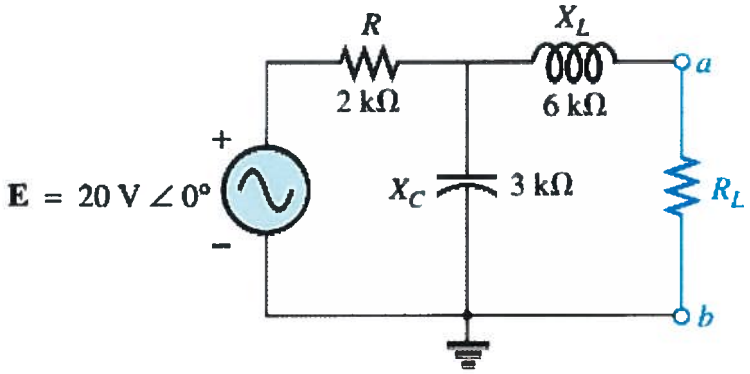
EEET-121 AC Circuits

Exam #3 2185 CH19.1 to CH22.4

NAME (printed): * SOLUTIONS * **Program:** _____

You have 50 minutes to complete this examination. You are allowed your calculator, a 3x5" card and the provided formulas/tables from the text.

- M/C Questions
  - Circle the best alternative that answers the question
  - NO partial credit will be awarded
- Work the Problem Questions
  - SHOW ALL your work in the space provided
  - BOX-IN your final answer
  - Partial credit may be awarded

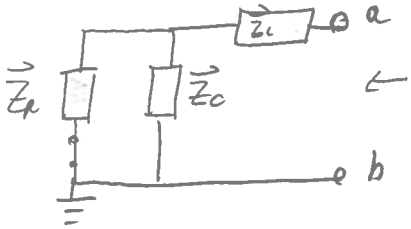


$\mathbf{E} = 20V_{RMS} < 0°$

For the circuit shown above, answer the following questions:

1. Calculate $\mathbf{Z_{TH}}$:

A) (1.39k + j5.08k) Ω
B) 5.26 kΩ < -74.7°
C) (2k – j3k) Ω
D) (2k + j3k) Ω



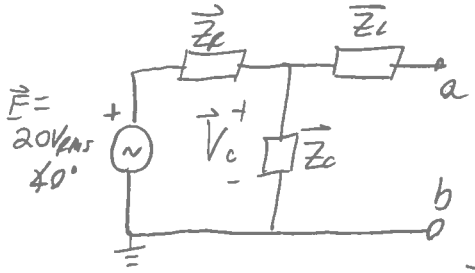
$\leftarrow \vec{Z}_{TH} = \vec{Z}_R // \vec{Z}_C + \vec{Z}_L$

$= 2000\Omega // -j3000\Omega + j6000\Omega$

$= (1.39k + j5.08k)\Omega$

2. Determine $\mathbf{V_{TH}}$:

A) 16.6 Vrms < +33.7°
B) 8.3 Vrms < +33.7°
C) 20 Vrms < 0°
D) 16.6 Vrms < -33.7°

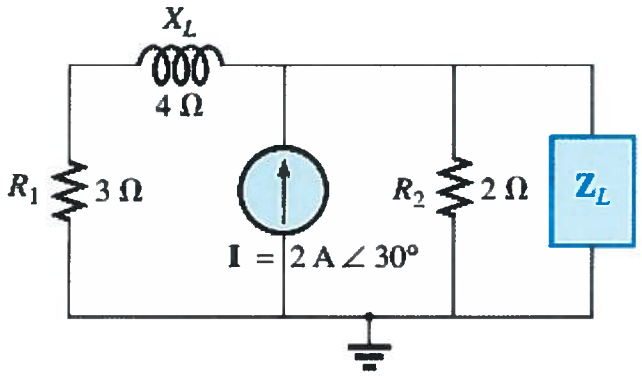


$\vec{V}_{TH} = \vec{V}_{ab_{oc}} = \vec{V}_C$

$= \vec{E}\,\frac{\vec{Z}_C}{\vec{Z}_C + \vec{Z}_R}$

$= 20V_{RMS} \angle 0° \left(\frac{-j3000\Omega}{(2000 - j3000)\Omega}\right)$

$\vec{V}_{TH} = 16.6V_{RMS} \angle -33.7°$



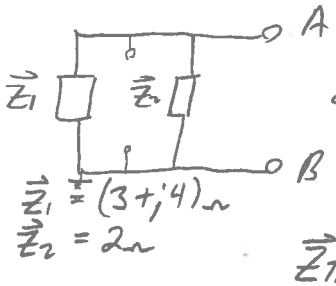
$\mathbf{I} = 2A_{RMS} < 30°$

For the circuit shown above, answer the following questions:

3. Find $\mathbf{Z_L}$ for maximum power transfer to the load:

A) (1.51 + j0.39) Ω
B) 5Ω < 53.1°
C) (1.51 - j0.39) Ω
D) (3 – j4) Ω

$\vec{Z}_{TH}^*$



$\vec{Z}_1 = (3+j4)\Omega$

$\vec{Z}_2 = 2\Omega$

$\vec{Z}_{TH} = \vec{Z}_1 // \vec{Z}_2$

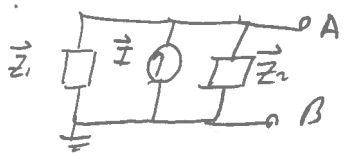
$= (3+j4)\Omega // 2\Omega$

$\vec{Z}_{TH} = (1.51 + j0.39)\Omega$

4. Find the power transferred to the load assuming $\mathbf{Z_L} = \mathbf{Z_{TH}}^*$:

A) 1.93 W
B) 1.61 W
C) 3.12 W
D) 1.31 W

$\vec{V}_{TH}$:

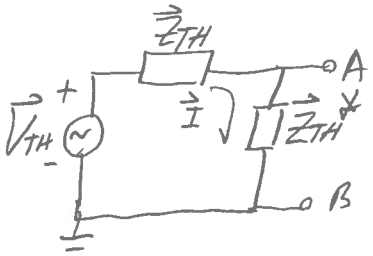


$\vec{V}_{TH} = \vec{V}_{AB\,oc}$

$= \vec{I}(\vec{Z}_1 // \vec{Z}_2)$

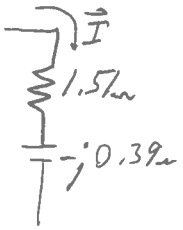
$= (2A_{RMS} \angle 30°)(1.51 + j0.39)\Omega$

$= 3.13V_{RMS} \angle 44.5°$



$\vec{I} = \dfrac{\vec{V}_{TH}}{\vec{Z}_{TH} + \vec{Z}_{TH}^*}$

$= 1.03A_{RMS} \angle 44.5°$



$P_{LOAD} = |\vec{I}_{RMS}|^2 (1.51\Omega)$

$= 1.61W$

5. A power level of 50 W is 6 dB above what power level?

A) 3.98 W
B) 25.1 W
C) 35.4 W
D) 12.6 W

$6\,dB = 10\log_{10}\left(\frac{50W}{P_1}\right)$

$P_1 = 12.56W$

6. Determine the power level in dBm corresponding to a power of 20 mW:

A) 7.07 dBm
B) 13.0 dBm
C) 20.0 dBm
D) 26.0 dBm

$P_{dBm} = 10\log_{10}\left(\frac{20mW}{1mW}\right)$

$= 13.01dBm$

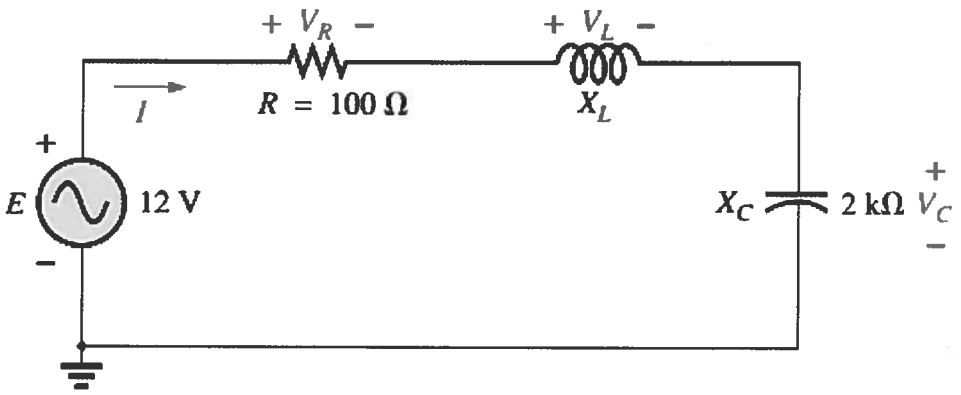
7. Find the output voltage for an amplifier with an input voltage of 10 mV and voltage gain of 22 dB:

A) 252 mV
B) 330 mV
C) 12.6 mV
D) 126 mV

$22dB = 20\log_{10}\left(\frac{P_o}{10mV}\right)$

P_i

$P_o = 126mV$



$$\mathbf{E} = 12V_{RMS} < 0°$$

$X_L = X_C$ @ RESONANCE

For the circuit shown above, answer the following questions:

8. Determine the quality factor of the circuit: (AT f_s)

A) 8.3
B) 20
C) Qs = ∞, as there is no R_L
D) 0.05

$$Q_s = \frac{X_L}{R_L} = \frac{X_C}{R} = \frac{2000\Omega}{100\Omega} = 20$$

9. If the resonant frequency is 5 kHz, find the value of L:

A) 31.9 mH
B) 200 uH
C) 628 uH
D) 63.7 mH

$$X_L = 2\pi f L$$
$$2000 = 2\pi (5kHz) L$$
$$L = 63.66\ mH$$

10. Find the bandwidth of the circuit if the resonant frequency is 5 kHz:

A) 1204 Hz
B) 602 Hz
C) 250 Hz
D) 302 Hz

$$BW = \frac{f_s}{Q_s} = \frac{5kHz}{20} = 250Hz$$

The load on a 240 VRMS, 60 Hz supply is 5kW (resistive), 8 kVAR (inductive) and 2kVAR (capacitive). Determine the following:

11. The total apparent power

$P = 5kW$

$Q = +j8000 - j2000 = +j6000\ VAR$

$\therefore \vec{S} = 5000\ W + j6000\ VAR$

OR

$\boxed{7,810\ VA \angle 50.19^\circ}$

12. The power factor of the system

$PF = Cos(\theta) = Cos(50.19^\circ) = \boxed{0.64\ LAGGING}$

INDUCTIVE $\therefore$ I LAGS V

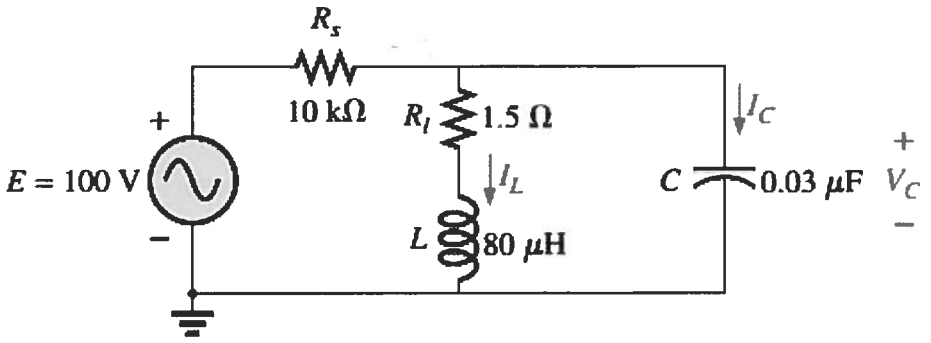
13. Find the amount of current drawn from the supply

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

$\vec{I}^* = \frac{\vec{S}}{\vec{V}} = \frac{7810\ VA \angle 50.19^\circ}{240 V_{RMS} \angle 0^\circ}$

$= 32.54 A_{RMS} \angle 50.19^\circ$

HENCE $\boxed{\vec{I} = 32.54 A_{RMS} \angle -50.19^\circ}$



$$\mathbf{E} = 100V_{pk} < 0°$$

For the circuit shown above, answer the following questions:

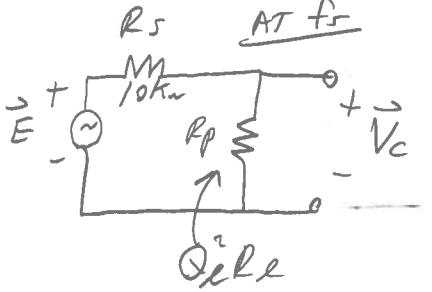
14. Find the resonant frequency (in Hz):

$f_p \sim f_s = \frac{1}{2\pi\sqrt{LC}} =$ 102.73 kHz

$Q_\ell \geq 10$? $Q_\ell = \frac{X_L}{R_\ell} = \frac{2\pi f L}{R_\ell} =$ 34.4 ✓ $Q_\ell \geq 10$

15. Find the quality factor of the inductor, Q_L:

16. Find the peak voltage across the capacitor at resonance, $|V_C|$:



$$\vec{V}_C = \vec{E}\,\frac{R_p}{R_p + R_s}$$

$$= 100V_{pk} \angle 0° \,\frac{(34.4)^2(1.5\Omega)}{(34.4)^2(1.5\Omega) + 10k\Omega}$$

$$= 15.1V_{pk} \angle 0°$$

$$|\vec{V}_C| = 15.1V_{pk}$$