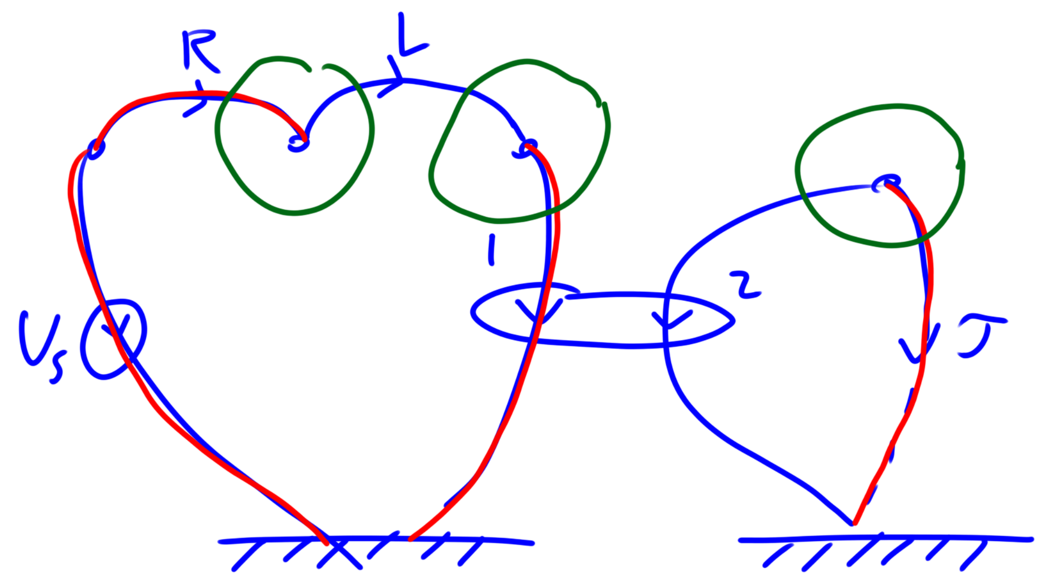

$$V_s = g(\Omega_{ref} - \Omega_J)$$

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

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

Elemental

$$V_R = R i_R = R i_L$$

$$\frac{di_L}{dt} = \frac{1}{L} V_L = \frac{1}{L}(V_s - V_R - V_1)$$

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

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

Continuity

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

Compatibility

$$V_L = V_s - V_R - V_1$$

$$\Omega_2 = \Omega_J$$

State eq

$$\frac{di_L}{dt} = \frac{1}{L}(V_s - V_R - V_1)$$

$$= \frac{1}{L}(g\Omega_{ref} - g\Omega_J - R i_L - K_a \Omega_J)$$

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

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

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

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