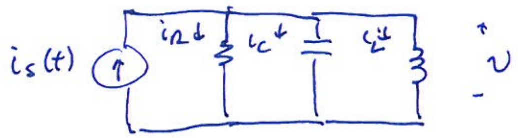
ECE 332 Summer 2017

ECE332 Quiz 2
(10 minutes)

Name: ______________________

1. [50 pts] **Given**: A parallel RLC circuit with a Norton current source. Assume an ideal inductor and an ideal current source i.e. no parasitic resistance and source resistance $R_S = \infty$.

[20 pts] **Find**: Develop the ODE using connection constraints (KVL and/or KCL) and i-v relationships with appropriate substitutions. Do not solve.



$$LC\, i_L'' + \frac{L}{R} i_L' + i_L = i_s$$

$$i_L'' + \frac{1}{RC} i_L' + \frac{1}{LC} i_L = \frac{1}{LC} i_s$$

$$i_R + i_C + i_L = i_s$$

$$i_R = \frac{v}{R} = \frac{L i_L'}{R}$$

$$i_C = C v_C' = \frac{CL}{\cancel{R}} i_L''$$

[10 pts] **Find**: The characteristic equation in terms of R, L, and C.

$$s^2 + \frac{1}{RC} s + \frac{1}{LC} = 0$$

[10 pts] **Find**: The roots of the characteristic equation in terms of R, L, and C.

$$s = -\frac{1}{2RC} \pm \sqrt{\left(\frac{1}{2RC}\right)^2 - \frac{1}{LC}}$$

[10 pts] **Find**: Given that the roots above are complex, explain whether increasing R makes your circuit **more** or **less** damped.

increasing R makes determinant closer to $\frac{1}{LC}$ $\Rightarrow$ decreases ζ

Cease work on Problem 1 and begin Problem 2

2. [50 pts] **Given**: Assume you found the characteristic equation from above to be

$$s^2 + \frac{1}{RC}s + \frac{1}{LC}$$

$$s^2 + 2\zeta\omega_o s + \omega_o^2$$

alternative form

a. [10 pts] **Find**: Using the alternative form of the characteristic equation, find the undamped natural frequency ω_o strictly in terms of R, L, and/or C.

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

b. [20 pts] **Find**: Using the alternative form of the characteristic equation, find the damping factor ζ in terms of R, L, and/or C.

$$2\zeta\omega_o = \frac{1}{RC}$$

$$2\zeta\frac{1}{\sqrt{LC}} = \frac{1}{RC}$$

$$\zeta = \frac{1}{2R}\sqrt{\frac{L}{C}}$$

c. [20 pts] **Find**: Determine R, L, and/or C for $\zeta = 0.25$. Standard parts are not required.

ω_o not given $\Rightarrow$ 2 degrees of freedom

choose $L = 1\,mH$

$C = 0.01\,\mu F$

$$0.25 = \frac{1}{2R}\sqrt{\frac{1m}{0.01\mu}} \qquad R = \frac{1}{2(.25)}\sqrt{\frac{1m}{.01\mu}} = 632\,\Omega$$