ECE 201, Section 3
Lecture 40

Prof. Peter Bermel

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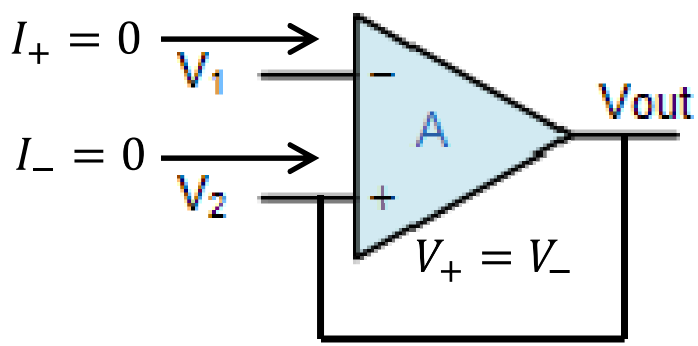
December 5, 2012

Final Exam

- Friday, December 14 from 3:30-5:30 pm in EE 129
- Review sessions:
  – Fri., Dec. 7 from 6:30-7:30 pm in MATH 175
  – Wed., Dec. 12 from 4:30-5:30 pm in ARMS 1010
- Office hours will be held MWF 12:30-1:30 pm (including Dec. 14) in EE 331A & by appointment
- TA office hours will be M-F, 8:30 am-4:30 pm, including December 14 (until 2:30 pm)

Ideal Op-Amps

- Golden rules:
  - Both input currents are zero
  - For closed loops: both input voltages are equal



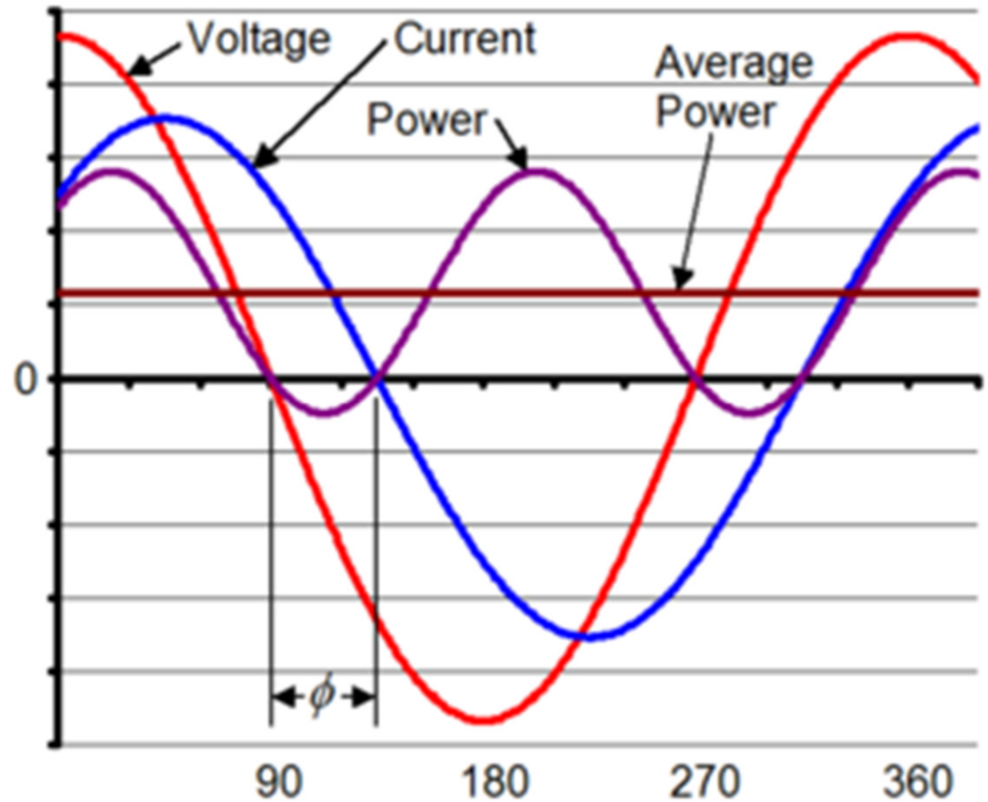
Effective Values

- We can generally define effective values for periodic signals, $f(t+T) = f(t)$, such that:

$$F_{eff} = \sqrt{\frac{1}{T}\int_{t_o}^{t_o+T} dt\, [f(t)]^2}$$

- Also known as root-mean-square (rms) value
- For AC signals, $F_{eff} = \frac{f_o}{\sqrt{2}}$

Average Power for SSS



Over half-integer periods, only the first term contributes, so that:

$$P_{ave} = IV\cos\phi$$

Complex Power

- Complex power is defined as:

$$\boldsymbol{S} = \boldsymbol{I}^*\boldsymbol{V}$$

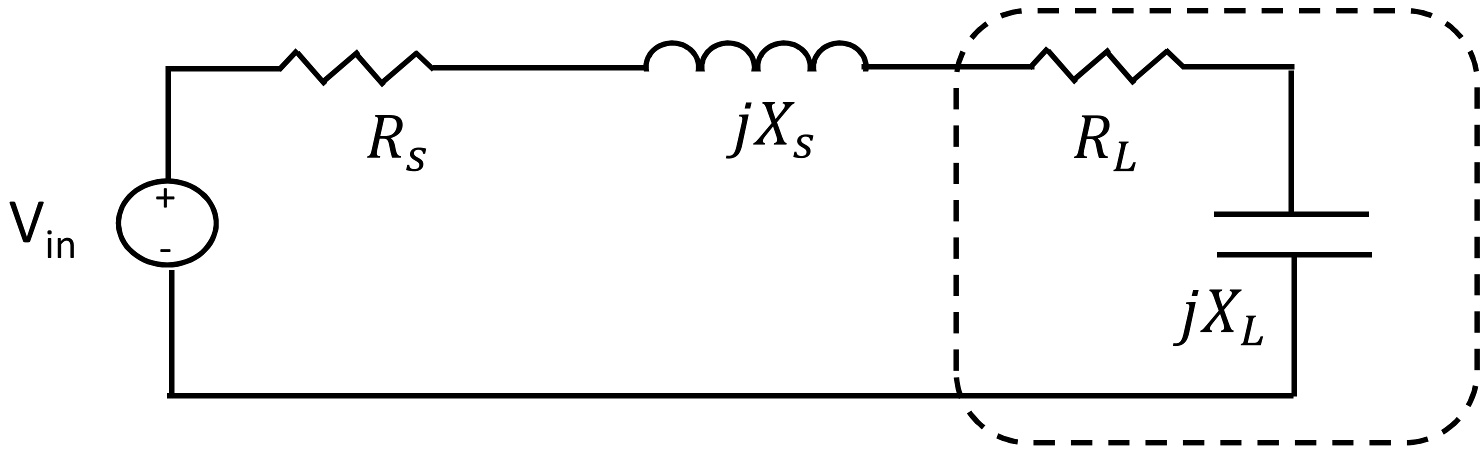
- For AC signals:

$$\boldsymbol{S} = Ie^{-j\omega t}Ve^{j(\omega t+\phi)}$$

$$\boldsymbol{S} = IVe^{j\phi} = IV(\cos\phi + j\sin\phi)$$

- Key definitions:
  - Re S – average power
  - Im S – reactive power
  - |S| – apparent power
  - $\cos\phi$ – power factor

Maximum Power Transfer



- For a source with impedance $Z_s = R_s + jX_s$, maximum power is transferred when load impedance $Z_L = Z_s^*$
  - Resistances are equal: $R_L = R_s$
  - Reactances are opposite: $X_L = -X_s$
- Magnitude of maximum power transfer:

$$P_{max} = \frac{V_{s,eff}^2}{4R_s}$$

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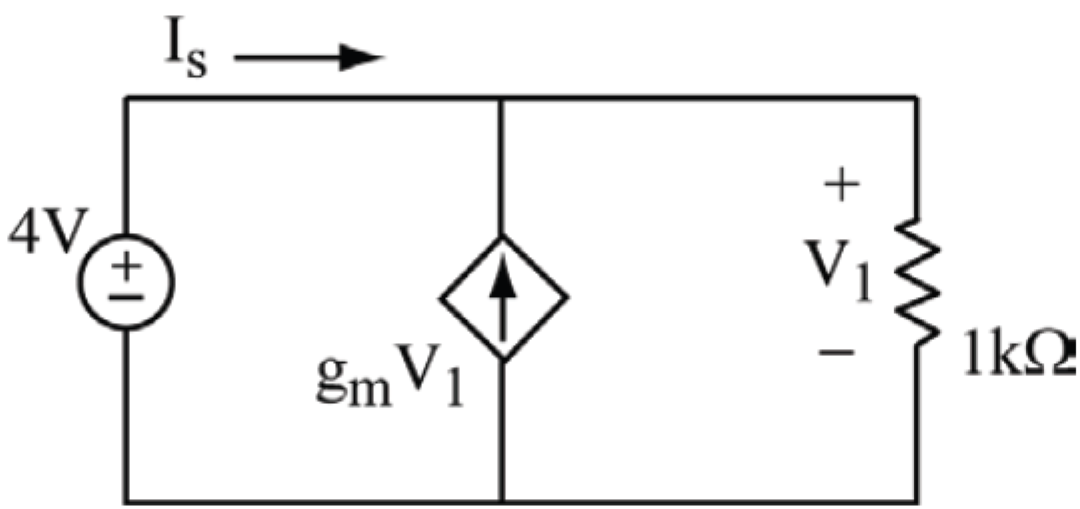
2. (6 pts) If the transconductance (g_m) equals 0.002 S, find the current I_s.



(1) 1A	(2) 2mA	(3) –2A	(4) –4mA
(5) 8mA	(6) 4A	(7) 0	

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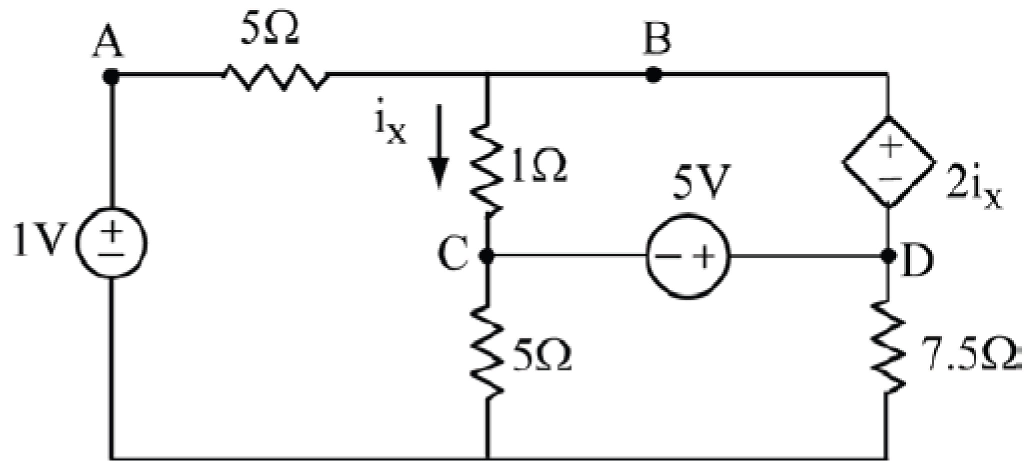
3. (9 pts) Find the power delivered by the dependent source (in W) using nodal or mesh analysis.



1) 10 | 2) 20 | (3) 30 | (4) 40
(5) 50 | (6) 60 | (7) 70

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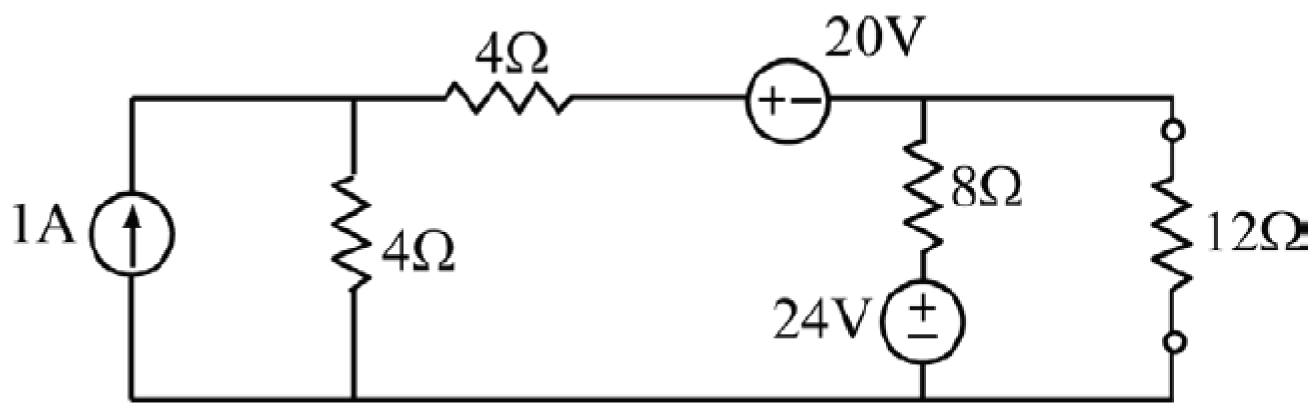
4. (9 pts) Using source transformation, find the power delivered to the 12 Ω resistor (in W)



(1) 1 (2) 12 (3) 0.75 (4) 48

(5) 0.5 (6) 0.0625 (7) 24

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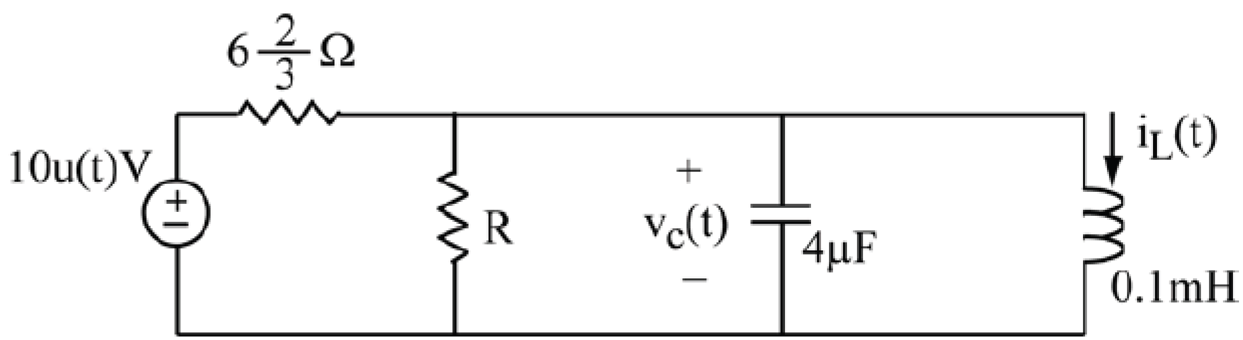
7. (9 pts) Find R (in Ω) for the capacitor voltage $v_c(t)$ for $t > 0$ to be critically damped.



(1) 20/3 (2) 2.5 (3) 3/20 (4) 0.4

(5) 5 (6) 4 (7) 1.25

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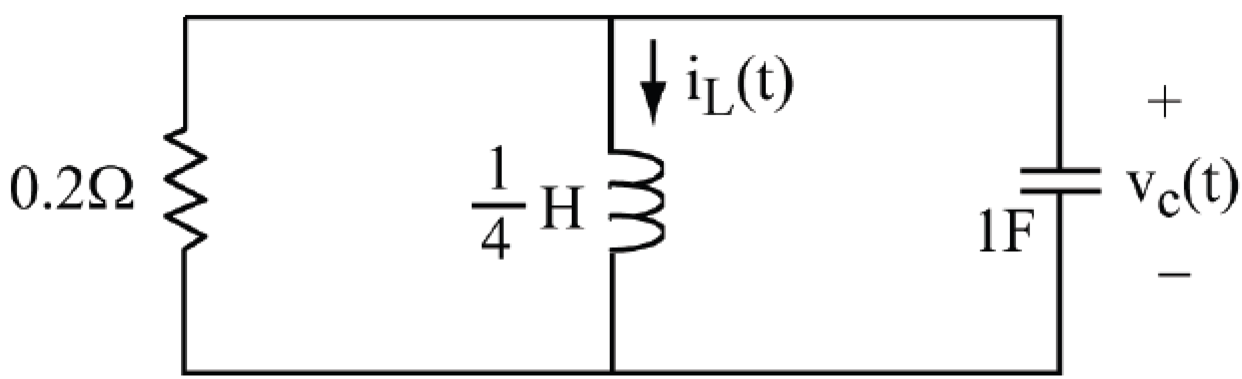
8. (9 pts) The circuit below has initial conditions, $i_L(0^-) = 8$ A and $v_C(0^-) = 20$ V. Find the value of $\frac{dv_c(0^+)}{dt}$ (in V/s).



(1) 12 (2) –4 (3) –92 (4) 8

(5) –108 (6) 92 (7) 0

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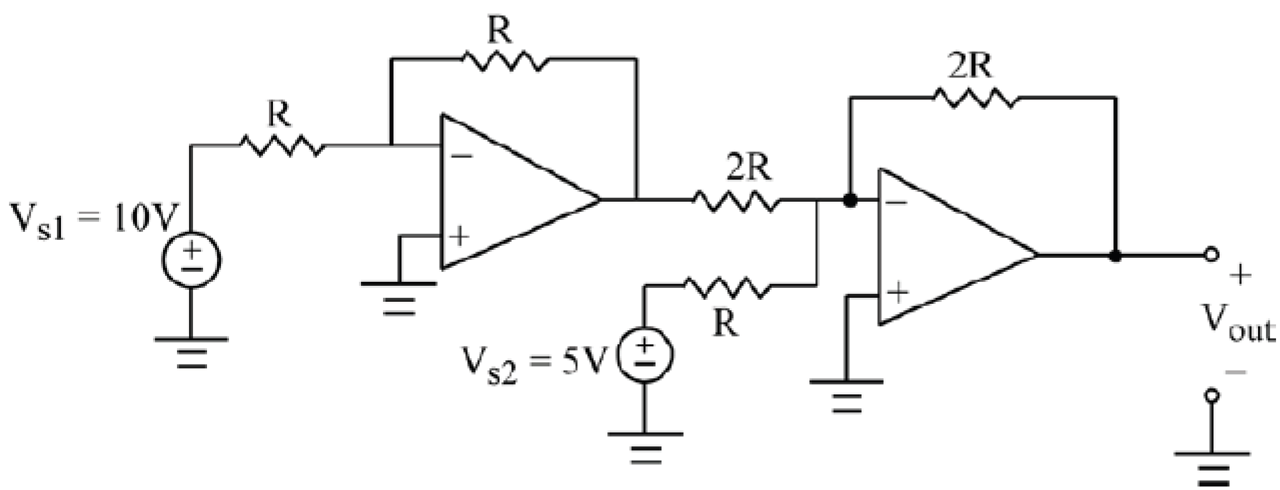
9. (9 pts) If the input voltage $V_{s1} = 10V$ and the input voltage $V_{s2} = 5V$, then V_{out} is (in V):



(1) 20 (2) 15 (3) –10 (4) 5

(5) 0 (6) –15

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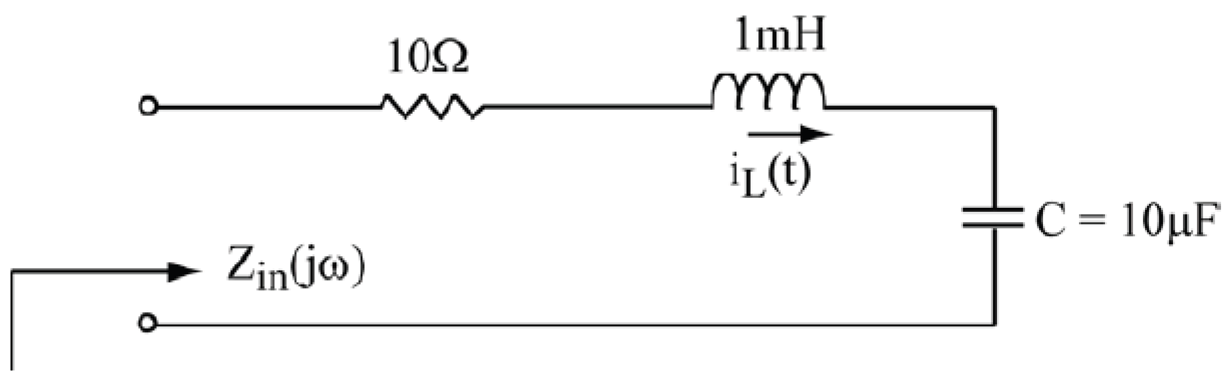
11. (9 pts) Determine the frequency ω, in rad/s, for which the input impedance $Z_{in}(j\omega)$ is purely resistive.



(1) 10,000 (2) 100,000 (3) 1,000,000 (4) 316

(5) 3160 (6) 31600 (7) 25

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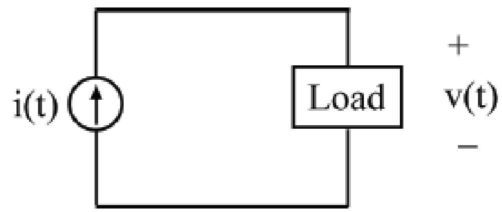
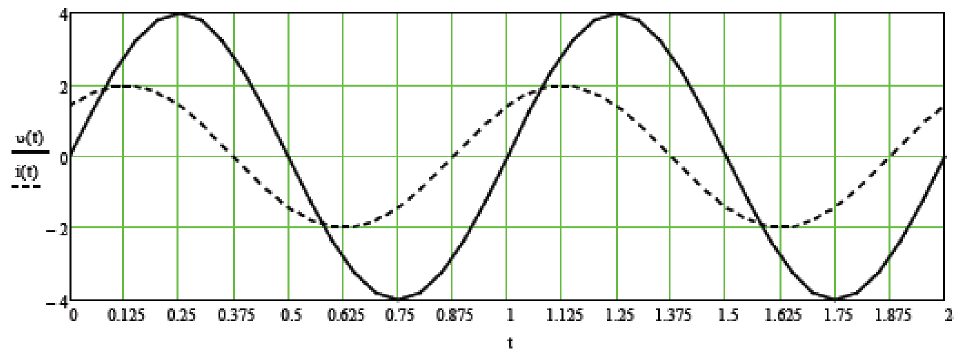
17. (9 pts) The load shown below consists of one resistor and one capacitor. Using the voltage and current waveforms shown below, compute the average power absorbed by the resistor in the load. Assume ω=2π rad/sec.





(1)	2 W	(2)	4 W
(3)	$\frac{2}{\sqrt{2}}$ W	(4)	$\frac{4}{\sqrt{2}}$ W
(5)	2 + j2 VA	(6)	2 – j2 VA
(7)	4 + j2 VA	(8)	4 – j2 VA

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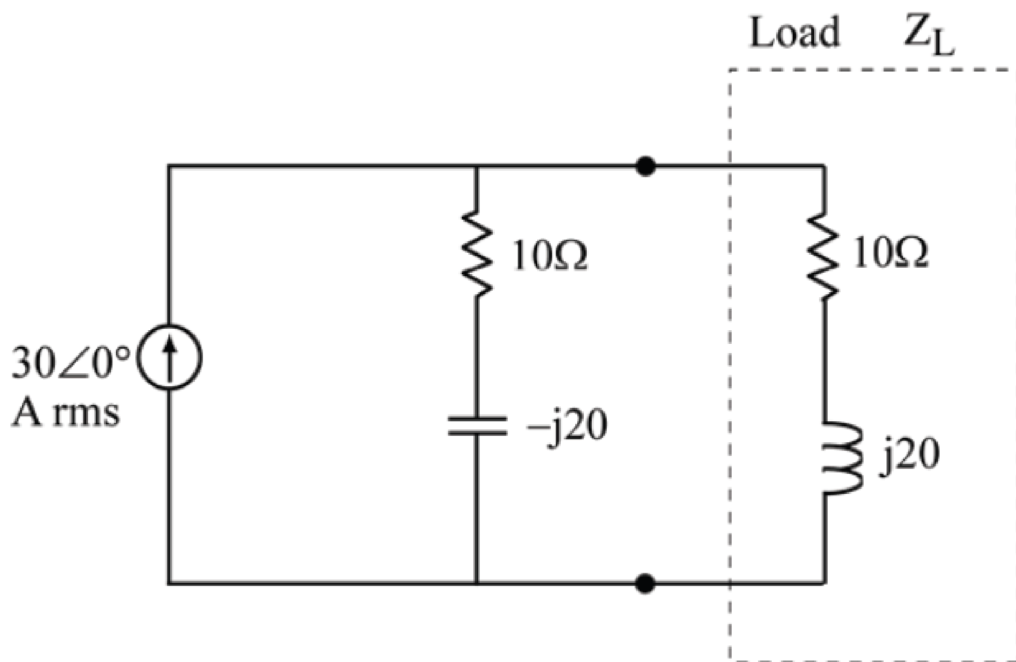
18. (9 pts) Find the complex power delivered to the load Z_L. Assume $\mathbf{I}_S = 30\angle 0°$ A rms.



(1) 11250 + j11250 VA
(2) 11250 - j11250 VA
(3) 11250 + j22500 VA
(4) 22500 + j11250 VA
(5) 11250 - j22500 VA
(6) 22500 - j11250 VA
(7) 22500 + j22500 VA

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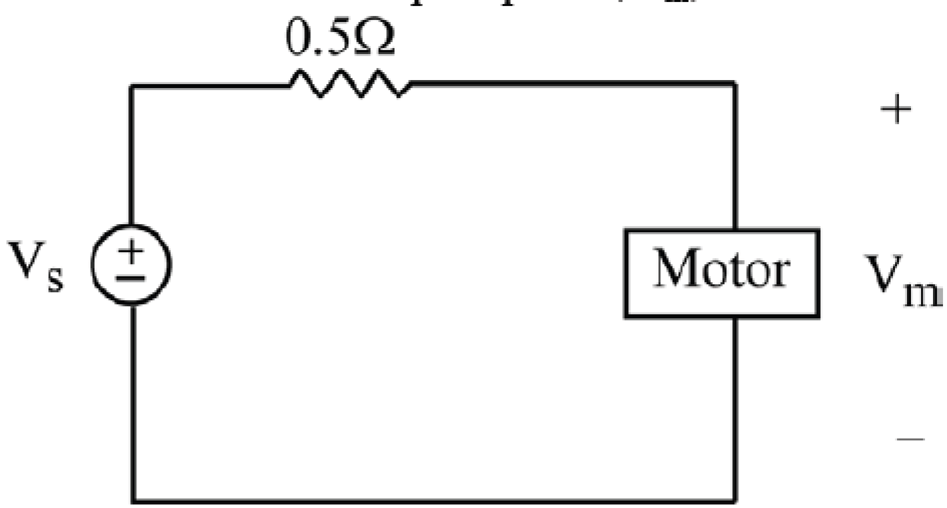
19. (9 pts) Consider a source that drives an electric motor that consumes an average power of 50kW at a power factor (pf) of "$1/\sqrt{2}$ lagging". Assume the motor needs a fixed voltage of $V_m = 110\angle 0°$. Find the complex power, $\mathbf{S}_m$, delivered to the motor. Assume $\omega = 120\pi$ rad/sec.



(1)	50 + j50 kVA	(2)	50 - j50 kVA
(3)	50 + j100 kVA	(4)	50 - j100 kVA
(5)	100 + j50 kVA	(6)	100 - j50 kVA
(7)	100 + j100 kVA		

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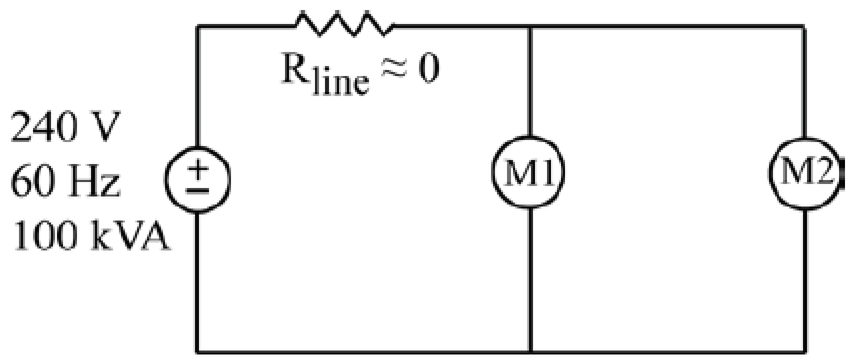
20. (9 pts) A voltage source rated at 240V, 60Hz and 100kVA is used to operate two equally-rated, 40kW motors. Find the minimum power factor (pf) rating for the motors that can be operated by the available voltage source. Neglect line losses.



(1) 0.9 (2) 0.8 (3) 0.7 (4) 0.6

(5) 0.5 (6) 0.4 (7) 0.3

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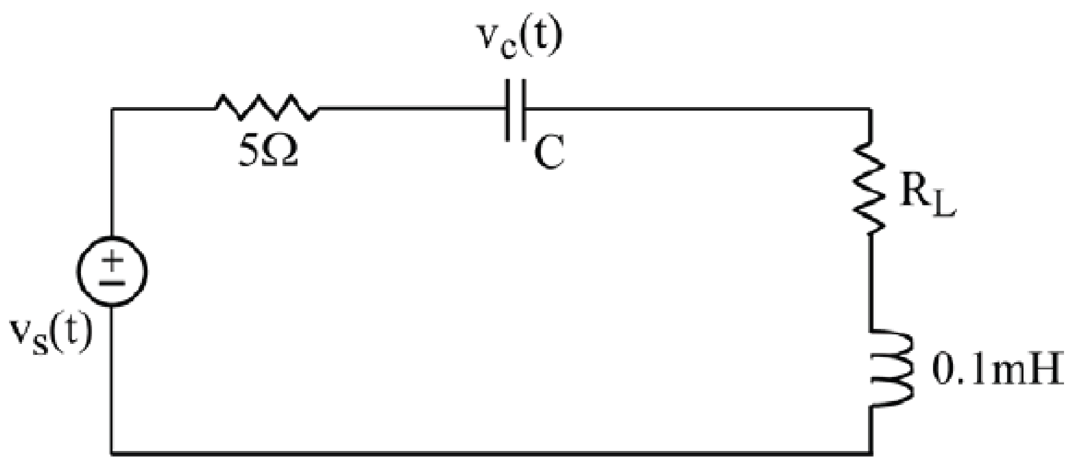
22. (9 pts) In the circuit below, $v_s(t) = 50\sqrt{2}\cos(2000t)V$. Find C (in mF) such that the maximum average power is absorbed by R_L, and find the maximum average power absorbed by R_L (in W).



(1) 1.25 mF, 125 W (2) 2.5 mF, 500 W (3) 3.75 mF, 250 W (4) 1.25 mF, 500 W

(5) 2.5 mF, 125 W (6) 3.75 mF, 500 W (7) 2.5 mF, 250 W

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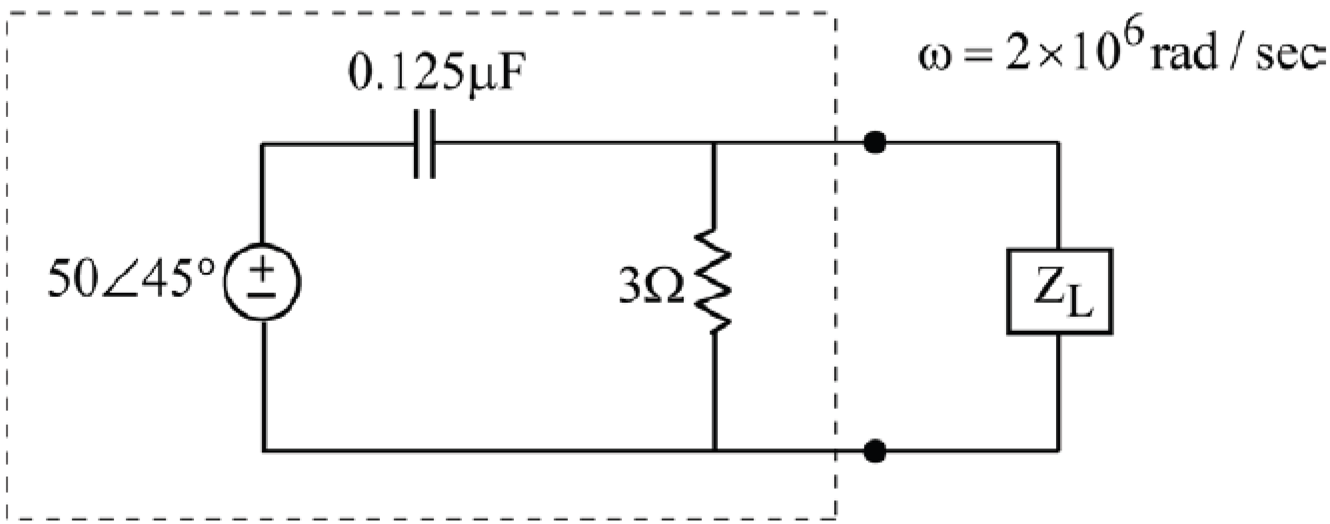
23. (9 pts) Find the load impedance (Z_L) that will absorb maximum power from the source network in the dotted line. Assume $\omega = 2\times10^6$ rad/sec.



(1)	$1.68 + j1.44\ \Omega$	(2)	$1.68 - j1.44\ \Omega$
(3)	$1.92 + j1.44\ \Omega$	(4)	$1.92 - j1.44\ \Omega$
(5)	$1.92 + j1.68\ \Omega$	(6)	$1.92 - j1.68\ \Omega$
(7)	$1.92 + j1.92\ \Omega$		

Homework

- HW #39 due today at 4:30 pm in EE 325B
- HW #40 (last one!) due Fri.: DeCarlo & Lin, Chapter 11:
  - Problem 30
  - Problem 32 [Correction: In ANSWER: change 250 watts to 4000 watts.]