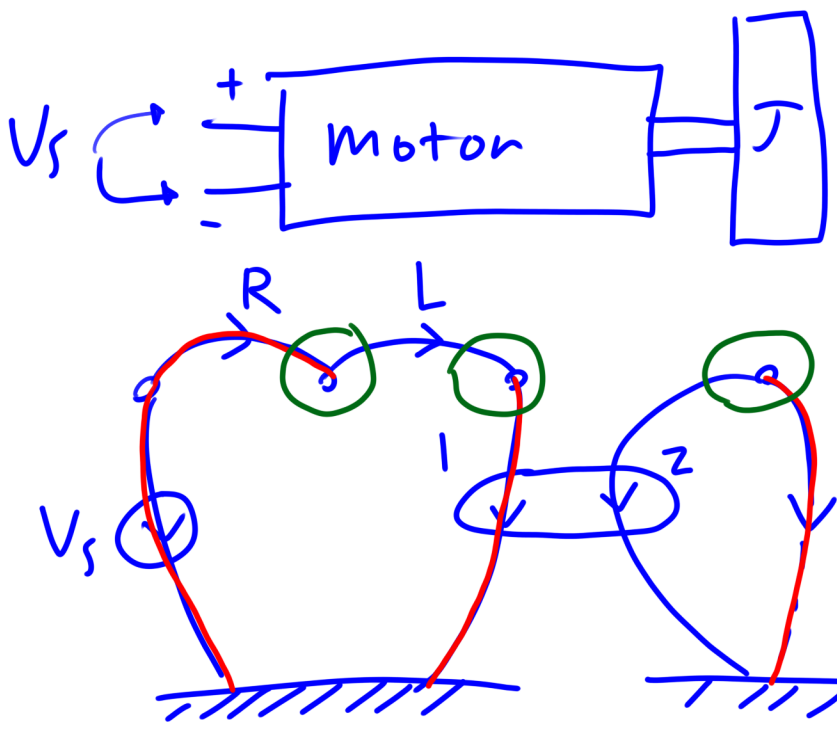

$$V_s = g(\Omega_{ref} - \Omega_J)$$

Primary: V_s V_R i_L V_1 τ_2 Ω_J

Secondary: I_s i_R V_L i_1 Ω_2 τ_J

State: Ω_J i_L

$$x = \begin{bmatrix} i_L \\ \Omega_J \end{bmatrix} \qquad y = \begin{bmatrix} \Omega_J \\ V_s \end{bmatrix} \qquad u = \begin{bmatrix} \Omega_{ref} \end{bmatrix}$$

Elemental

$$V_R = R i_R = R i_L$$

$$\frac{d i_L}{dt} = \frac{1}{L} V_L = \frac{1}{L}(V_s - V_R - V_1) = \frac{1}{L}(g(\Omega_{ref} - \Omega_J) - R i_L - K_a \Omega_J)$$

$$\begin{bmatrix} V_1 \\ i_1 \end{bmatrix} = \begin{bmatrix} K_a & 0 \\ 0 & -1/K_a \end{bmatrix} \begin{bmatrix} \Omega_2 \\ \tau_2 \end{bmatrix} \qquad V_1 = K_a \Omega_2 = V_1 = K_a \Omega_J$$

$$\tau_2 = -K_a i_1 = -K_a i_L$$

$$\frac{d \Omega_J}{dt} = \frac{1}{J} \tau_J = \frac{-1}{J} \tau_2 = \frac{K_a}{J} i_L$$

Continuity

$$i_R = i_L \qquad i_1 = i_L \qquad \tau_J = -\tau_2$$

Compatability

$$V_L = V_s - V_R - V_1$$

$$\Omega_2 = \Omega_J$$

$$\frac{d}{dt}\begin{bmatrix} i_L \\ \Omega_J \end{bmatrix} = \begin{bmatrix} -R/L & -(g + K_a)/L \\ K_a/J & 0 \end{bmatrix} \begin{bmatrix} i_L \\ \Omega_J \end{bmatrix} + \begin{bmatrix} g/L \\ 0 \end{bmatrix} \begin{bmatrix} \Omega_{ref} \end{bmatrix}$$

$$\begin{bmatrix} \Omega_J \\ V_s \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ 0 & -g \end{bmatrix} \begin{bmatrix} i_L \\ \Omega_J \end{bmatrix} + \begin{bmatrix} 0 \\ g \end{bmatrix} \begin{bmatrix} \Omega_{ref} \end{bmatrix}$$

$$\boxed{V_s = g(\Omega_{ref} - \Omega_J)}$$