Your name: ____

EECS 215 – Final Exam
April 24, 2017

This text consists of 7 problems with points as indicated to total 70 points.

Read through the entire exam before beginning.
Show all work (on the pages provided in this booklet) to earn partial credit. Briefly explain major steps, include units, and write your final answers in the areas provided.

No credit will be given if no work is shown.

Do not unstaple the pages.

Exam policies

- No food allowed during exam.
- This is a closed-book exam: No books allowed
- Table 14.3 (Bode plots) & exam 2 equation sheet attached
- One, two-sided, 8.5"x11" note page allowed
- Scientific calculators allowed (graphing calculators not permitted; enforced via CoE honor code).
- No communication of any kind is allowed. No use of cell phones, computers, or any devices besides calculators. Violation of this will be treated as an honor code violation.

In which section are you enrolled? ☐**EECS 215-001 (Finelli)** ☐**EECS 215-002 (Phillips)**

Write and sign the honor pledge ("I have neither given nor received unauthorized aid on this examination, nor have I concealed any violations of the Honor Code."):

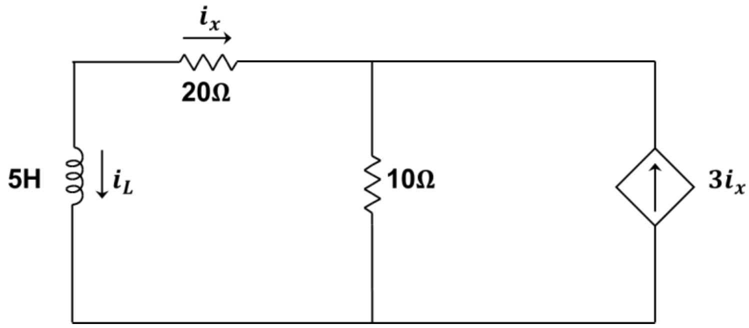
Signed: ____

Do not write in this space

Problem 1: [ ]/10	Problem 5: [ ]/10
Problem 2: [ ]/10	Problem 6: [ ]/10
Problem 3: [ ]/10	Problem 7: [ ]/10
Problem 4: [ ]/10	

Total score [ ]/70

1. The RL circuit below is energized by a voltage source which is disconnected at $t = 0$ seconds. At that time, the initial inductor current is $i_L(0) = 25$ mA. Determine the current $i_L(t), t \geq 0$.

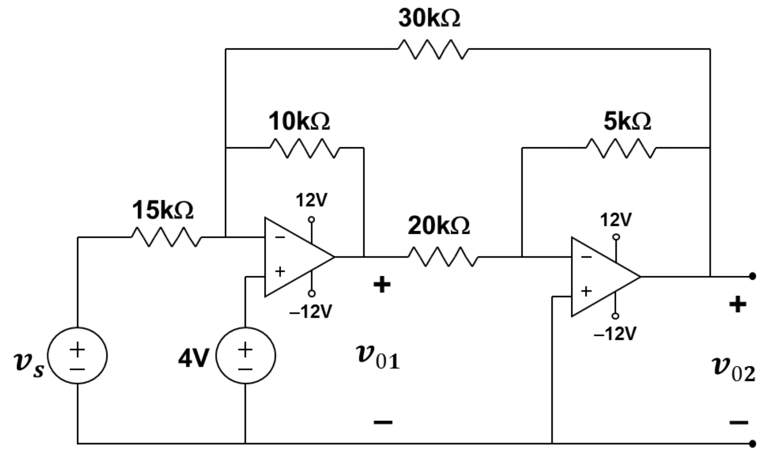


Write your answer here:

$i_L(t), t \geq 0$ =____

Problem 1 score: [ ]/10

2. For the cascaded op amp circuit shown below:
   a) Find the output voltage v_{o2}
   b) Determine the range of v_s for which the both op amps of the circuit will operate linearly.



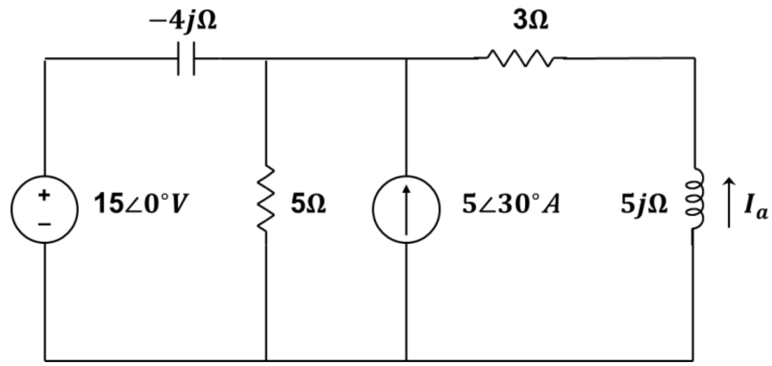
Write your answer here:

a) $v_{o2} =$ ____________________

b) Range of v_s for linear operation: ____________________

Problem 2 score: [ ]/10

3. The sources in the circuit below operate at a frequency of $\omega = 1{,}000$ rad/sec.
   a) Find the phasor current $\boldsymbol{I_a}$
   b) Determine the expression for $i_a(\mathrm{t})$.



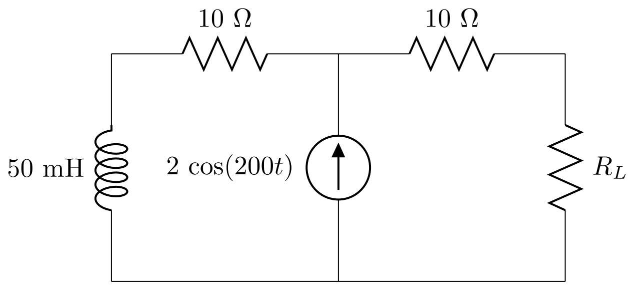
Write your answer here:

a) $\boldsymbol{I_a} =$ ____

b) $i_a(t) =$ ____

Problem 3 score: [ ]/10

4. Find the maximum power that can be delivered to R_L in the circuit below.

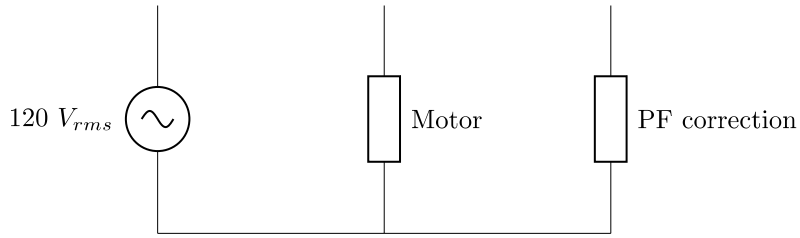


Write your answer here:

$P_{max} =$ ____

Problem 4 score: [ ]/10

5. The circuit below has a 120 V_{rms}, 60 Hz source connected to an inductive motor that dissipates real power of 5 kW at a power factor (PF) of 0.8 (lagging). Determine the capacitance required for PF correction to increase the PF to 0.96 lagging.

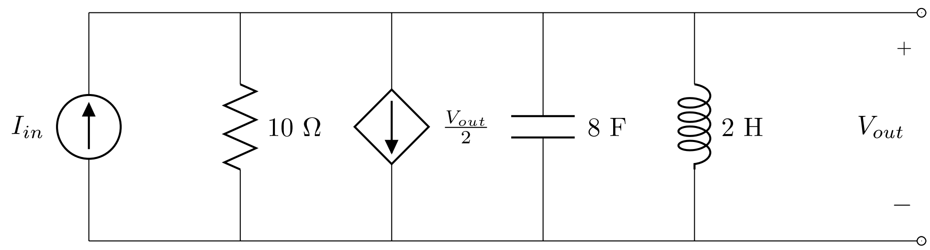


Write your answer here:

$C =$ ______________________________

Problem 5 score: [   ]/10

6. Determine the transfer function defined by $H(s) = V_{out}/I_{in}$ for the circuit below. Express the transfer function in standard form for Bode plots, e.g. $H(s)=N(s)/D(s)$ or $H(\omega) = N(\omega)/D(\omega)$ such that the numerator and denominator have clearly identifiable poles and zeros and are of the form represented on Table 14.3 (attached).



Write your answer here:

$H(s)$(OR) $H(\omega) =$ ____

Problem 6 score: [ ]/10

7. A transfer function for a circuit is given below.

$$H(s) = \frac{10{,}000s^2}{(s+10)(4s^2+32{,}000s)}$$

(OR)

$$H(\omega) = \frac{10{,}000(j\omega)^2}{(j\omega+10)(4(j\omega)^2+32{,}000j\omega)}$$

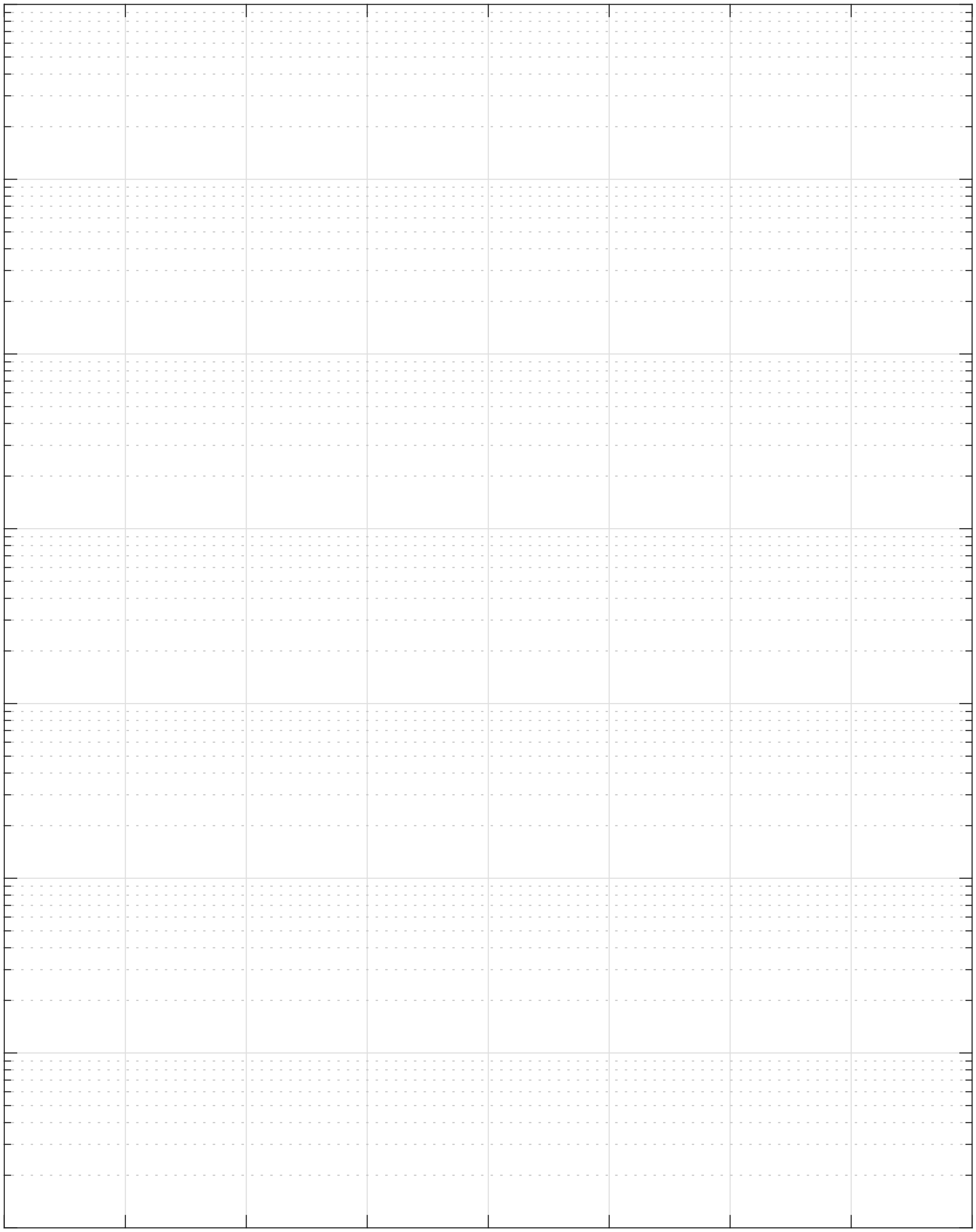
a) Identify all poles, zeros, and constant terms
b) Sketch the linear approximation to the magnitude Bode plot on the following graph on the next page. Full credit will only be granted for plots that are neat and that include clearly labeled axes and tick marks.
c) What type of filter does this circuit represent?

Write your answer here:

a) Poles, zeros, constants = ____

c) Type of filter = ____

Problem 7 score: [ ]/10



Final Exam: EECS 215
Introduction to Electronic Circuits

Reference sheets to be provided for Final Exam, Winter 2017

Capacitors and Inductors

$i = C\frac{dv}{dt}$ $\qquad v = L\frac{di}{dt}$

First Order Circuits

Step Response:

$v(t) = v(\infty) + [v(0) - v(\infty)]e^{-\frac{t}{\tau}}$

$i(t) = i(\infty) + [i(0) - i(\infty)]e^{-\frac{t}{\tau}}$

$\tau = RC\ (RC\ circuit)$

$\tau = L/R\ (RL\ circuit)$

Second Order Circuits

$$\frac{d^2x(t)}{dt^2} + 2\alpha\frac{dx(t)}{dt} + \omega_0^2 x(t) = f(t)$$

$$s_{1,2} = -\alpha \pm \sqrt{\alpha^2 - \omega_0^2}$$

Series RLC: $\alpha = R/(2L)$ $\quad \omega_0 = 1/\sqrt{LC}$

Parallel RLC: $\alpha = 1/(2RC)$ $\quad \omega_0 = 1/\sqrt{LC}$

Over Damped ($\boldsymbol{\alpha > \omega_0}$):

$$x(t) = A_1 e^{s_1 t} + A_2 e^{s_2 t} + x(\infty)$$

Critically Damped ($\boldsymbol{\alpha = \omega_0}$):

$$x(t) = (A_1 t + A_2)e^{-\alpha t} + x(\infty)$$

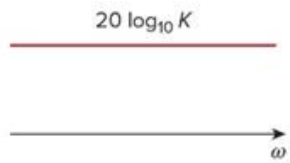
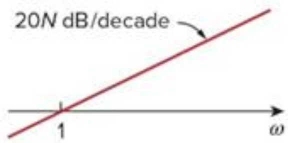
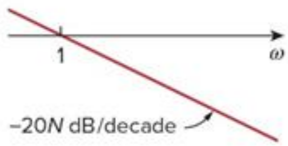
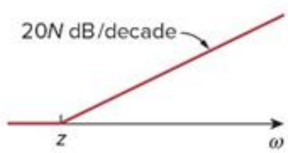
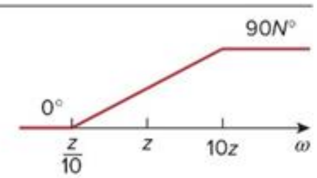
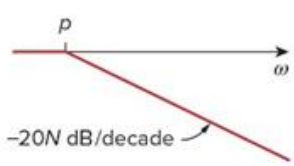
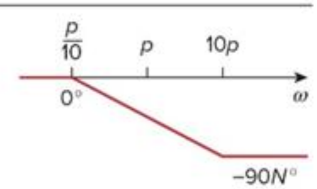
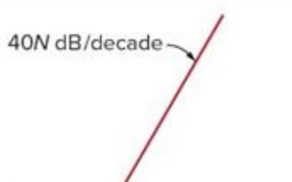
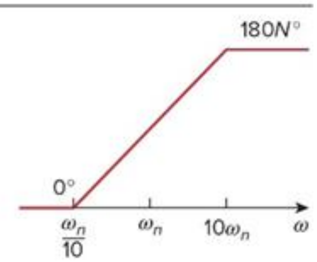
Under Damped ($\boldsymbol{\alpha < \omega_0}$):

$$x(t) = e^{-\alpha t}(B_1 \cos\omega_d t + B_2 \sin\omega_d t) + x(\infty)$$

$$\omega_d = \sqrt{\omega_0^2 - \alpha^2}$$

TABLE 14.3

Summary of Bode straight-line magnitude and phase plots.

Factor	Magnitude	Phase
K		
$(j\omega)^N$		
$\dfrac{1}{(j\omega)^N}$		
$\left(1+\dfrac{j\omega}{z}\right)^N$		
$\dfrac{1}{(1+j\omega/p)^N}$		
$\left[1+\dfrac{2j\omega\zeta}{\omega_n}+\left(\dfrac{j\omega}{\omega_n}\right)^2\right]^N$		
$\dfrac{1}{[1+2j\omega\zeta/\omega_k+(j\omega/\omega_k)^2]^N}$