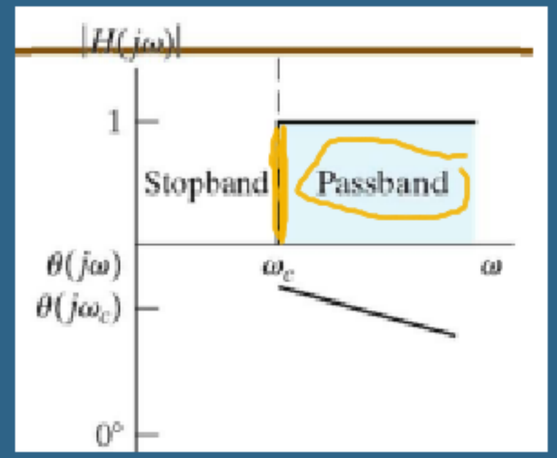
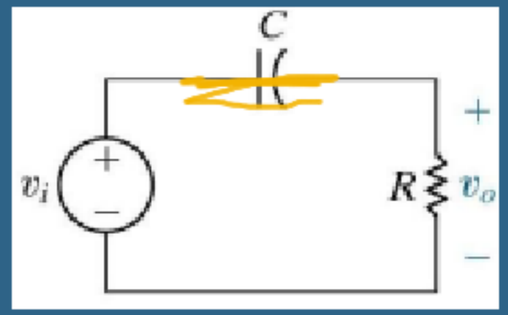
High-pass filters

==>passes signals at frequencies higher than the cutoff frequency.

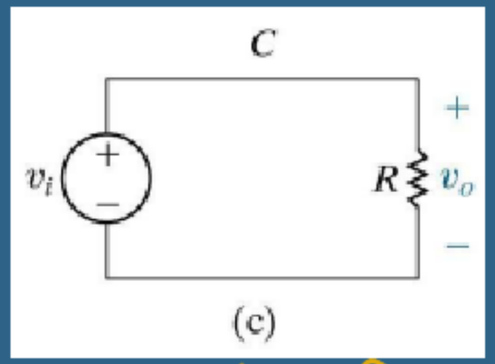


RC Circuit $Z_C = \frac{1}{j\omega C}$

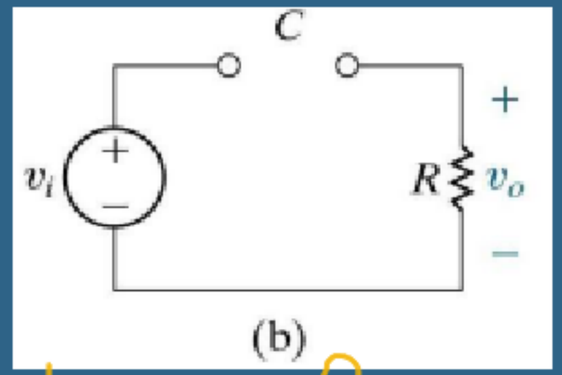


==> At ω = ∞ , the capacitor behaves as a s.c, so the capacitor voltage is zero.

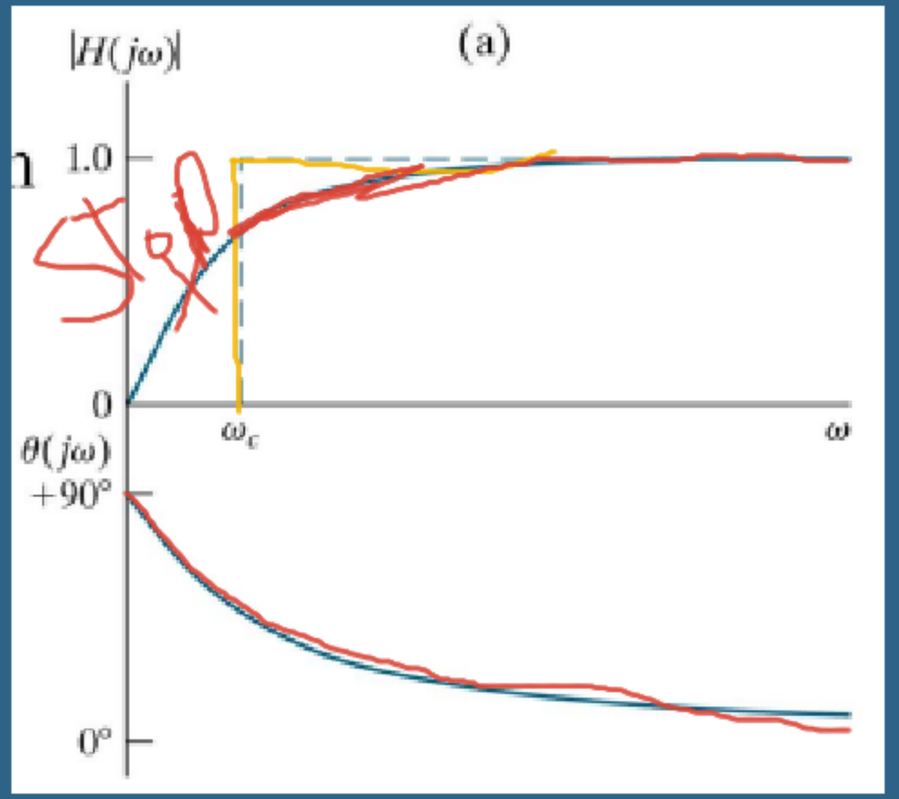
==> At ω = 0, the capacitor behaves as an o.c, so no current on R.



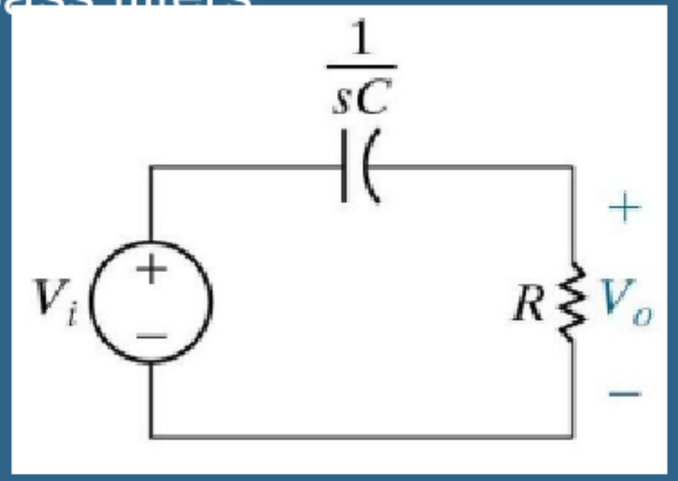
high freq



low freq

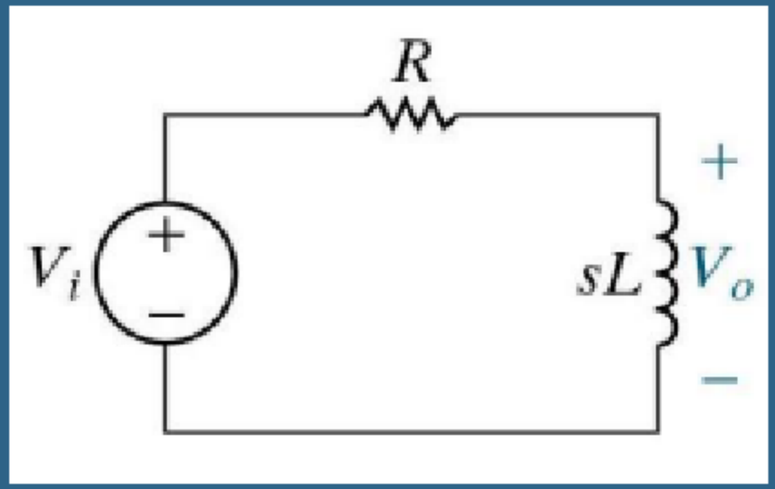


High-pass filters



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

$$\omega_c = 1/RC$$



$$H(s) = \frac{s}{s + R/L}$$

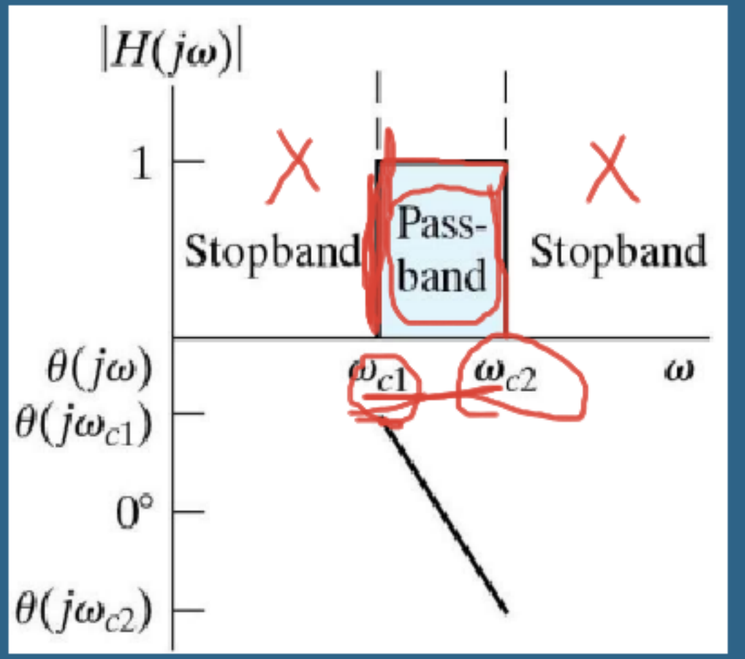
$$\omega_c = R/L$$

$$H(s) = \frac{s}{s + \omega_c}.$$

Band-pass filters

==> passes a source voltage to the output only when the source frequency is within the band defined by the two cutoff frequencies.

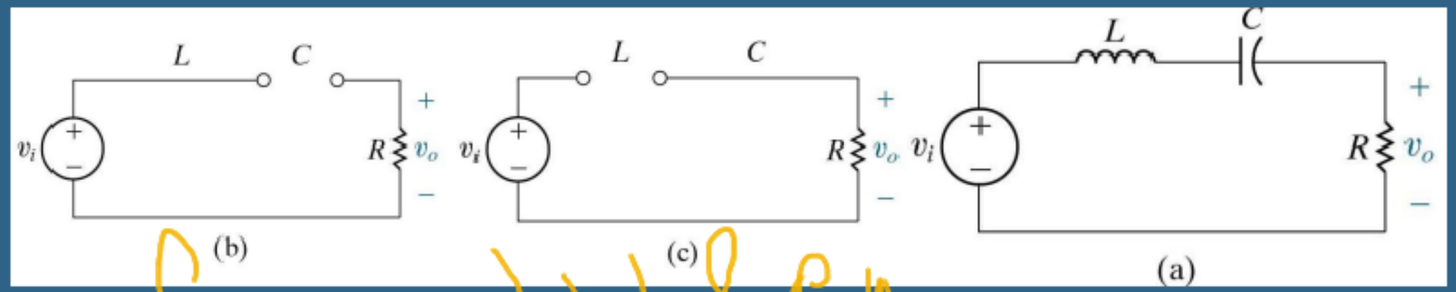
==> Ideal bandpass filters have two cutoff frequencies.



Series RLC Circuit

==> At ω = 0: the capacitor behaves like an o.c,
and the inductor behaves like a s.c.

==> At ω = ∞, the capacitor behaves like a s.c,
and the inductor behaves like an o.c.



$$\omega_o = \sqrt{\frac{1}{LC}} = \frac{1}{\sqrt{LC}}$$

$$\omega_{c1} = -\frac{R}{2L} + \sqrt{\left(\frac{R}{2L}\right)^2 + \left(\frac{1}{LC}\right)}$$

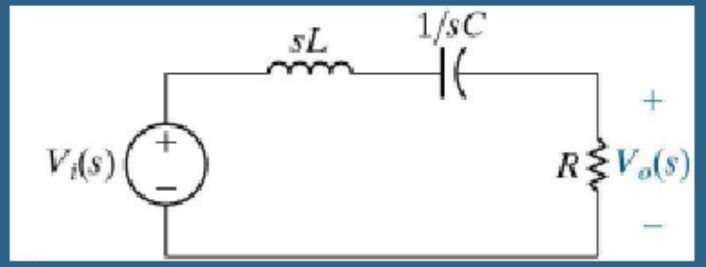
$$\omega_{c2} = \frac{R}{2L} + \sqrt{\left(\frac{R}{2L}\right)^2 + \left(\frac{1}{LC}\right)}$$

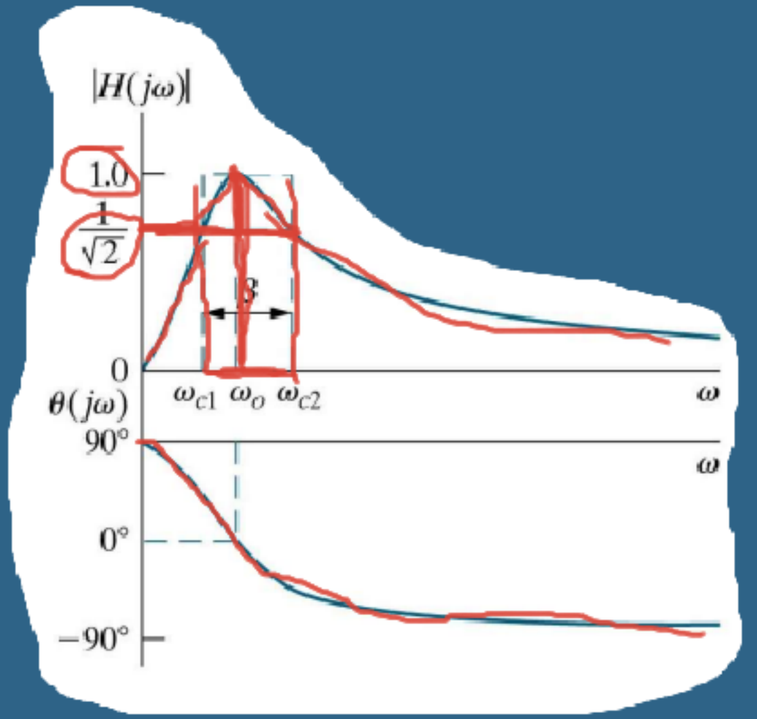
$$\omega_o = \sqrt{\omega_{c1} \cdot \omega_{c2}}$$

$$\beta = \omega_{c2} - \omega_{c1}$$

$$\beta = \frac{R}{L}$$

Bandwidth





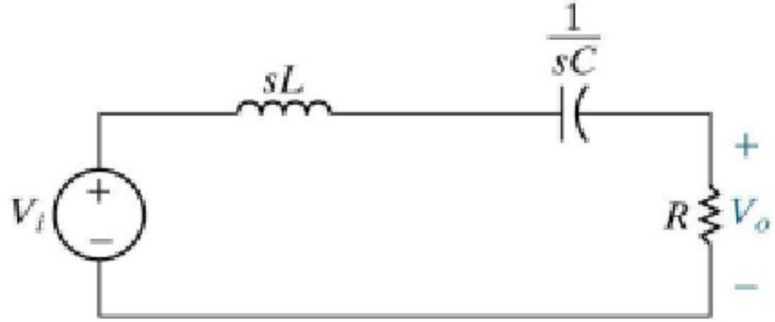
RELATIONSHIP AMONG QUALITY FACTOR CENTER FREQUENCY AND BANDWIDTH

$$Q = \frac{\omega_o}{\beta}$$

QUALITY FACTOR, SERIES *RLC* FILTERS

$$Q = \sqrt{\frac{L}{R^2C}}$$

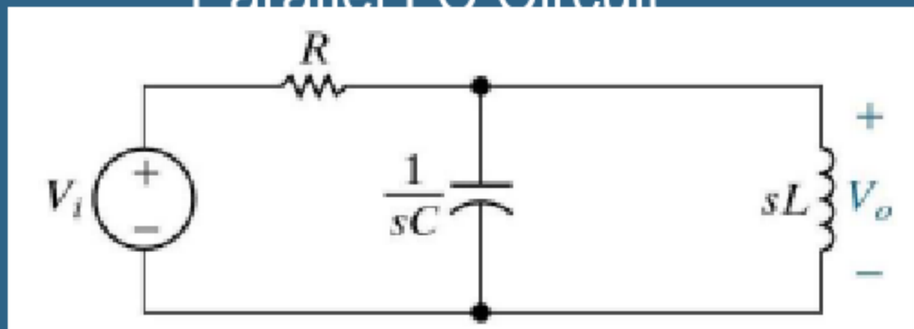
Series RLC Circuit



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

$\omega_0 = \sqrt{1/LC}$ $\beta = R/L$

Parallel LC Circuit



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

$\omega_0 = \sqrt{1/LC}$ $\beta = 1/RC$

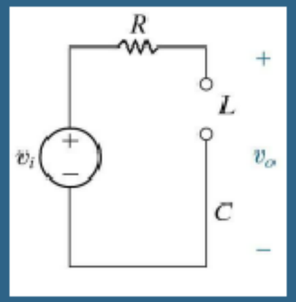
Voltage Divider

Band-reject filter

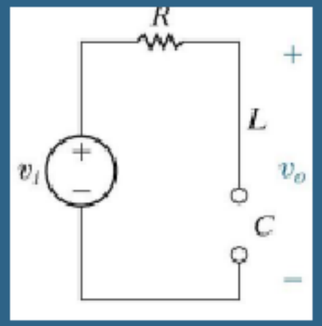
passes a source voltage to the output only when the source frequency is outside the band defined by the two cutoff frequencies.

==> At $\omega = 0$: the capacitor behaves like an o.c, and the inductor behaves like a s.c.

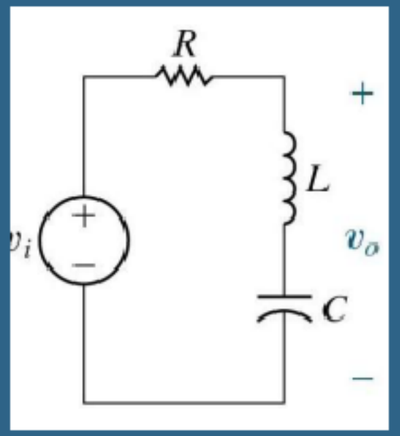
==> At $\omega = \infty$: the capacitor behaves like a s.c, and the inductor behaves like an o.c.

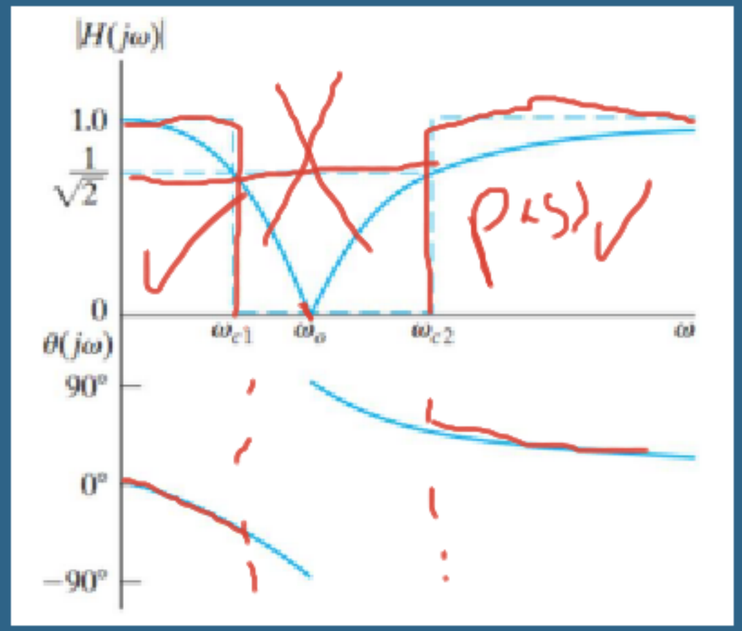


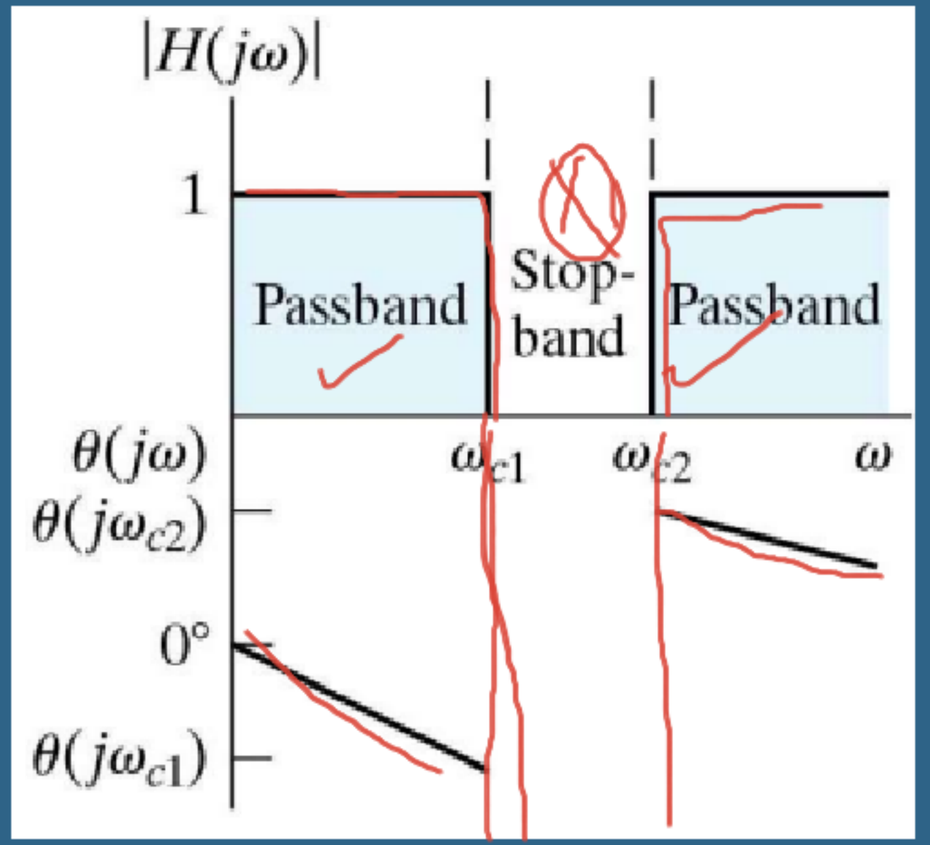
high



low







Filter Design Process