EE301 Name: Answers - Review

Review #2 - Major Topics

1. Capacitors & Transient Response
2. Inductors & Transient Response
3. Capacitor/ Inductor Thevenin Problems
4. Sinusoidal Waveforms, Peak & RMS Values
5. AC Response & Average Power
6. Power Factor
7. Complex Numbers & Phasors
8. AC Series & AC Parallel Circuits
9. Circuit Simplification Techniques
10. AC Thevenin Circuits - E_{TH} and Z_{TH}
11. Max Power Transfer in AC Circuits
12. AC Power & AC Power Triangle
13. Power Factor Correction
14. RLC Circuits & Resonance

Short Answer #2

1. The impedance of an Inductor at steady state when a DC voltage is applied across a series RL circuit is _0_ ohms.
2. The impedance of a Capacitor appears to be an (Short Open) Circuit at steady state when a DC voltage is applied across a series RC circuit.
3. To produce a transient response in an RL or RC series circuit, use a (DC AC) signal voltage applied through a switch.
4. Steady State conditions are achieved in response to a transient signal excitation in a series RC or RL circuit after (1τ 3τ 5τ) time constants.
5. Current in an RL series circuit (Leads Lags) the AC voltage applied across the terminals of the inductor.
6. The formula for calculating the time constant in an RL circuit that has a sudden voltage applied is (τ = L/R τ = L*R τ = R/L).
7. The formula for calculating the time constant in an RC circuit that has a sudden voltage applied is (τ = C/R τ = R*C τ = R/C).

8. The period for an AC sinusoidal voltage of frequency 20 KHZ is:
(50 μsec   50 msec   5 msec).

9. π/6 radians converts to (30 deg   60 deg   90 deg).

X 10. An AC waveform is expressed as v (t) = 100 sin 6283 t in the time domain. This waveform has a frequency of (60 Hz   100 Hz   1000 KHz). 1000 Hz

11. The rectangular expression (3 + j4) is equivalent to what in polar form:
($5\angle 0^\circ$ $5\angle 36.9^\circ$ $5\angle 53.1^\circ$).

12. The Inductive reactance of a 5mH inductor at DC is: (0 Ω 5 Ω Open circuit).

13. Steady State conditions are achieved in response to a transient signal excitation in a series RC or RL circuit with a time constant of 5 seconds in:

a. 5 seconds
b. 10 seconds
c. 20 seconds
d. 25 seconds

14. π/2 radians converts to:

a. 30 degrees
b. 60 degrees
c. 90 degrees
d. 180 degrees

15. An AC waveform is expressed as v(t) = 200 sin 377t in the time domain. The RMS value of the voltage is:

a. 141.4 volts
b. 200 volts
c. 70.7 volts
d. 377 volts

16. The rectangular expression (4 + j3) for Impedance is equivalent to what in polar form:

a. Z = 5 at 0 degrees
b. Z = 5 at 36.9 degrees
c. Z = 5 at 53.1 degrees
d. Z = 5 at 90.0 degrees

17. True / False A lagging Power Factor means the circuit is inductive

18. True / False Adding a DC voltage to an AC waveform changes the period of the AC waveform.

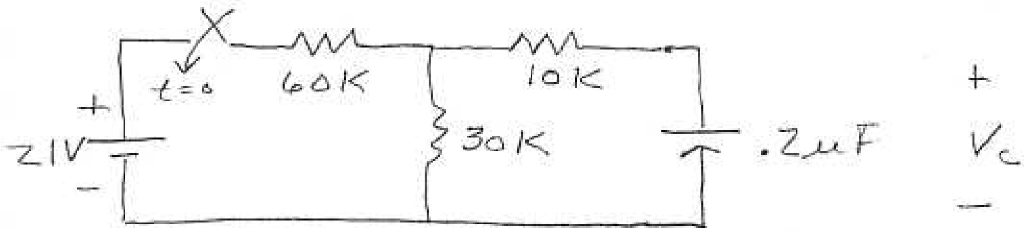
19. True / False An AC waveform is applied to a purely capacitive load. The phase angle of the current through the inductor will be = + 90 degrees.

20. True / False At Resonance, the Impedance of an RLC circuit is purely inductive.

ANSWERS REVIEW A

1) EE-301 REVIEW A - EXAM #2

1. GIVEN THE FOLLOWING CIRCUIT, CALCULATE THE CHARGING TIME CONSTANT τ_c



a) $\tau_c = (30K)(.2 \times 10^{-6})$
$= 6 \times 10^{-3} = 6\text{ msec}$

$R_{TH} = 60K \| 30K + 10K$
$20K + 10K = 30K$

$E_{TH} = 7V$
$R_{TH} = 30K$

b) WRITE THE EXPRESSION FOR $V_c(t)$

$V_c = V_F + (V_i - V_F)e^{-t/\tau}$
$= 7 + (0-7)e^{-t/\tau} = 7(1-e^{-t/\tau})$ VOLTS

c) WRITE THE EXPRESSION FOR $I_c(t)$

$I_c = A e^{-t/\tau} = \frac{7}{30K} = .233 mA\, e^{-t/\tau}$

D) THE SWITCH IS OPENED AT t = 1 SECOND, WRITE THE EQUATION FOR $V_c(t)$ AFTER 1 SECOND.

$R = 40K \quad C = .2\mu F$
$\tau = (40K)(.2\mu F) = 8\text{ msec}$

$V_c = V_F + (0 - V_F)e^{-t/\tau}$
$= 0 + (7-0)e^{-t/\tau} = 7e^{-t/\tau}$

2) EE-301 REVIEW A

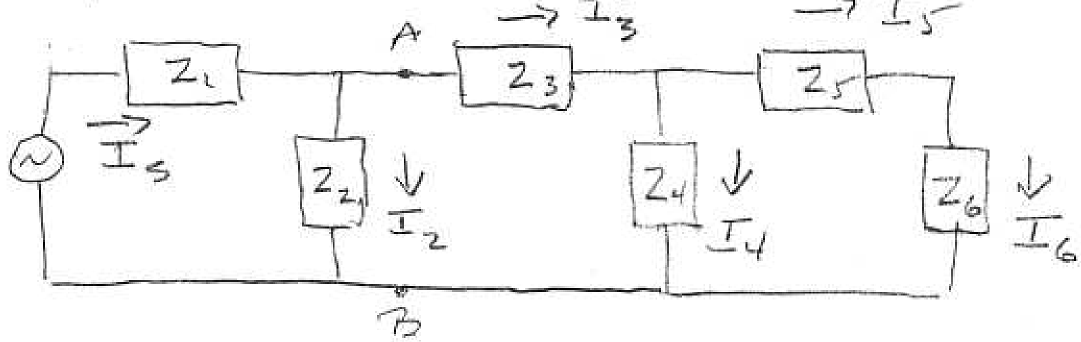
2. FOR THE DIAGRAM BELOW, WHICH IS ALWAYS TRUE

A $I_S = I_3$ X

B $I_3 = I_4 + I_6 = I_4 + I_5 = I_4 + I_6$

C $I_3 = I_2 + I_5$ X

D $I_4 = I_6$ X

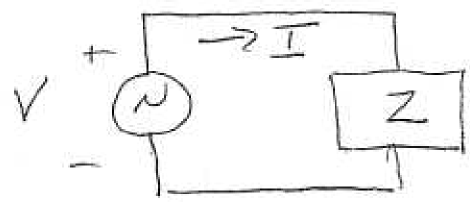


b) WRITE THE IMPEDANCE SEEN FROM TERMINALS AB AND LOOKING TO THE RIGHT

$$Z_{AB} = \left[(Z_5 + Z_6) \parallel Z_4\right] + Z_3$$

3. EE-301 REVIEW A

3. GIVEN THE CIRCUIT AND THE FOLLOWING INFORMATION, DETERMINE THE CIRCUIT COMPONENT OR COMPONENTS.



$V = 16V \angle 65^\circ$

$I = 2mA \angle -25^\circ$

$$Z = \frac{16V \angle 65^\circ}{2mA \angle -25^\circ} = 8K \angle 90^\circ$$

$Z = 8K \angle 90^\circ$

COMPONENT (R, L, C)
CIRCLE ONE

IF $\omega = 1000$ RAD/SEC, DETERMINE THE VALUE OF THE ELEMENT IN Ω, H, OR F.

VALUE = 8 H

$X_L = \omega L$

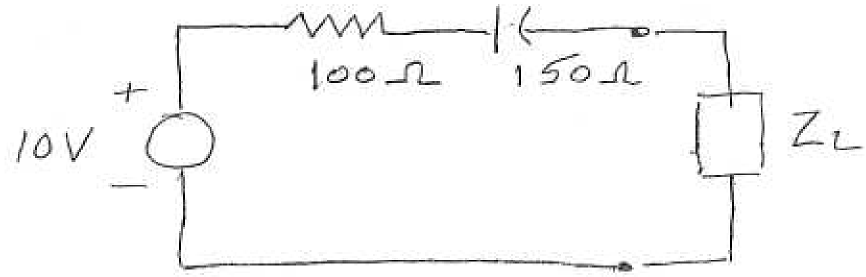
$8K = \omega L$

$= 10^3 L$

$$L = \frac{8K}{10^3} = 8\,H$$

4 EE-301 REVIEW A

4. A THEVENIN CIRCUIT IS SHOWN FOR A NETWORK WITH A LOAD.



A) DETERMINE Z_L FOR MAX POWER TO LOAD

$$Z_L = 100 + j150$$

B) WHAT 2 ELEMENTS MAKE UP THIS LOAD

ELE #1 RESISTOR ELE #2 INDUCTOR

C) DETERMINE THE MAX POWER DELIVERED

$$P_{MAX} = \frac{E_{TH}^2}{4R_{TH}} = \frac{10^2}{4(100)} \qquad P_{MAX} = .25\text{ WATTS}$$

$$= \frac{100}{4(100)} = \frac{1}{4}$$

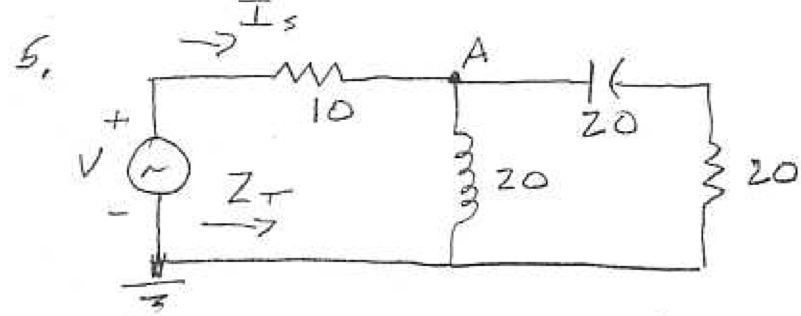
$$I = \frac{10}{200} = 50\,mA$$

$$P = I^2R$$

$$= (50 \times 10^{-3})^2(10^2) = \underline{.25\text{ WATTS}}$$

5 EE-301 REVIEW A

5.



$V = 100\angle 0°$

a) DETERMINE $Z_T = (20 - j20) \,\|\, j20 + 10$

$$\frac{(\cancel{20}\sqrt{2}\angle -45)(20\angle 90°)}{20 - j20 + j20 = \cancel{20}} = 20\sqrt{2}\angle 45° + 10$$

$= 20 + j20 + 10 = 30 + j20$

$30 + j20$

$\underline{\underline{36.06\angle 33.69°}}$

b) DETERMINE I_S

$$I_S = \frac{100\angle 0°}{36.06\angle 33.69°} = \underline{\underline{2.77A\angle -33.69°}}$$

c) DETERMINE V_A

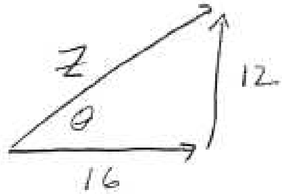
$$V_A = \frac{Z_{\|}(V)}{Z_T} = \frac{(20\sqrt{2}\angle 45)(100\angle 0°)}{36.06\angle -33.69°}$$

$= \underline{\underline{78.43\angle 78.69°}}$ Volts

(1) EE-301 REVIEW B ANSWERS

1. $Z_T = 16 + j12 \quad V = 20 \angle 30^\circ$

A. $Z_T = 16 + j12 \qquad Z = \sqrt{16^2 + 12^2} = \underline{\underline{20 \angle 36.9^\circ}}$



$Z = 20 \quad \theta = 36.9^\circ$

B. $\underline{I} = \dfrac{V}{Z} = \dfrac{20 \angle 30^\circ}{20 \angle 36.9^\circ} = \underline{\underline{1A \angle -6.9^\circ}}$

C. $V = 20V \angle 30^\circ$

$V(t) = 20\sqrt{2} \text{ sen} (\omega t + 30^\circ)$ VOLTS

$= 28.28 \text{ sen} (\omega t + 30^\circ)$ VOLTS

$\underline{I} = 1A \angle -6.9^\circ$

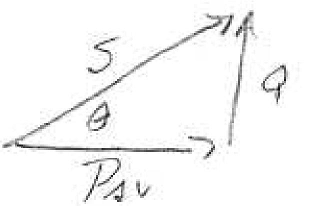
$\underline{I}(t) = (1)\sqrt{2} \text{ sen} (\omega t - 6.9^\circ)$ AMPS

$= 1.414 \text{ sen} (\omega t - 6.9^\circ)$ AMPS

D. $S = V\underline{I}^* = (20 \angle 30^\circ)(1 \angle +6.9^\circ)$

$= 20 \angle 36.9^\circ$ WATTS

POWER



$S = 20 \angle 36.9^\circ = \underline{20 \text{ WATTS}}$

$P_{AV} = 20 \cos 36.9^\circ$

$P = \underline{16} \text{ WATTS}$

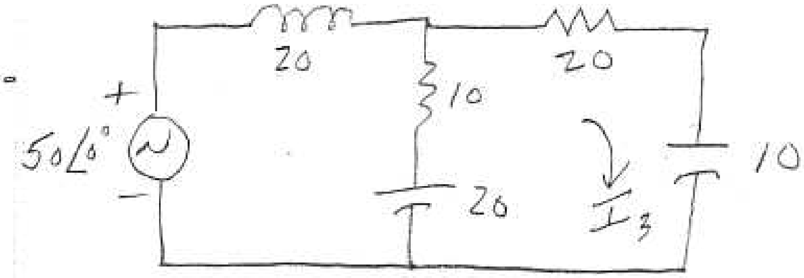
$Q = 20 \text{ sen } 36.9^\circ$

$Q = 12 \underline{\text{ VAR}}$

$F_P = \cos \theta = \underline{\underline{.80}}$

(2) EE-301 REVIEW B ANSWERS

2.



A $\quad Z_T = (20 - j10) \parallel (10 - j20) + j20$

$$= \frac{(22.36\angle -26.57^\circ)(22.36\angle -63.43^\circ)}{20 - j10 + 10 - j20 = 30 - j30} + j20$$

$$= \frac{(22.36\angle -26.57^\circ)(22.36\angle -63.43^\circ)}{42.43\angle -45^\circ} + j20$$

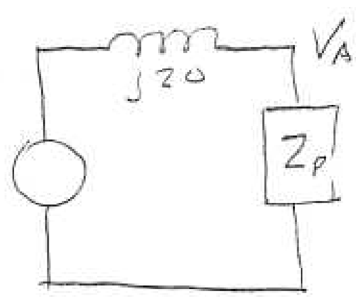
$$= 11.78\angle -45^\circ + j20$$

$$= 8.33 - j8.33 + j20 = \underline{\underline{8.33 + j11.67}}$$

$$= \underline{\underline{14.34\angle 54.48^\circ}}$$

$$I = \frac{V}{Z_T} = \frac{50\angle 0^\circ}{14.34\angle 54.48^\circ} = \underline{\underline{3.49A\angle -54.48^\circ}}$$

B.



Z_P = Parallel COMB.
$= 11.78\angle -45^\circ$

$$V_A = \frac{Z_P}{Z_T} \times V_S = \frac{11.78\angle -45^\circ (50)}{14.34\angle 54.48}$$

$$= 41.07\angle -99.48^\circ$$

$$I_3 = \frac{V_A}{20 - j10} = \frac{41.07\angle -99.48}{22.36\angle -26.57^\circ}$$

$$I_3 = 1.837\angle -72.91^\circ$$

(3) EE-301 REVIEW B ANSWERS

B CONT'D

$$V_{C2} = (I_3)(Z_{C2}) = (1.837 \angle -72.91)(10 \angle -90^\circ)$$

$$= \underline{\underline{18.37 \angle -162.91^\circ \text{ VOLTS}}}$$

C. POWER FACTOR

$$F_p = \cos\theta = \cos(54.48^\circ)$$

$$= \underline{\underline{.58}}$$

$\theta = +54.48$ SO ELI

LAGGING (SEE I ALSO)

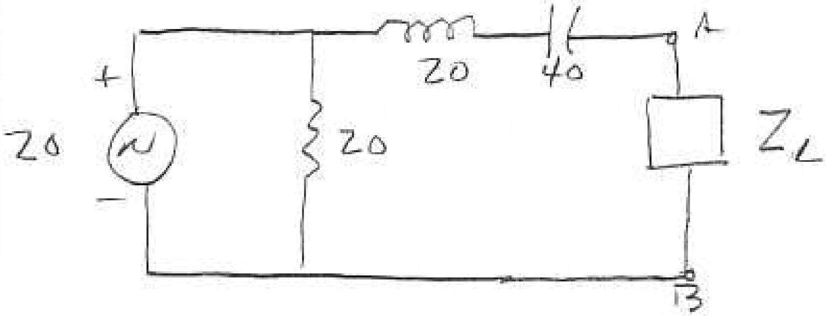
D. $X_C = 10 = 1/2\pi f C$ @ 10KHZ

$$C = \frac{1}{2\pi(10^4)(10)} = .00159 \times 10^{-3}$$

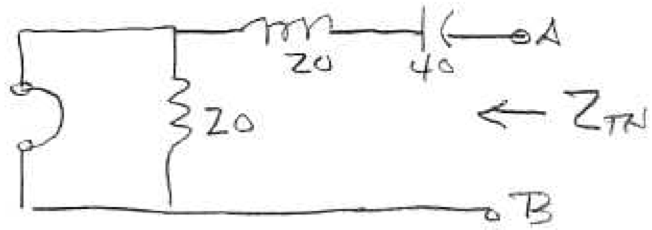
$$= 1.59 \times 10^{-6} = \underline{\underline{1.59\mu F}}$$

(4) EE-301 REVIEW B ANSWERS

3. LEFT SIDE DOES NOT APPLY

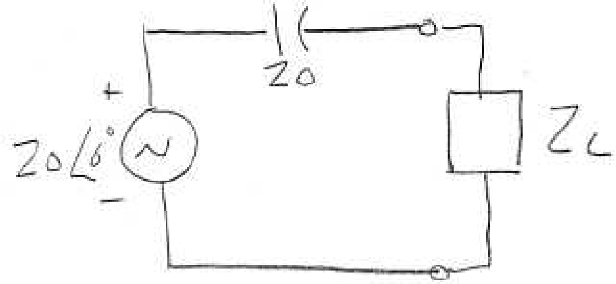


A) REMOVE LOAD LOOK AT AB. SHORT SOURCE



$$Z_{TH} = (0 \parallel 20) + j20 - j40$$
$$= 0 + j20 - j40 = -j20 = 20\angle -90^\circ$$

$$E_{TH} = E_{20\Omega} = E_{AB} = 20V\angle 0^\circ$$



$$Z_L = Z_{TH}^* = 20\angle +90^\circ = j20 = \text{INDUCTOR}$$
$$X_L = 20\Omega$$

c) $P_{MAX} = \dfrac{E_{TH}^2}{4R_{TH}} = 0$ NO RESISTANCE
ALL REACTIVE POWER

(5) EE-301 REVIEW B ANSWERS

4.

A) $V = 10V\ (PEAK)\ \angle 0^\circ$

$I = 5mA\ (PEAK)\ \angle +60^\circ$

$V(t) = 10 \sin(\omega t + 0^\circ)$

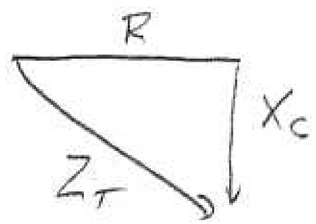
$I(t) = 5\times10^{-3} \sin(\omega t + 60^\circ)$ or $5mA \sin(\omega t + 60^\circ)$

B) $V\ (PHASOR) = V_P/\sqrt{2} = 7.07V\ \angle 0^\circ$

$I\ (PHASOR) = 3.54mA\ \angle +60^\circ$

c) $Z_T = \frac{V}{I} = \frac{7.07\ \angle 0^\circ}{3.54\times10^{-3}\ \angle +60^\circ} = 2.0\times10^{3}\ \angle -60^\circ$

$= \underline{\underline{2K\Omega\ \angle -60^\circ}}$

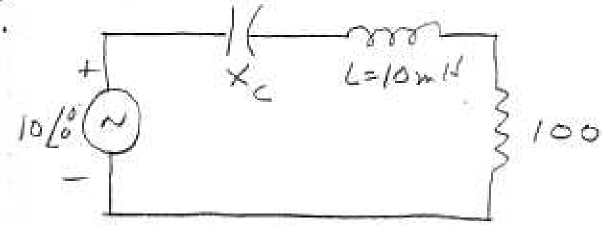


D) ELI

LEADING POWER FACTOR (SEE I $\angle$-ANGLE)

6) EE-301 REVIEW B

5.



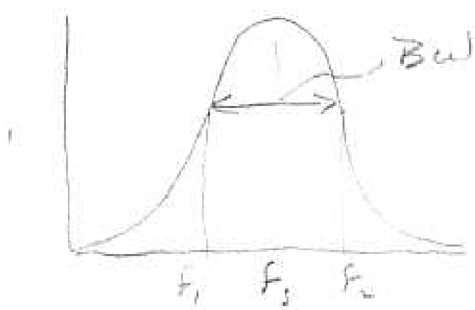
A) $X_L = 2\pi f L = 2\pi\ 16 \times 10^3 (10 \times 10^{-3}) = 628.3\ \Omega$

B) $X_C = X_L = 628.3\ \Omega$

c) $Q = X_L / R = 628.3/100 = 6.28$

$BW = \frac{f_s}{Q} = \frac{10\,KHz}{6.28} = 1.59\,KHz$

D)



$f_1 = f_s - BW/2 = 10.0\,KHz - .795\,KHz = \underline{9.205}\,KHz$

$f_2 = f_s + BW/2 = \underline{10.795}\,KHz$