

$$H(s) = \frac{I_a(s)}{E_a(s)} = \frac{Js + B}{L_a Js^2 + (BL_a + JR_a)s + (BR_a + K_m K_b)}$$

$$= \frac{1}{L_a J} \left[\frac{Js + B}{s^2 + \frac{BL_a + JR_a}{L_a J} s + \frac{BR_a + K_m K_b}{L_a J}} \right]$$

$$G(s) = \frac{\omega(s)}{E_a(s)} = \frac{1}{L_a J} \left[\frac{K_m}{s^2 + \frac{BL_a + JR_a}{L_a J} s + \frac{BR_a + K_m K_b}{L_a J}} \right]$$

$$K = \frac{K_m}{L_a J}$$

=

$$\frac{K}{s^2 + 2\zeta\omega_n s + \omega_n^2}$$

$$\omega_n = 2\pi f_n \text{ [rad/sec]}$$

f_n = undamped natural frequency [Hertz]

ζ = damping ratio $\rightarrow$

$$\omega_n^2 = \frac{BR_a + K_m K_b}{L_a J}$$

$$2\zeta\omega_n = \frac{BL_a + JR_a}{L_a J}$$