ECE 20100 – Spring 2017
Final Exam

May 2, 2017

Section (circle below)

Qi (12:30) – 0001　　Tan (10:30) – 0004　　Hosseini (7:30) – 0005

Cui (1:30) – 0006　　Jung (11:30) – 0007

Lin (9:30) – 0008　　Peleato-Inarrea (2:30) – 0009

Name ______________________________　　PUID_____________

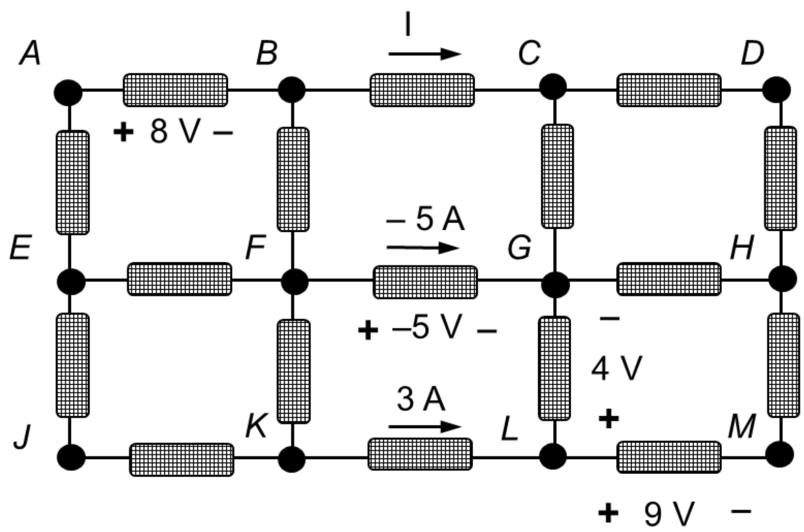
Instructions

1. DO NOT START UNTIL TOLD TO DO SO.
2. Write your name, section, professor, and student ID# on your **Scantron** sheet. We may check PUIDs.
3. This is a CLOSED BOOKS and CLOSED NOTES exam.
4. The use of a TI-30X IIS calculator is allowed.
5. If extra paper is needed, use the back of test pages.
6. Cheating will not be tolerated. Cheating in this exam will result in, at the minimum, an F grade for the course. In particular, **continuing to write after the exam time is up is regarded as cheating**.
7. If you cannot solve a question, be sure to look at the other ones, and come back to it if time permits.

By signing the scantron sheet, you affirm you have not received or provided assistance on this exam.

Question 1:

In the circuit shown, rectangular shapes represent general circuit elements (either resistors or sources). Find the current (I) between nodes B and C (in A).



(1) – 4

(2) – 3

(3) – 2

(4) – 1

(5) 1

(6) 2

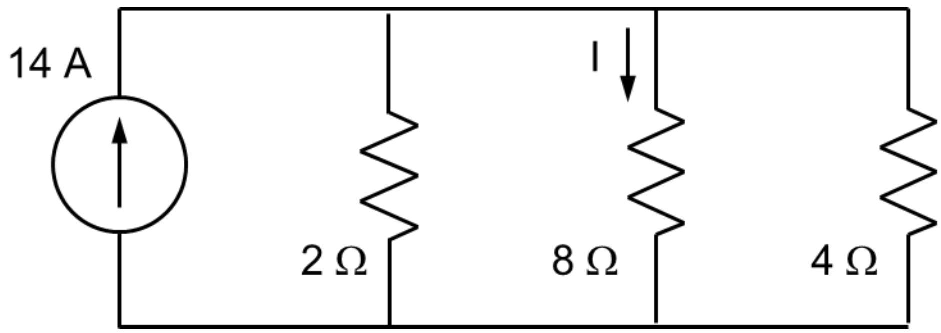
(7) 3

(8) 4

(9) None of the above

Question 2:

Find the value of the current (I) in the circuit below (in A).



(1) 1

(2) 2

(3) 3

(4) 4

(5) 5

(6) 6

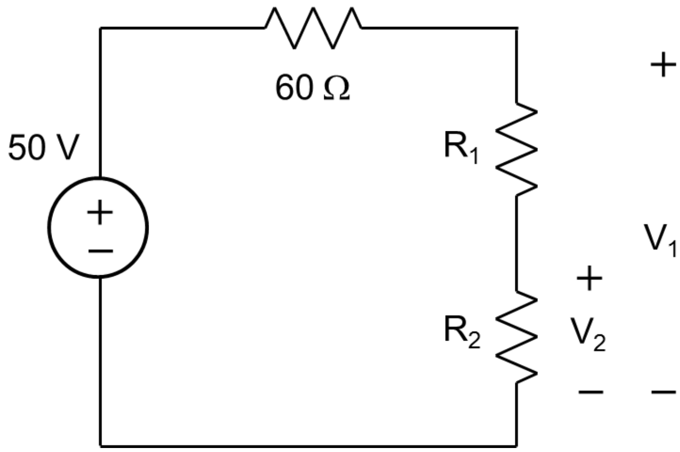
(7) 7

(8) 8

(9) None of the above

Question 3:

In the circuit below, V_1 = 35 V and V_2 = 10 V. Find the value of R_1 (in Ohm) to achieve these voltages.



(1) 10

(2) 20

(3) 40

(4) 50

(5) 60

(6) 75

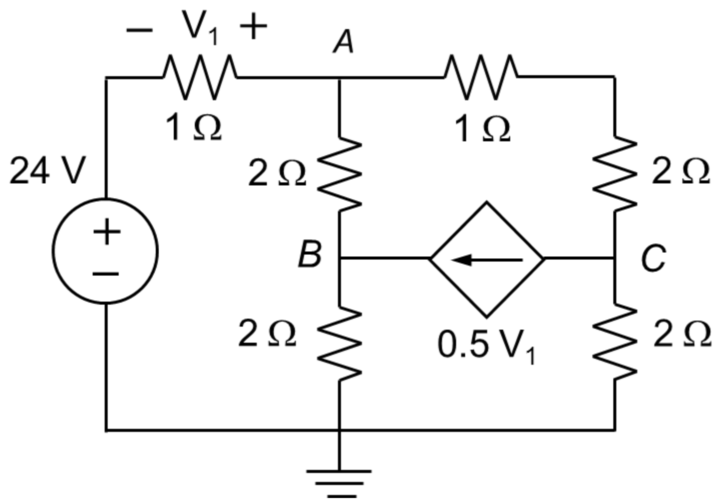
(7) 80

(8) 100

(9) None of the above

Question 4:

In the circuit below, find nodal voltage V_B (in Volts) when nodal voltage V_A equals 16 V.



(1) 1

(2) 2

(3) 3

(4) 4

(5) 8

(6) 12

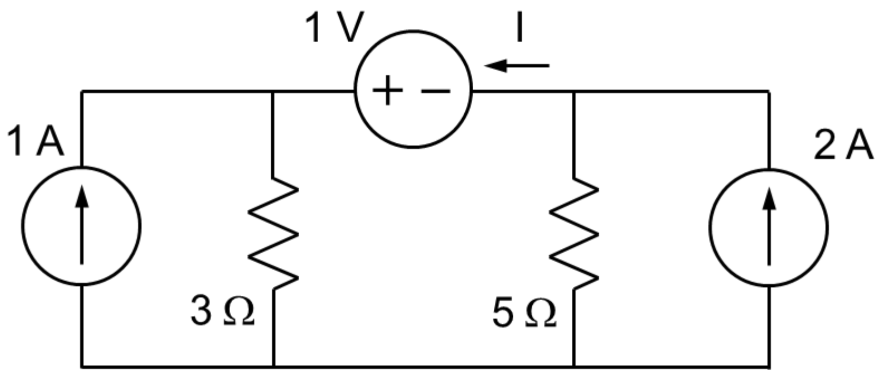
(7) 16

(8) 20

(9) None of the above

Question 5:

Use source transformation to determine the current *I* in the circuit below. Find the current *I* (in A).



(1) 1

(2) 2

(3) 3

(4) 5

(5) – 1

(6) – 2

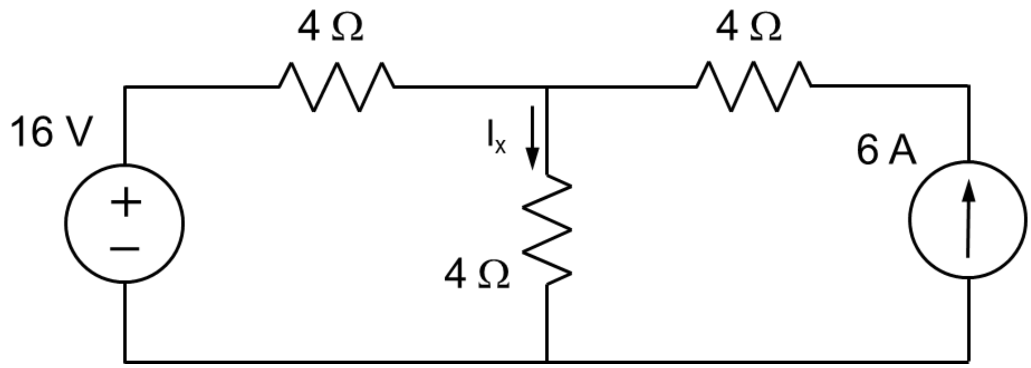
(7) – 3

(8) – 5

(9) None of the above

Question 6:

Using superposition, find the contributions to the current I_x (in A) from each source (VS – voltage source active only; CS – current source active only).



(1) $i_x(VS) = 0.5$; $i_x(CS) = 2$

(2) $i_x(VS) = 1$; $i_x(CS) = 2$

(3) $i_x(VS) = 1.5$; $i_x(CS) = 4$

(4) $i_x(VS) = 16$ $i_x(CS) = 1.5$

(5) $i_x(VS) = 0.3$; $i_x(CS) = 0.75$

(6) $i_x(VS) = 4$; $i_x(CS) = 1$

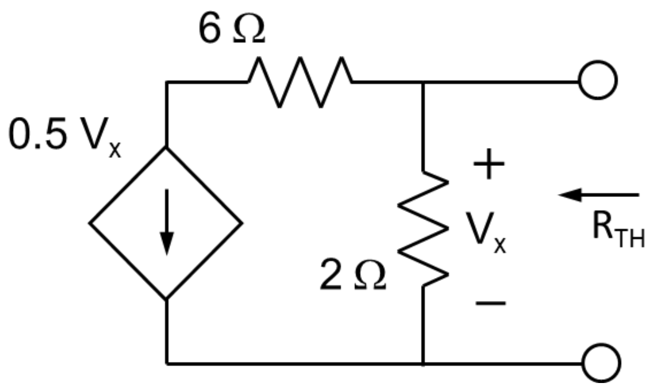
(7) $i_x(VS) = 2$; $i_x(CS) = 3$

(8) $i_x(VS) = 2$; $i_x(CS) = 1.5$

(9) None of the above

Question 7:

Find the Thévenin equivalent resistance, R_{th} for the circuit below (in Ω).



(1) 1

(2) 2

(3) 3

(4) 4

(5) 5

(6) 6

(7) 7

(8) 8

(9) None of the above

Question 8:

In a first-order RC circuit, the capacitor voltage is represented as,

$$v_C\,(t) = 10\,(1 - e^{-t/3})\text{ V}$$

Find the time (in s) required for the capacitor voltage to change from 2 V to 8 V.

(1) 1 ln(5/2)

(2) 1 ln(3)

(3) 1 ln(4)

(4) 1 ln(10)

(5) 3 ln(5/2)

(6) 3 ln(3)

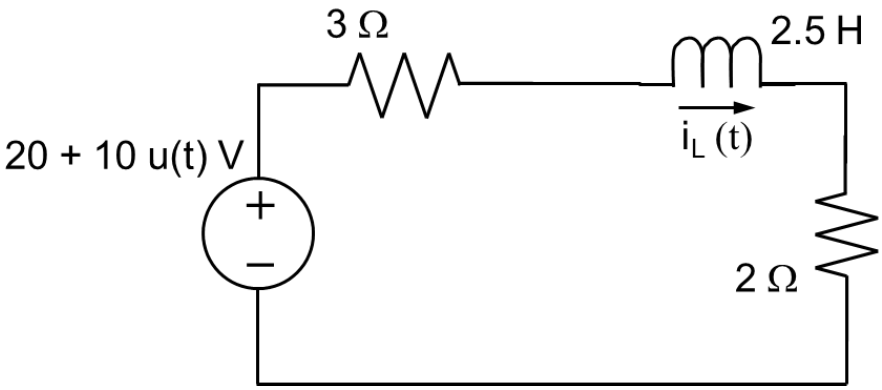
(7) 3 ln(4)

(8) 3 ln(10)

(9) None of the above

Question 9:

In the circuit shown, find the inductor current $i_L(t)$ for $t \geq 0$ s (in A).



(1) $7.5 - 2.5\, e^{-2t}$

(2) $7.5 - 2.5\, e^{-0.5t}$

(3) $5\, e^{-2t}$

(4) $5\, e^{-0.5t}$

(5) $6 - 2\, e^{-2t}$

(6) $6 - 2\, e^{-0.5t}$

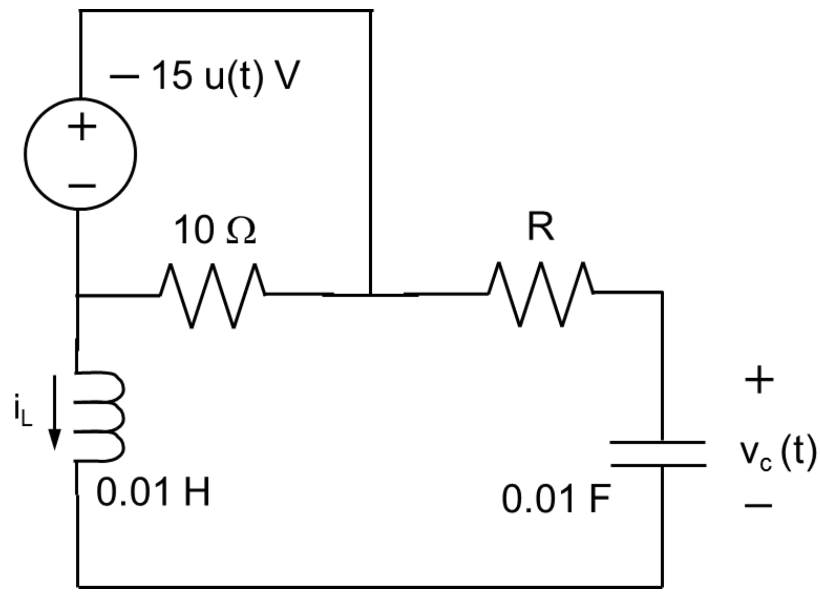
(7) $4.5 - 2.5\, e^{-2t}$

(8) $4.5 - 2.5\, e^{-0.5t}$

(9) None of the above

Question 10:

Find the range for resistance R (in Ohm) that makes the circuit *underdamped*.



(1) $0 \le R \le 2$

(2) $0 \le R \le 4$

(3) $0 \le R \le 5$

(4) $0 \le R \le 10$

(5) $2 \le R \le \infty$

(6) $4 \le R \le \infty$

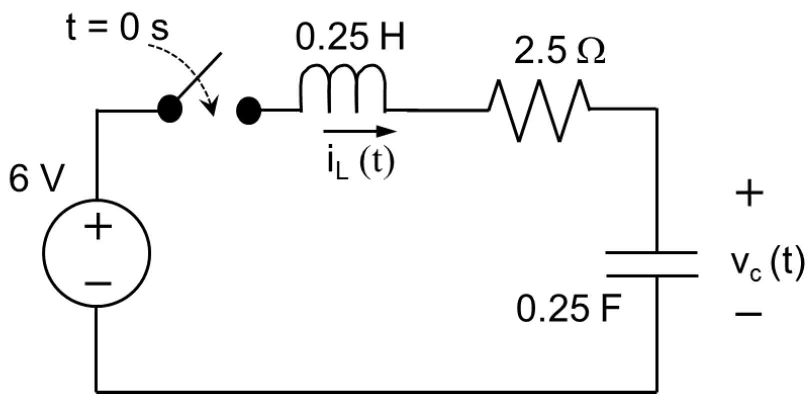
(7) $5 \le R \le \infty$

(8) $10 \le R \le \infty$

(9) None of the above

Question 11:

In the following circuit, the switch has been open for a long time and it closes at $t = 0$ s. The capacitor voltage $v_C\ (t)$ was 0 V at $t = 0^-$ s. Find the capacitor voltage $v_C\ (t)$ for $t \geq 0$ s (in Volts).



(1) $6 - 6(1 + t)\, e^{-2t}$

(2) $6 - (6 \cos 8t + 8 \sin 8t)\, e^{-2t}$

(3) $6 + 2\, e^{-8t} - 8\, e^{-2t}$

(4) $8\, e^{-8t} - 8\, e^{-2t}$

(5) $6 - 6(1 + t)\, e^{-8t}$

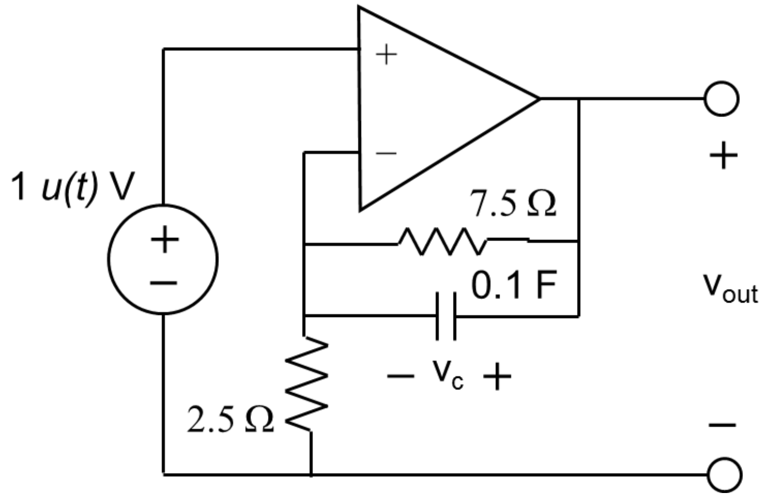
(6) $6 + (-8 \cos 8t + 6 \sin 8t)\, e^{-2t}$

(7) $6 + 8\, e^{-8t} - 6\, e^{-2t}$

(8) None of the above

Question 12:

In the ideal op amp circuit below, find $v_{out}(\infty)$ (in Volts).



(1) 1

(2) 2

(3) 3

(4) 4

(5) 5

(6) 6

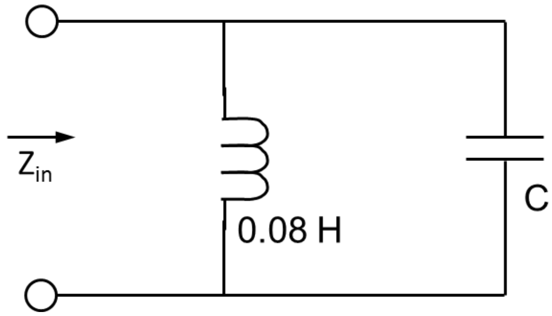
(7) 7

(8) 8

(9) None of the above

Question 13:

The circuit shown is to have an input impedance of $Z_{in}(j\omega) = 25j$ Ohm at $\omega = 100$ rads/sec. Find the capacitance C to achieve this impedance (in mF).



(1) 0.10

(2) 0.23

(3) 0.37

(4) 0.44

(5) 0.50

(6) 0.66

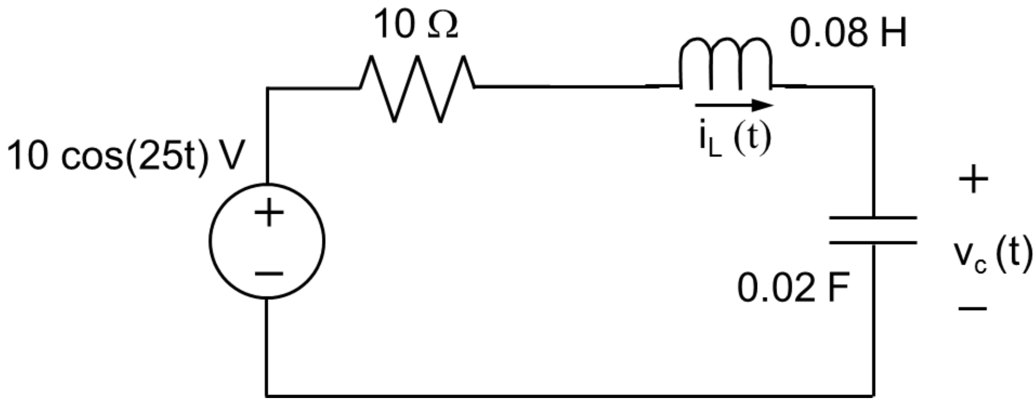
(7) 0.85

(8) 1.0

(9) None of the above

Question 14:

In the following circuit, find the sinusoidal steady state capacitor voltage v_C *(t)* (in Volts).



(1) cos(25t)

(2) 2 cos(25t + 90°)

(3) 2 cos(25t − 90°)

(4) 2 cos(25t)

(5) 0.2 cos(25t − 90°)

(6) 0.2 cos(25t + 90°)

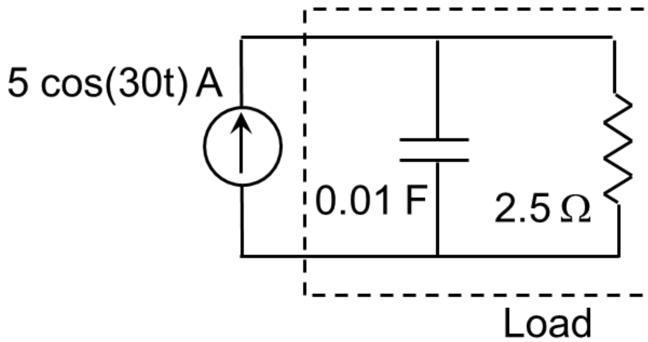
(7) 0.2 cos(25t)

(8) 0

(9) None of the above

Question 15:

Find the instantaneous power (in W) absorbed by the load.



(1) $5\cos(53.13°) + 5\cos(60t + 53.13°)$

(2) $25\cos(53.13°) + 25\cos(60t + 53.13°)$

(3) $12.5\cos(53.13°) + 12.5\cos(60t + 53.13°)$

(4) $25\cos(53.13°) + 5\cos(30t + 53.13°)$

(5) $5\cos(-36.87°) + 5\cos(60t - 36.87°)$

(6) $25\cos(-36.87°) + 25\cos(30t - 36.87°)$

(7) $12.5\cos(-36.87°) + 12.5\cos(60t - 36.87°)$

(8) $25\cos(-36.87°) + 25\cos(60t - 36.87°)$

(9) None of the above

Question 16:

Find the effective (rms) value (in V rms) of the voltage waveform,

$$v\,(t) = 5\,(1 + \cos(\omega t))\ \text{V}$$

(1) 5

(2) $2.5\sqrt{2}$

(3) $5\sqrt{2}$

(4) $5\sqrt{3/2}$

(5) $5 + 2.5\sqrt{2}$

(6) $5 + 5\sqrt{2}$

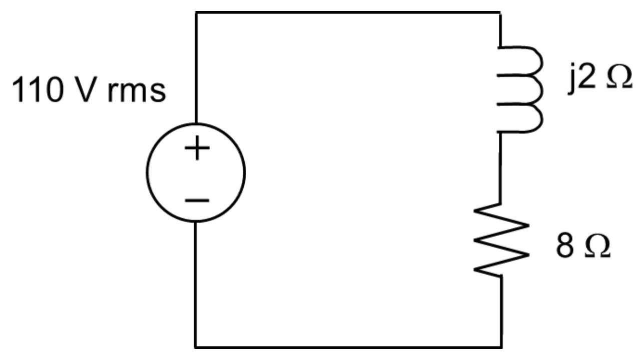
(7) $5 + 5\sqrt{3/2}$

(8) 7.5

(9) None of the above

Question 17:

Find the apparent power (in VA) supplied by the 110 V rms source.



(1) 875.6

(2) 1023.9

(3) 1237.1

(4) 1467.3

(5) 1612.5

(6) 1866.2

(7) 2085.2

(8) 3025.0

Question 18:

Find the complex power delivered to a load that absorbs 1 kW average power with a power factor (pf) equal to 0.91 *leading* (in VA):

(1) 1,000 + j118.4

(2) 1,000 + j237.1

(3) 1,000 + j314.5

(4) 1,000 + j455.6

(5) 1,000 − j118.4

(6) 1,000 − j237.1

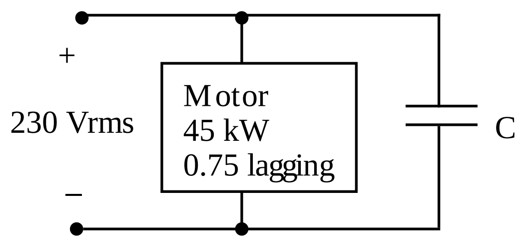
(7) 1,000 − j314.5

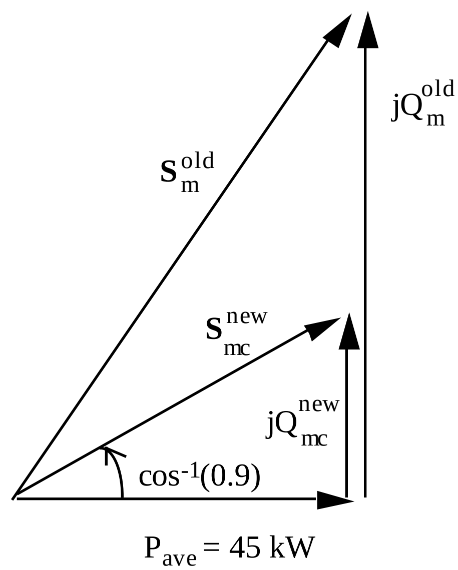
(8) 1,000 − j455.6

(9) None of the above

Question 19:

The motor in the circuit below consumes 45 kW at a power factor of 0.75 lagging. The effective voltage across the motor is 230 V at $\omega = 120\pi$. A capacitor is put in parallel with the motor to increase the power factor to 0.9 lagging. It is already known that with compensation, $Q_{mc}^{new} = 21.8$ kVAR, and without compensation, $Q_m^{old} = 39.7$ kVAR. The capacitance (in μF) is:





(1) 7801.7

(2) 1994.4

(3) 897.6

(4) 472.0

(5) 99.0

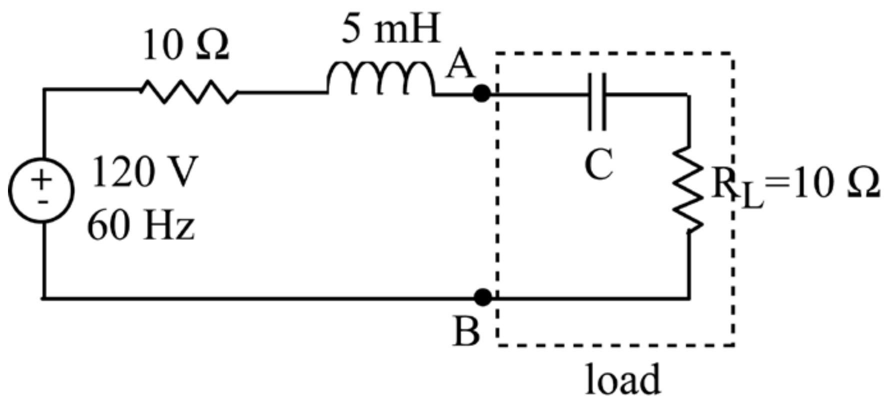
(6) 26.5

(7) 21.2

(8) 15.4

Question 20:

Find the value of C (in mF) that will deliver maximum power to R_L.



(1) 0.0014

(2) 0.055

(3) 0.53

(4) 1.41

(5) 14.1

(6) 55.6

(7) 251.6

(8) 530.5

Potentially Useful Formulas (2nd Midterm)

$$x(t) = x(\infty) + \left[x(t_0^+) - x(\infty) \right] e^{-(t-t_0)/\tau} \text{ , where } \tau = R_{TH} C \text{ or } \tau = \frac{L}{R_{TH}}$$

$$v_L(t) = L \frac{di_L(t)}{dt} \qquad\qquad i_C(t) = C \frac{dv_C(t)}{dt}$$

$$i_L(t) = i_L(t_0) + \frac{1}{L} \int_{t_0}^{t} v_L(t') dt' \qquad\qquad v_C(t) = v_C(t_0) + \frac{1}{C} \int_{t_0}^{t} i_C(t') dt'$$

$$W_L(t_0, t_1) = \frac{L}{2} \left[\left(i_L(t_1) \right)^2 - \left(i_L(t_0) \right)^2 \right] \qquad\qquad W_C(t_0, t_1) = \frac{C}{2} \left[\left(v_C(t_1) \right)^2 - \left(v_C(t_0) \right)^2 \right]$$

$$-\ln x = \ln \frac{1}{x}$$

Elapsed time formula: $t_2 - t_1 = \tau \ln[(X_1 - x(\infty))/(X_2 - x(\infty))]$

Potentially Useful Formulas (3rd midterm)

First order circuit: $x(t) = x(\infty) + \left[x(t_o^+) - x(\infty)\right]e^{-\left(t-t_o^+\right)/\tau}$, $\tau = L/R$ or $\tau = RC$

Series RLC: $s^2 + \frac{R}{L}s + \frac{1}{LC} = 0$

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

$$x(t) = x(\infty) + \left(A\cos\omega_d t + B\sin\omega_d t\right)e^{-\sigma t}$$

$$x(t) = x(\infty) + \left(A + Bt\right)e^{-\sigma t}$$

$$x(t) = x(\infty) + \left(Ae^{s_1 t} + Be^{s_2 t}\right)$$

$s_1, s_2 = \frac{-b \pm \sqrt{b^2 - 4c}}{2}$ for $s^2 + bs + c = 0$, where $c = \left(LC\right)^{-1}$

$$\sigma = \frac{b}{2} = \begin{cases} R/2L & \text{(series)} \\ \frac{1}{2RC} & \text{(parallel)} \end{cases}$$

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

$$s_{1,2} = -\sigma \pm \sqrt{\sigma^2 - \omega_o^2}$$

$$\omega_d = \frac{\sqrt{4c - b^2}}{2} = \sqrt{\omega_o^2 - \sigma^2}$$

Potentially Useful Formulas (since Exam 3)

$$P_{ave} = \frac{1}{T}\int_0^T p(t)dt = \frac{V_m I_m}{2}\cos(\theta_V - \theta_I) = V_{eff} I_{eff} \cos(\theta_V - \theta_I) = V_{rms} I_{rms} \cos(\theta_V - \theta_I)$$

$$\mathbf{S} = \frac{1}{2}\mathbf{V}_m \mathbf{I}_m^* = \mathbf{V}_{eff}\mathbf{I}_{eff}^* = \mathbf{V}_{rms}\mathbf{I}_{rms}^* = P + jQ \text{ VA}$$

$$pf = \frac{P}{|\mathbf{S}|} = \frac{P}{\sqrt{P^2 + Q^2}} = \cos(\theta_V - \theta_I) \text{ , } pfa = (\theta_V - \theta_I)$$

$$\cos\alpha\cos\beta = \frac{1}{2}\cos(\alpha - \beta) + \frac{1}{2}\cos(\alpha + \beta)$$

Item	A	B	C	D	E	F	G	H	I
1.						X 10.00			
2.		X 10.00							
3.								X 10.00	
4.				X 10.00					
5.	X 10.00								
6.							X 10.00		
7.	X 10.00								
8.							X 10.00		
9.					X 10.00				
10.	X 10.00								
11.			X 10.00						
12.				X 10.00					
13.							X 10.00		
14.			X 10.00						
15.								X 10.00	
16.				X 10.00					
17.				X 10.00					
18.								X 10.00	
19.			X 10.00						
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