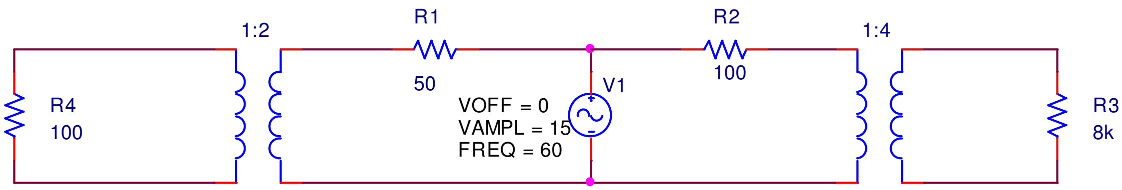
How do overdamped, critically damped, and underdamped bandpass circuits relate to each other?
Is an underdamped bandpass circuit useful?

Exam 3 Review

Review 1)

A load consisting of a 2.5kΩ resistor in parallel with a 2 μF capacitor is connected across a 440-V (rms), 60 Hz voltage source. Find the complex power delivered to the load and the load power factor. State whether the power factor is leading or lagging.

Review 2:



a. Determine the current produced by the source.

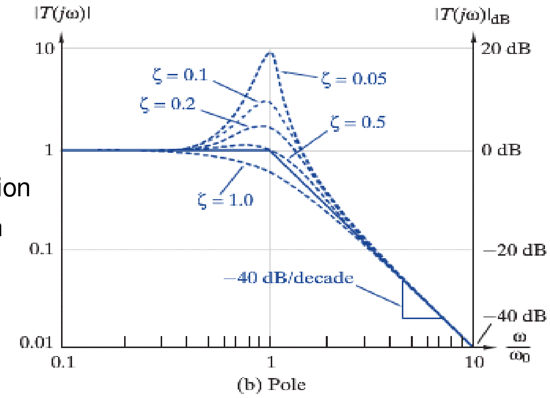
b. Determine the current through R2.

c. Determine the current through R3.

Underdamped circuit ζ<0.5
Low Pass and High Pass Circuit

Critically damped at extremes

Find value of Gain in dB at ω_0
Last week we plugged $j\omega_0$ into our transfer function and made a substitution for α using α=ζ*ω0 then found $\left|H(j\omega_0)\right|$



Look back at notes and you'll find that

$$\boxed{\left|H(j\omega_0)\right| = \frac{1}{2\zeta}}$$

Finally take $20\log\left(\left|H(j\omega_0)\right|\right)$

i.e. ζ=0.5 gave $\left|H(j\omega_0)\right| = 1$

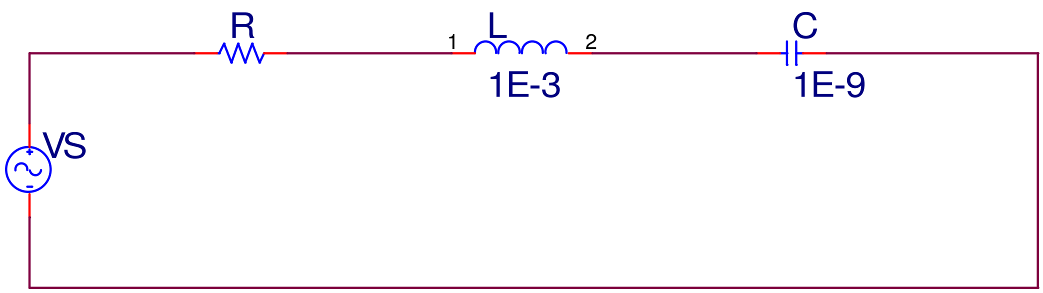
$\zeta = \frac{1}{\sqrt{2}}$ $\qquad \left|H(j\omega_0)\right| = 0.707$

$\zeta = 0.05$ $\qquad \left|H(j\omega_0)\right| = 20$

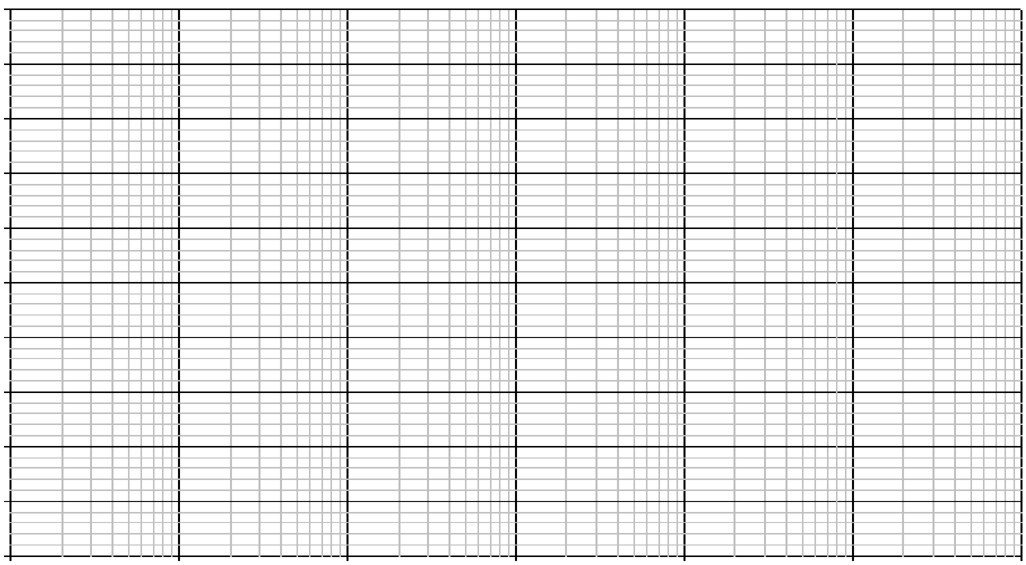
Process Summary (fill in below!)

Problem 1)

1) Second order circuits

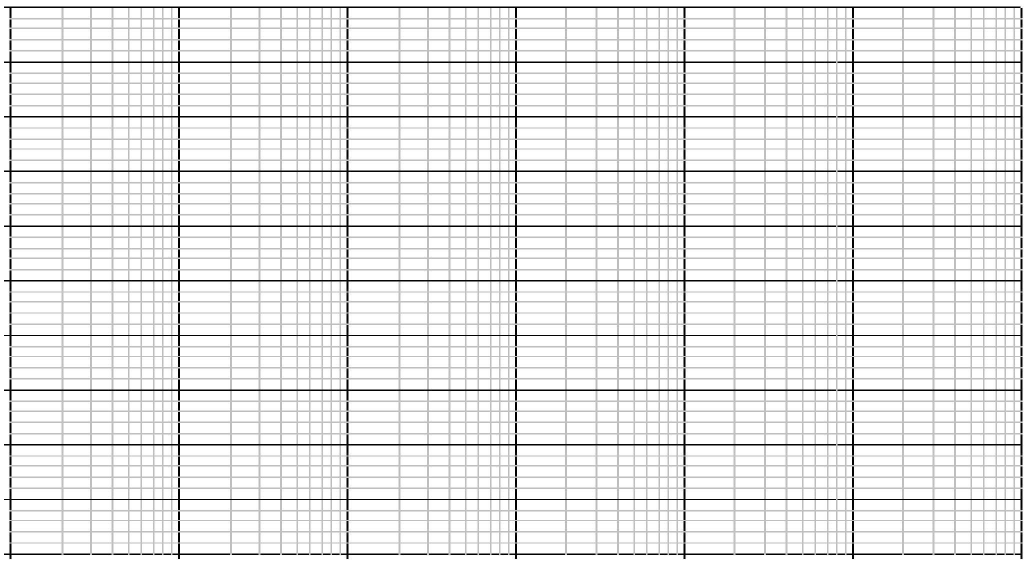


a) H(s) = VR(s)/V(s) when R=2kΩ

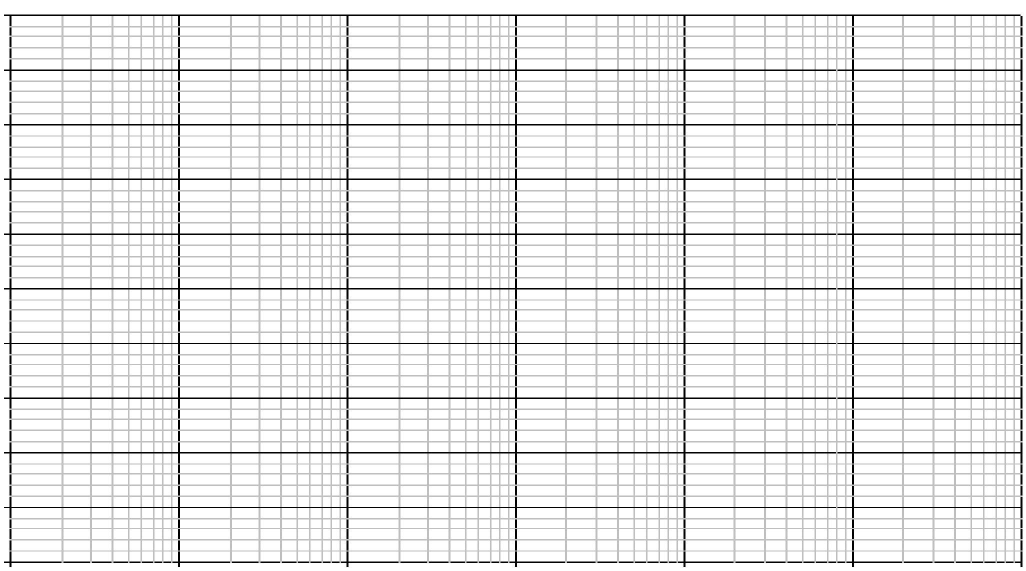


a.) H(s) = VR(s)/V(s) when R = 2kΩ

b) H(s) = VR(s)/V(s) when R=10.1kΩ (ζ=5.05)



b) H(s) = VR(s)/V(s) when R=100Ω



Introduction to Filter design

First order filters

Low pass filter form $\dfrac{\omega_c}{s+\omega_c}$ 1 pole

High pass filter form $\dfrac{s}{s+\omega_c}$ 1 zero at origin
1 pole

Second order filters

Low pass filter form

$$H(s) = \frac{K}{\left(\frac{s}{\omega_0}\right)^2 + 2\cdot\zeta\left(\frac{s}{\omega_0}\right) + 1}$$

$$\frac{\omega_0^{\;2}}{s^2 + 2\alpha s + \omega_0^{\;2}}$$

2 poles

High pass filter form

$$H(s) = \frac{K\left(\frac{s}{\omega_0}\right)^2}{\left[\left(\frac{s}{\omega_0}\right)^2 + 2\cdot\zeta\left(\frac{s}{\omega_0}\right) + 1\right]}$$

$$\frac{s^2}{\left(s^2 + 2\alpha s + \omega_0^{\;2}\right)}$$

2 zeros at orgin

2 poles

Bandpass filter form

$$H(s) = \frac{K\left(\frac{s}{\omega_0}\right)}{\left[\left(\frac{s}{\omega_0}\right)^2 + 2\cdot\zeta\left(\frac{s}{\omega_0}\right) + 1\right]}$$

$$\frac{2\alpha s}{s^2 + 2\alpha s + \omega_0^{\;2}}$$

1 zero

2 poles

Bandstop (notch filter form)

$$H(s) = \frac{K\cdot\left[\left(\frac{s}{\omega_0}\right)^2 + 1\right]}{\left[\left(\frac{s}{\omega_0}\right)^2 + 2\cdot\zeta\left(\frac{s}{\omega_0}\right) + 1\right]}$$

$$\frac{s^2 + \omega_0^{\;2}}{s^2 + 2\alpha s + \omega_0^{\;2}}$$

3) Filter Design

Design a filter that meets the specifications below. You need to pick values for any resistors, capacitors or inductors in your circuit.

ω [rad/s]	|H(s)| in dB
10	-25
100	-5
1000	12
1E4	15
1E5	15
1E6	15