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EE42/100 Midterm 2

NO CALCULATORS, CELL PHONES, or other electronics allowed. Show your work, and put final answers in the boxes provided. Use proper units in all answers.

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1. [5] Express the following power ratios in dB

P/Pref	P/Pref [dB]
20	13
50	17
$2x10^{-10}$	-97
1/4	-6
$2.5x10^{8}$	74

1pt, no partial credit
no units necessary (dB on top)

No credit for answers that include log of anything.

2. [5] Express the following voltage ratios in dB

V/Vref	V/Vref [dB]
Sqrt(2)	3
1/2	-6
0.04	-28
1	0
$2x10^{-3}$	-24

$2^2 10^{-2} \Rightarrow 2.6 \approx 2.20$

3. [8] You measure an AC voltage across a 1kΩ resistor. The digital voltmeter that you use measures in RMS (like all voltmeters), and reports that the voltage is 1 V. use units

a. What is the zero-to-peak voltage?

$V = \sqrt{2}\,1V = 1.4$ $\sqrt{2}$ OK

$V_{0\text{-}p} = 1.4\,V$

b. What is the peak-to-peak voltage

$V_{p\text{-}p} = 2.8\,V$

c. What is the max power dissipated in the resistor?

$\frac{(1.4)^2}{1K} = \frac{2V^2}{1K}$

$P_{max} = 2\,mW$

d. What is the average power dissipated in the resistor?

$V_{avg} = 1mW$

-1 1 missing unit

-2 all missing units

-1 right formula, wrong calc

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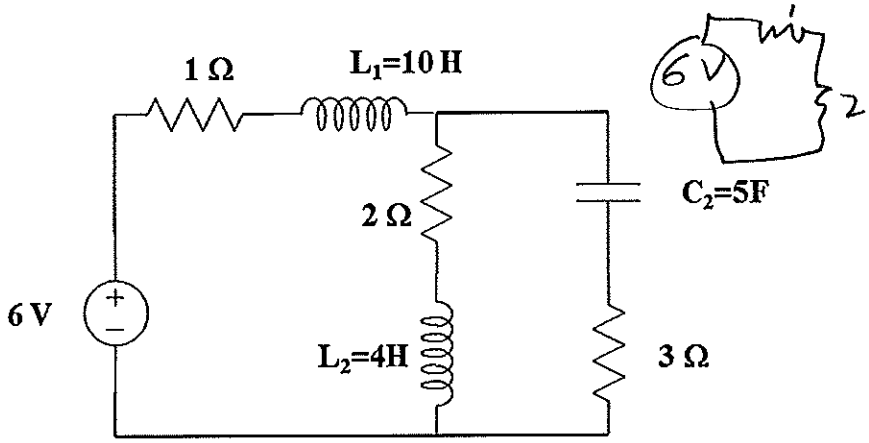
4. [10] For the circuit below, calculate the steady state values for the current in the two inductors, the voltage across the capacitor, the energy stored in L_1, and the energy stored in C_2.



I_{L1}	2 A
I_{L2}	2 A
V_{C2}	4 V
W_{L1}	20 J
W_{C2}	40 J

OK if consistent w/ wrong answer above

$\frac{1}{2} L_1 i_1^2 = \frac{1}{2}(10\,H)(2A)^2 = 20$

$\frac{1}{2} C v^2 = \frac{1}{2}(5)(4^2) = 40$

5. [10] Two capacitors, each 2μF, are charged in parallel from a single AA battery with a voltage of 1.5V, and then discharged in series into a 1kΩ load. The battery has a source resistance of 1Ω .

a. What is the equivalent capacitance seen by the battery during charging?

C_{charge}= 4μF

b. What is the time constant during charging?

τ_{charge}= 4μs

c. What is the equivalent capacitance of the series combination driving the load?

C_{series}= 1μF

d. What is the time constant during discharging?

$\tau_{discharge}$= 1ms

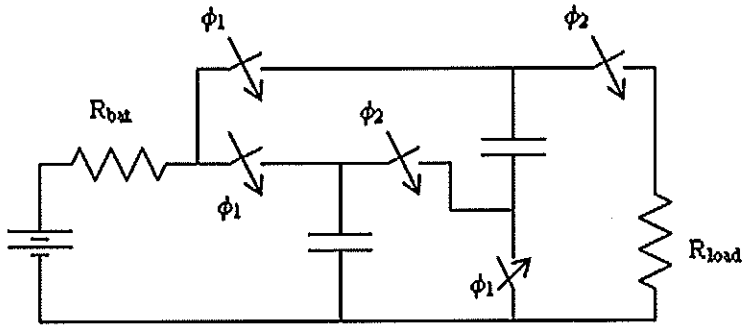
e. How long does it take for the output voltage to droop 5% after the phi2 switches are closed?

(5%)(1ms) =

$t_{5\%}$= 50μs

also accept $-0.001 \ln(0.95)$

-1 right formula wrong calc



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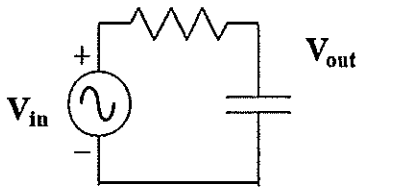
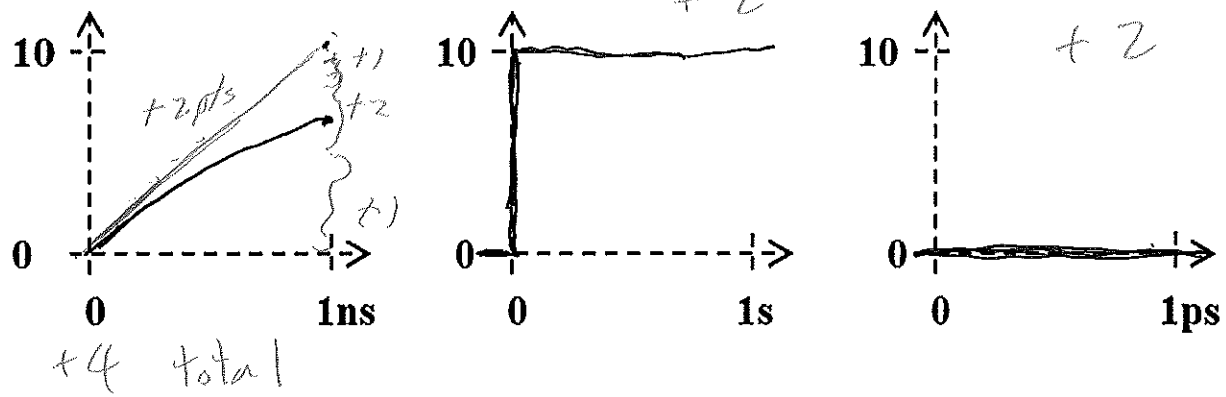
6. [10] In the RC circuit below assume V_{in} is a voltage step from 0 to 10V at t=0. If R=1 and C=1nF, sketch the response of the circuit on the three different time scales provided.

$\tau = RC = 10^{-9}s$ +2

$H(s) = \frac{1}{1 + j\omega/\omega_p}$ $\omega_p = 10^9$ rad/sec.





+4 total

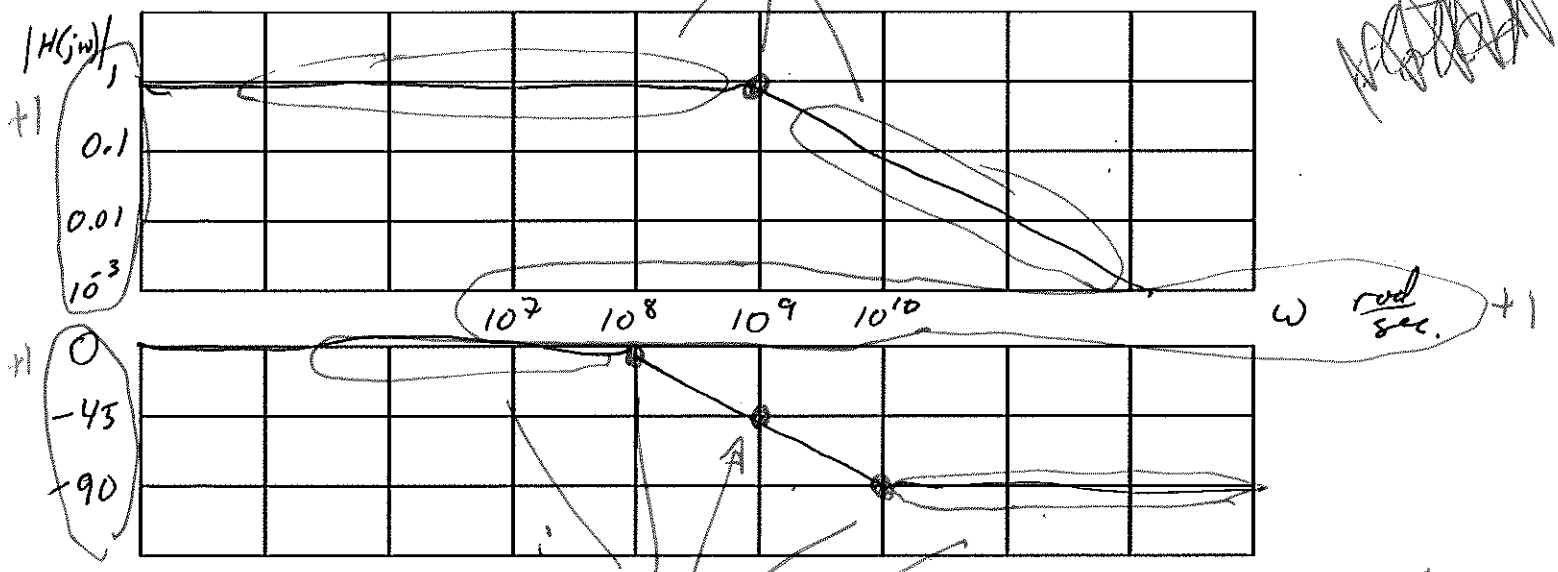
7. [8] The RC circuit above is driven by an input signal $v_{in}(t)=\sin(100t)+\cos(10^9t)$. What is $V_{out}(t)$ in steady state? $V_{out}(t) = \sin(100t) + \frac{1}{\sqrt{2}}\cos(10^9t - 45^\circ)$

2 pts each or $\sin(100t - 10^7)$ −1 each

dB OK

8. [8] Sketch a Bode plot of the transfer function of the RC circuit above. Label each axis!

−2 pts total max



−1 wrong pole freq

1pt off for missing any of these (−3 max)

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$L = 10^{-4}$ $10^7 = \frac{1}{\sqrt{10^{-4} C}}$ $10^{14} = \frac{1}{10^{-4} C}$ $C = 10^{-10}$

9. [18 total] You want to build an AM radio with an LC tank at a resonant frequency of 10^7 rad/sec. Your inductor is 100uH and has a series resistance of 20Ω.

   a. [2] How big should your capacitor be?

   C= 100pF

   b. [6] Sketch the magnitude of the inductor impedance (including series resistor) and capacitor impedance on the axes below. Label each axis!

   c. [2] Assuming an ideal capacitor, what will the Q of your LC tank be?

   $\frac{\omega_p L}{R} = \frac{10^7 10^{-4}}{20} = \frac{1000}{20} = 50$

   Q= 50

   d. [2] What is the magnitude of the tank impedance at 1 rad/sec?

   Z(j1)= 20

   e. [2] What is the magnitude of the tank impedance at 10^6 rad/sec?

   $Z(j10^6)$= 100

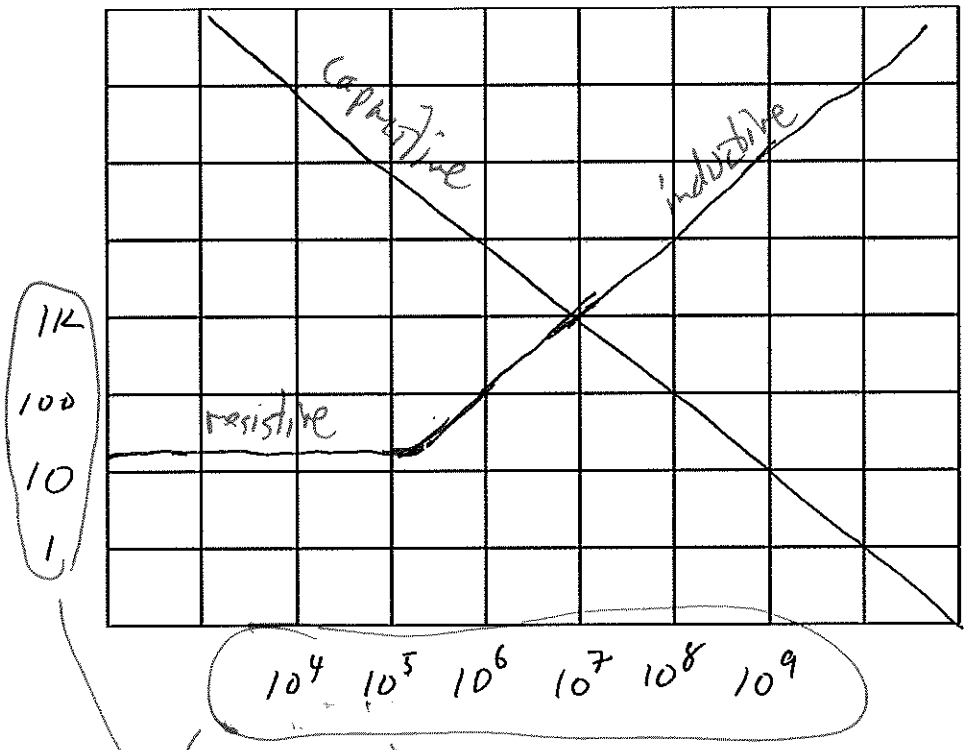
   f. [2] What is the magnitude of the tank impedance at the resonant frequency?

   Q $\omega_p L$

   $Z(j\omega_p)$= 50K

   g. [2] What is the magnitude of the tank impedance at 10^9 rad/sec?

   $Z(j10^9)$= 10



dotted

-1 total if either or both are missing

2 pts each for Resistive/inductive, capacitive parts { 1 pt shape, 1 pt correct value.

Rubric:

- Off by OOM but wrote formula (-1)
  (Wrong, no work (-2)).

only punished once on the problem for wrong units.

- (b) Missing axis (one or both) (-1)
  - 1 pt. each for crossing
  - 1 pt. each for shape
  - only squiggle 1/2 credit
  - (-1) additionally if resistor and inductor not added correctly.

- (a) Wrong units (-1)
  no units: ok.

Wrong L value (-1)

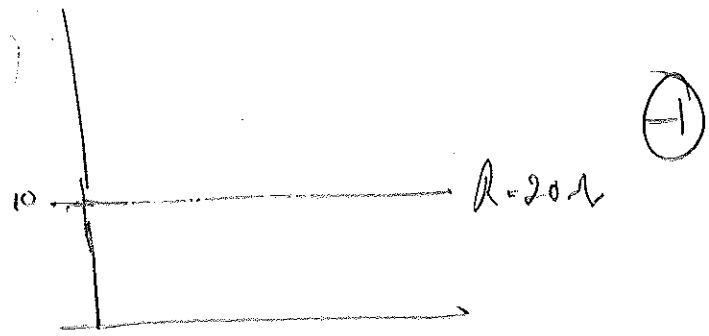
- (c) two formulas for Q (wrong answer) (-1)
- (-1) no axes labels.
- No simplification (-1)

- 120 Ω
- (e) → correct answer

full credit.

find this paper.

- (g) 20Ω instead of 10Ω (-2) (didn't use C value → used R instead).
- (f) did not multiply by Q (-1)

- 120Ω versus 100Ω
- read off correctly from their graph: no penalty, ok.
- propagated wrong L value. ok. no penalty.
- inverted Q (-1)
- just expression left but evaluates to correct answer (-1)
- Symbolic expression (-2)
- C is right
  graph is wrong (-2)
  answer is wrong, but taken from graph
- 

(-1)
- add Q instead of multiply by Q.