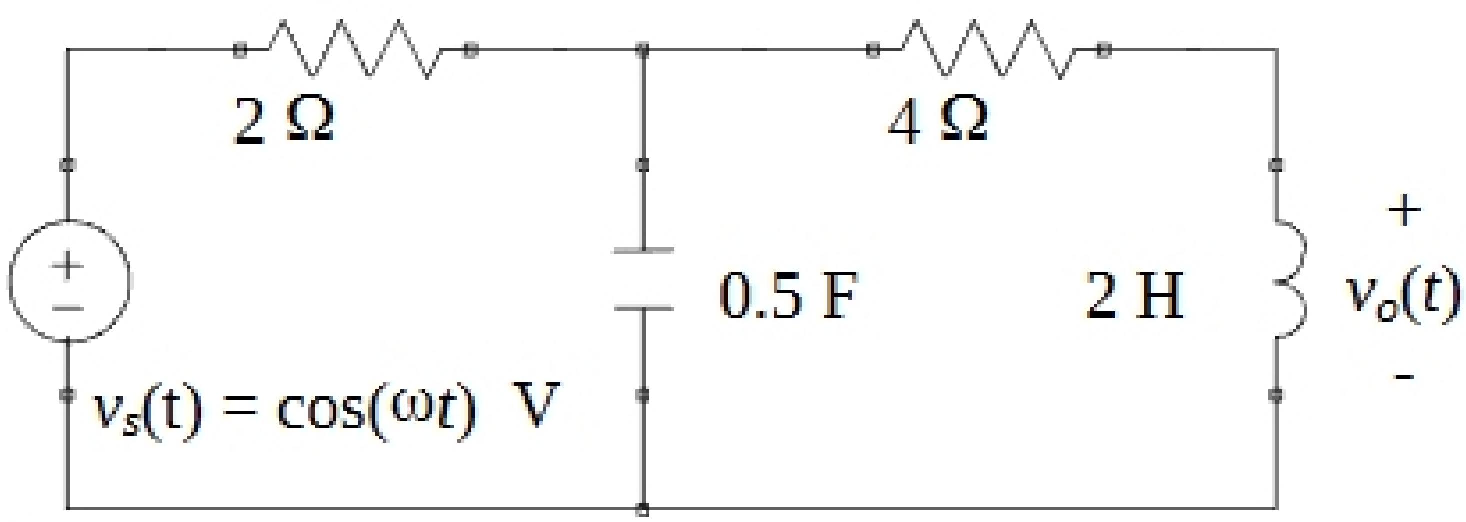
Circuits II
EE221
Unit 4
Instructor: Kevin D. Donohue

Transfer Function, Complex Frequency, Poles and Zeros, and Bode Plots, Resonant Circuits

Node Voltage Example

- Perform phasor analysis to determine $v_o(t)$. Since the frequency of the source is not specified, leave impedances in terms of $j\omega = s$. Express the phasor of $v_o(t)$ in terms of a product between a rational polynomial in s and the phasor of the input. Then substitute $\omega = 2$ and solve for $v_o(t)$.



- Show that

$$\hat{V}_o = \hat{V}_s \frac{s}{s^2+3s+3} = |\hat{V}_s| \frac{\sqrt{\omega^2}}{\sqrt{(3-\omega^2)^2+9\omega^2}} \angle\left(\angle(\hat{V}_s) + 90^\circ - \tan^{-1}\left(\frac{3\omega}{3-\omega^2}\right)\right)$$

- Show $v_o(t) = .33\cos(2t - 9.46^\circ)$ V when $\omega = 2$

Transfer Functions

- From the last example let:

$$\hat{H}(s) = \frac{s}{s^2 + 3s + 3}$$

- Note that for $s = j\omega$, the above function represents the phasor ratio of output to input for any ω:

$$\frac{\hat{V}_o(j\omega)}{\hat{V}_s(j\omega)} = \hat{H}(j\omega) = \frac{\sqrt{\omega^2}}{\sqrt{(3-\omega^2)^2 + 9\omega^2}} \angle \left(90^\circ - \tan^{-1}\left(\frac{3\omega}{3-\omega^2} \right) \right)$$

- Therefore, for any input magnitude, phase, and frequency of ω_i the output can be determined by multiplying the input magnitude by $\left|\hat{H}(j\omega_i)\right|$ and adding $\angle \hat{H}(j\omega_i)$ to the input phase. In this sense, $\hat{H}(s)$ describes how to *transfer* the input value to the output value.