum}}}{F_y}$$
$$\mu_{kinetic} = \frac{F_x}{F_y}$$

Chapter 5

$$\overline{\text{speed}} = \frac{\text{distance}}{\text{time}}$$

[1] Subscripts *i* and *f* refer to initial and final values of the variable

$$\bar{v} = \frac{\Delta s}{\Delta t} = \frac{s_f - s_i}{\Delta t}$$

$$v = \lim_{\Delta t \to 0} \frac{\Delta s}{\Delta t}$$

$$= \frac{ds}{dt} = \dot{s}$$

$$\bar{v} = \sqrt{\bar{v}_x^2 + \bar{v}_y^2}$$

$$\theta_v = \tan^{-1}\left(\frac{\bar{v}_y}{\bar{v}_x}\right)$$

$$\theta = \frac{s}{r} \text{ radians}$$

$$1 \text{ radian} = \frac{180 \text{ degrees}}{\pi}$$

$$\approx 57.3 \text{ degrees}$$

$$\bar{\omega} = \frac{\theta_f - \theta_i}{\Delta t}$$

$$\omega = \frac{d\theta}{dt} = \dot{\theta}$$

$$\bar{a} = \frac{\Delta v}{\Delta t} = \frac{v_f - v_i}{\Delta t}$$

$$a = \frac{dv}{dt} = \frac{d^2 s}{dt^2}$$

$$= \dot{v} = \ddot{s}$$

$$\bar{\alpha} = \frac{\omega_f - \omega_i}{\Delta t}$$

$$\alpha = \frac{d\omega}{dt} = \frac{d^2\theta}{dt^2} = \dot{\omega} = \ddot{\theta}$$

$$v_f = v_i + at$$

$$s_f = s_i + v_i t + ½at^2$$

$$v_f^2 = v_i^2 + 2a(s_f - s_i)$$

$$s_f = s_i + ½(v_i + v_f)t$$

$$\omega_f = \omega_i + \alpha t$$

$$\theta_f = \theta_i + \omega_i t + ½\alpha t^2$$

$$\omega_f^2 = \omega_i^2 + 2\alpha(\theta_f - \theta_i)$$

$$\theta_f = \theta_i + ½(\omega_i + \omega_j)t$$

$$s_{f_x} = s_{i_x} + v_x t$$

$$v_{f_y} = v_{i_y} - gt$$

$$s_{f_y} = s_{i_y} + v_{i_y} t - ½gt^2$$

$$v_{f_y}^2 = v_{i_y}^2 - 2g(s_{f_y} - s_{i_y})$$

$$s_{f_y} = s_{i_y} + ½(v_{i_y} + v_{f_y})t$$

$$s = r\theta$$

$$s_{circle} = 2\pi r$$

$$v_t = r\omega$$

$$a_t = r\alpha$$

$$a_r = r\omega^2$$

$$= v_t / r$$

$$a = \sqrt{a_r^2 + a_t^2}$$

Chapter 6

$$\underline{R} = \Sigma \underline{F} = m\underline{a}$$
$$M_R = \Sigma M_{cg} = I_{cg}\alpha$$
$$\Sigma F_x = ma_x$$
$$\Sigma F_y = ma_y$$
$$\Sigma M_{z_{cg}} = I_{cg}\alpha$$

$$I_{cg} = mk_{cg}^2$$
$$k_{cg} = K_{cg} length$$
$$I_a = \int r^2 dm$$
$$I_{axis} = I_{cg} + mr^2$$

Chapter 7

$$\int_{t_i}^{t_f} F dt = mv_f - mv_i$$

$$\text{lin. impulse} = \overline{F}t = \int F dt$$
$$\text{lin. momentum} = p = mv$$

$$\int_{t_i}^{t_f} M_R dt = I_{cg_f}\omega_f - I_{cg_i}\omega_i$$

$$\text{ang. impulse} = \int M_R dt$$
$$= \int (\underline{r} \times \underline{F}) dt$$
$$\text{ang. momentum} = L = I_{cg}\omega$$

Chapter 8

$$W = work$$
$$= \Delta E = E_f - E_i$$
$$= (mgy_f + \tfrac{1}{2}mv_f^2 + \tfrac{1}{2}I_{cg}\omega_f^2) -$$
$$(mgy_i + \tfrac{1}{2}mv_i^2 + \tfrac{1}{2}I_{cg}\omega_i^2)$$

$$E_{potential} = mgy$$
$$E_{translational} = \tfrac{1}{2}mv^2$$
$$E_{rotational} = \tfrac{1}{2}I\omega^2$$
$$E_{total} = E_{potential} + E_{translational} + E_{rotational}$$

$$W_{force} = \int_{s_i}^{s_f} F ds$$
$$= \overline{F}s$$
$$= Fs\cos\theta$$
$$= \underline{F} \cdot \underline{s}$$
$$= F_x s_x + F_y s_y$$

$$W_{moment} = \int_{\theta_i}^{\theta_f} M d\theta$$
$$= \overline{M}\theta$$

$$\overline{P} = \frac{\Delta E}{\Delta t}$$

$$P = \frac{dE}{dt}$$

$$= Fv\cos\theta$$

$$= \underline{F} \cdot \underline{v}$$

$$= F_x v_x + F_y v_y$$

$$P_{moment} = M\omega$$

$$= (rF\sin\theta)\omega$$

$$W_{external} = \sum_{j=1}^{J} \int_{t_i}^{t_f} M_j \omega_j \, dt$$

$$W_{total} = \sum_{j=1}^{J} \int_{t_i}^{t_f} \left| M_j \omega_j \right| dt$$

$$W_{internal} = W_{total} - W_{external}$$

Chapter 9

$$\text{density} = \rho = \frac{m}{V}$$

$$\text{pressure} = p = \frac{F}{A}$$

$$F_{bouyant} = pA = \rho g V$$

$$F_{vd} = -6\pi r \eta v$$

$$F_{fd} = -\tfrac{1}{2} C_{drag} A_{normal} \rho v^2$$

$$v_{terminal} = \sqrt{\frac{2mg}{C_{drag} A_{normal} \rho}}$$

$$F_{lift} = (p_2 - p_1) A_{perpendicular}$$

$$= C_{lift} A_{perpendicular} \rho v^2$$

Chapter 10

$$\text{stride rate} = 1 / \text{stride time}$$

$$\text{cadence} = 120 \times \text{stride rate}$$

$$\text{stride velocity} = \frac{\text{stride length}}{\text{stride time}}$$

$$= \text{stride length} \times \text{stride rate}$$

$$Rp - Wg = I\alpha$$

$$\text{COP} - \text{COM} = -k a_{COM}$$

$$k = I / Wd$$