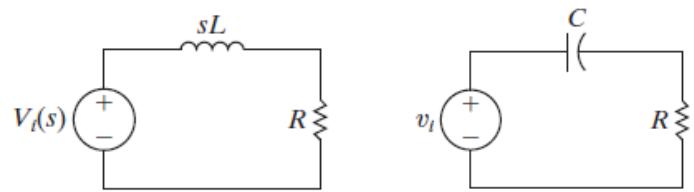


EECE 290, Problem solving

Session 9

Frequency responses: low pass, band pass, high pass, band stop
 first order: high pass or low pass



$$H(j\omega) = \frac{R}{R+1/j\omega C} = \frac{j\omega RC}{j\omega RC + 1} = \frac{j\omega/\omega_c}{j\omega/\omega_c + 1}$$

$$H(j\omega) = \frac{j\omega L}{R+j\omega L} = \frac{j\omega L/R}{j\omega L/R + 1} = \frac{j\omega/\omega_c}{j\omega/\omega_c + 1}$$

$$\omega_c = 1/\tau = 1/RC \text{ or } 1/GL = R/L$$

$$H(j\omega) = \frac{1/j\omega C}{R+1/j\omega C} = \frac{1}{j\omega RC + 1} = \frac{1}{j\omega/\omega_c + 1}$$

$$H(j\omega) = \frac{R}{R+j\omega L} = \frac{1}{j\omega L/R + 1} = \frac{1}{j\omega/\omega_c + 1}$$

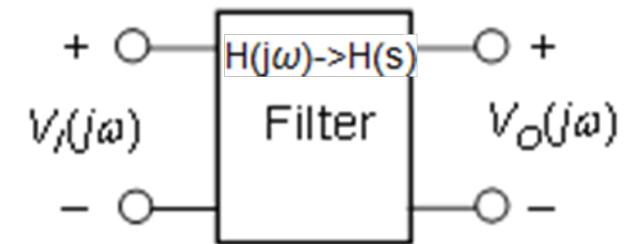
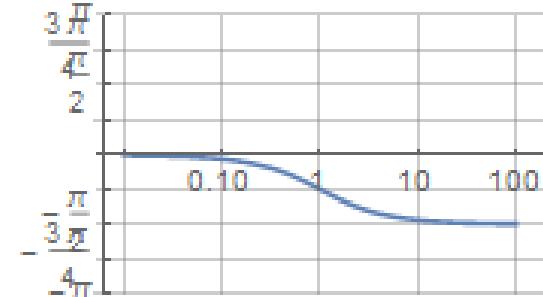
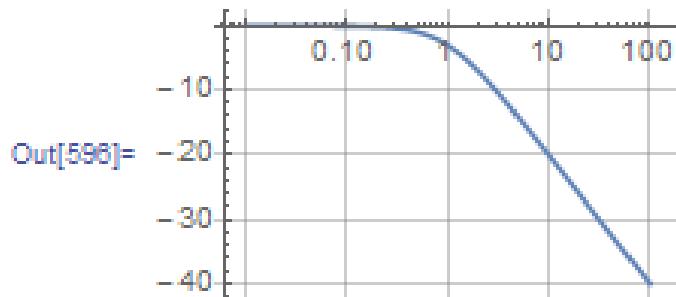
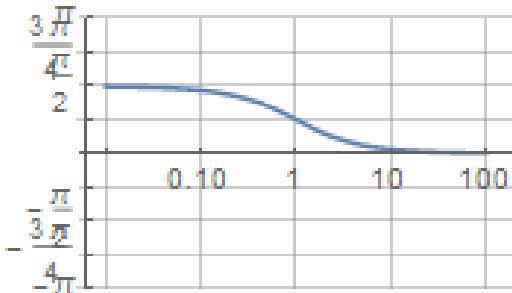
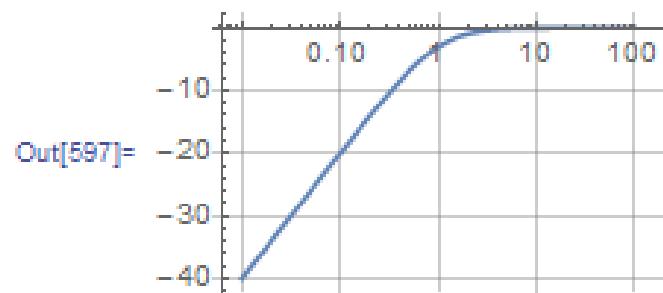
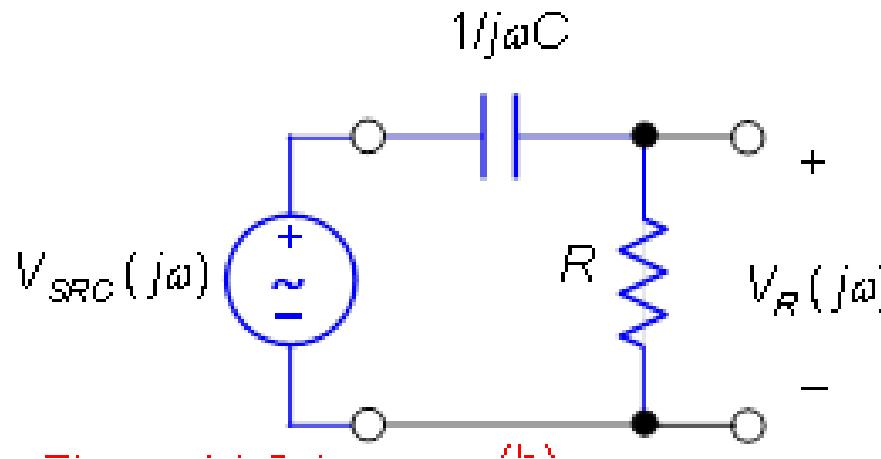


Figure 14.1.1

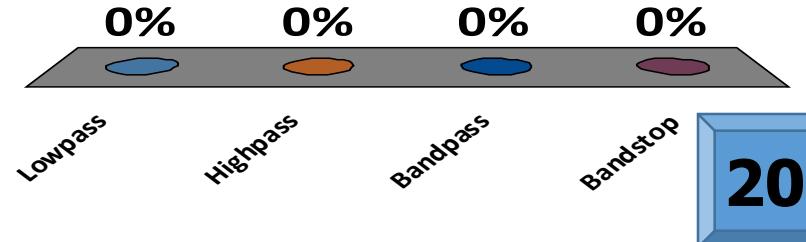


$$H_R(j\omega) = \frac{V_R(j\omega)}{V_{SRC}(j\omega)}$$

The response of
this circuit is



- A. Lowpass
- B. Highpass
- C. Bandpass
- D. Bandstop



2nd order frequency responses summary

$$j\omega > s, B = \omega_2 - \omega_1, Q = \frac{\omega_0}{B}, \omega_1 \omega_2 = \omega_0^2$$

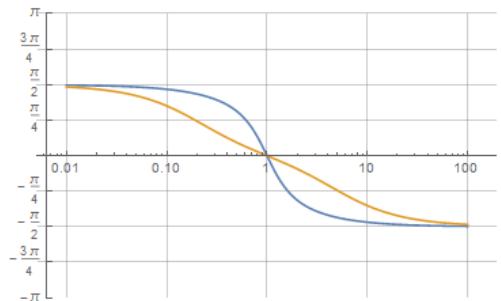
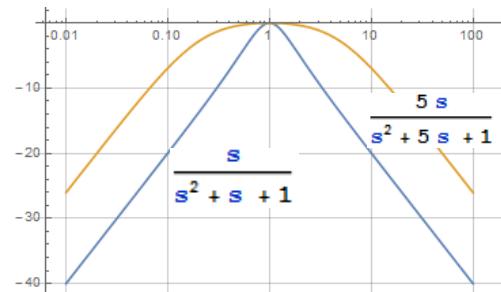
$K \frac{s^2}{s^2 + Bs + \omega_0^2}$ highpass

$K \frac{Bs}{s^2 + Bs + \omega_0^2}$ bandpass

$K \frac{\omega_0^2}{s^2 + Bs + \omega_0^2}$ lowpass

$K \frac{s^2 + \omega_0^2}{s^2 + Bs + \omega_0^2}$ bandstop

$K \frac{s^2 - Bs + \omega_0^2}{s^2 + Bs + \omega_0^2}$ allpass



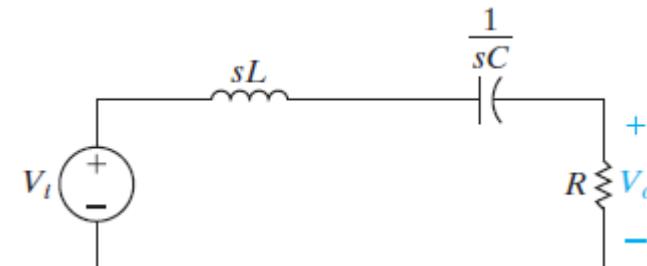
ω_0 is resonance frequency

B is bandwidth.

Q is quality factor.

ω_1, ω_2 are half power frequencies.

$$\omega_{1,2} = \pm \frac{B}{2} + \sqrt{\left(\frac{B}{2}\right)^2 + \omega_0^2}$$



$$\text{2nd order : } \frac{R}{R + j\omega L + \frac{1}{j\omega C}} = \frac{\frac{R}{L} s}{s^2 + \frac{R}{L} s + \frac{1}{LC}}$$

Series RCL

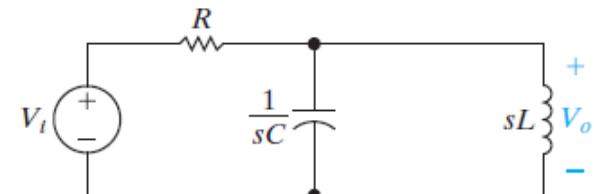
$$\omega_0^2 = \frac{1}{LC}, B = \frac{R}{L}, Q = \omega_0 \frac{L}{R}$$

$$\omega_{1,2} = \pm \frac{R}{2L} + \sqrt{\left(\frac{R}{2L}\right)^2 + \frac{1}{LC}}$$

Parallel GCL \rightarrow RCL

$$\omega_0^2 = \frac{1}{LC}, B = \frac{1}{RC}, Q = \omega_0 RC$$

$$\omega_{1,2} = \pm \frac{1}{2RC} + \sqrt{\left(\frac{1}{2RC}\right)^2 + \frac{1}{LC}}$$



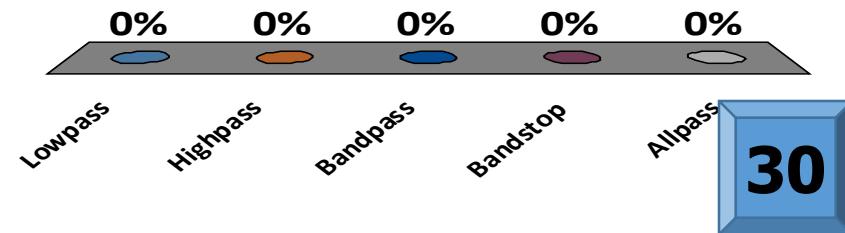
$$H(s) = \frac{s/RC}{s^2 + s/RC + 1/LC}$$

$$\frac{s^2 + \omega_0^2}{s^2 + \frac{\omega_0}{Q}s + \omega_0^2}$$

$$\frac{\square}{s^2 + Bs + \omega_0^2}; Q = \frac{\omega_0}{B}; \omega_0^2 = \frac{1}{LC}; Q = \frac{\omega_0 L}{R}$$

This response is

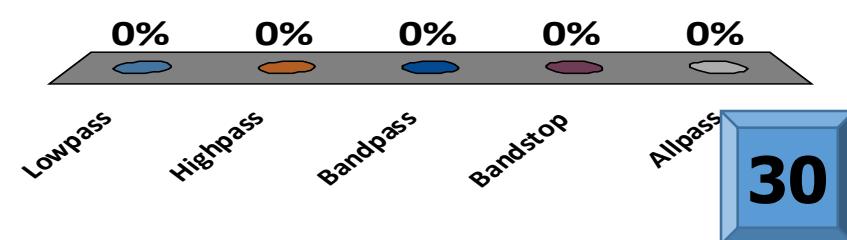
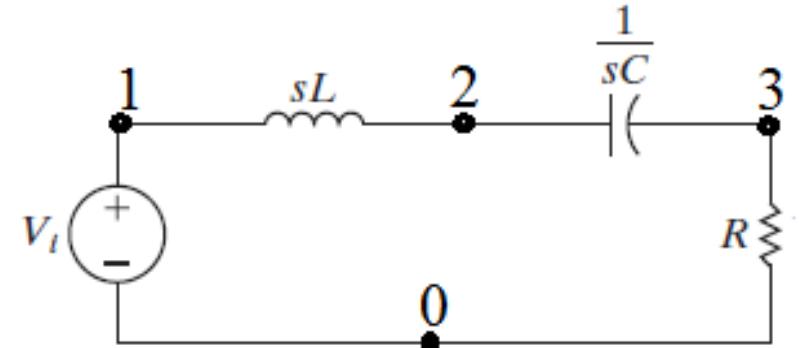
- A. Lowpass
- B. Highpass
- C. Bandpass
- D. Bandstop
- E. Allpass



$$\frac{\square}{s^2 + Bs + \omega_0^2}; Q = \frac{\omega_0}{B}; \omega_0^2 = \frac{1}{LC}; Q = \frac{\omega_0 L}{R}$$

This response can be realized by

- A. V_{21}/V_I
- B. V_{31}/V_I
- C. V_{32}/V_I
- D. V_{20}/V_I
- E. V_{30}/V_I

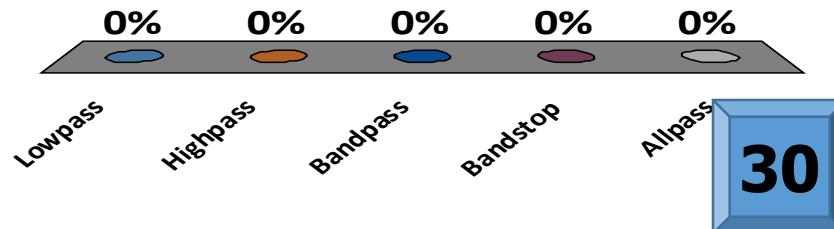


$$\frac{\frac{\omega_0}{Q} s}{s^2 + \frac{\omega_0}{Q} s + \omega_0^2}$$

$$\frac{\square}{s^2 + Bs + \omega_0^2}; Q = \frac{\omega_0}{B}; \omega_0^2 = \frac{1}{LC}; Q = \frac{\omega_0 L}{R}$$

This response is

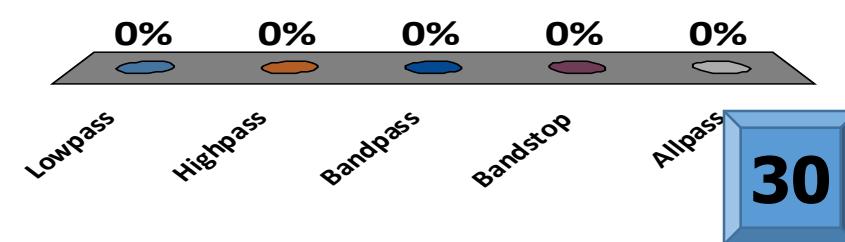
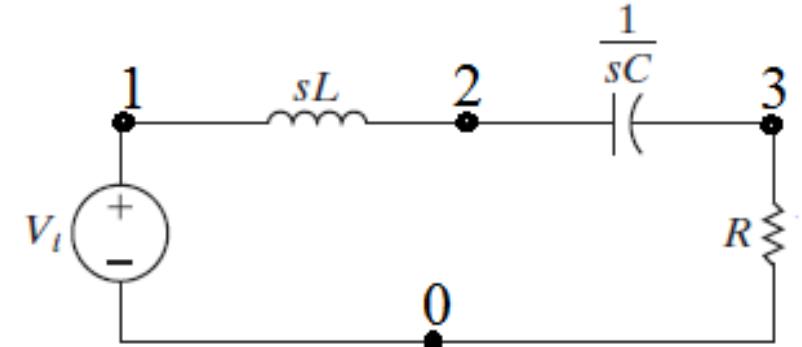
- A. Lowpass
- B. Highpass
- C. Bandpass
- D. Bandstop
- E. Allpass



$$\frac{\square}{s^2 + Bs + \omega_0^2}; Q = \frac{\omega_0}{B}; \omega_0^2 = \frac{1}{LC}; Q = \frac{\omega_0 L}{R}$$

This response can be realized by

- A. V_{21}/V_I
- B. V_{31}/V_I
- C. V_{32}/V_I
- D. V_{20}/V_I
- E. V_{30}/V_I

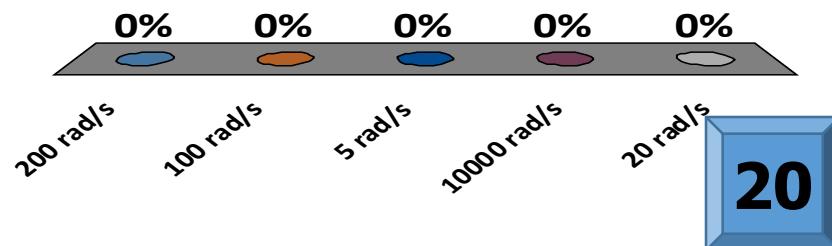


$$\frac{20s}{s^2 + 20s + 40000}$$

$$\frac{\square}{s^2 + Bs + \omega_0^2}; Q = \frac{\omega_0}{B}; \omega_0^2 = \frac{1}{LC}; Q = \frac{\omega_0 L}{R}$$

ω_0 (*center or resonance frequency*)
is

- A. 200 rad/s
- B. 100 rad/s
- C. 5 rad/s
- D. 10000 rad/s
- E. 20 rad/s



$$\frac{20s}{s^2 + 20s + 40000}$$

$$\frac{\square}{s^2 + Bs + \omega_0^2}; Q = \frac{\omega_0}{B}; \omega_0^2 = \frac{1}{LC}; Q = \frac{\omega_0 L}{R}$$

B (bandwidth) is

- A. 200 rad/s
- B. 100 rad/s
- C. 5 rad/s
- D. 10000 rad/s
- E. 20 rad/s

