# EELE 354: Electric Power Applications Homework 1: Electrical Fundamentals <br> Assigned: Monday, 10/13/2013 <br> Due: Wednesday, 10/23/2013 

Read through Chapter 7 of your textbook, Industrial Electricity, 8th Edition by Brumbach. At the end of the chapter are review questions. Note: Your book generally does not consider phase, only magnitude. Thus, in the author's description, when he writes current, I, for example, he really means current magnitude, |II. The same is true for impedance, $Z$, voltage, $E$, power, $P$, etc.

- Answer the multiple choice questions: 1-4, 7-12, 14, 19-22.
- Solve problems 2, 4, 5, 11-14, 18, and 19.
- For problems 13 and 19, the resistance of the coil (13) and that of the capacitor (19) are due to "non-idealities" in the devices. For these problems, note if the resistance has a significant effect on the total impedance of the device.
- For the inductor of problems 13 and 14 , if a 2 k resistor is placed in series with the inductor, what is the impedance (magnitude) of the circuit and the current (magnitude) flowing through it? What is the power factor of the circuit? Assume a $120 \mathrm{~V}, 60 \mathrm{~Hz}$ supply.
- For the capacitor of problem 19, what is the total circuit impedance (magnitude) if a 80 resistor is placed in series with it? What is the current (magnitude) if a 240 V , 60 Hz supply is connected to the circuit? What is the power factor of the circuit?


## Multiple Choice:

1. c. both a and b
2. a. frequency
3. c. 60 Hz (cycles per second)
4. a. hertz (Hz)
5. b. two or more vectors joined together to convey information
6. a. longest side
7. c. opposite side
8. d. hypotenuse
9. b. value that produces the same heating effect as a specific value of a steady direct current
10. c. effective value
11. b. greater than the effective value
12. a. lags the voltage
13. b. leads the voltage
14. d. ohm
15. b. true power to the apparent power

## Solution Problems:

2. $E=0.707 E_{m}$
$E=0.707 * 170$
$E=120.19 \mathrm{~V}$
3. $E=E_{m} \sin \phi$
a. $E=170 \sin 30^{\circ}=170 * 0.5=85 \mathrm{~V}$
b. $E=170 \sin 60^{\circ}=170 * 0.866=147.22 \mathrm{~V}$
c. $E=170 \sin 90^{\circ}=170 * 1=170 \mathrm{~V}$
d. $E=170 \sin 120^{\circ}=170 * 0.866=147.22 \mathrm{~V}$
4. $E=0.707 E_{m}$
$E_{m}=277 / 0.707$
$E_{m}=391.796 \mathrm{~V}$
5. $X_{L}=2 \pi f L$
$X_{L}=2 \pi 60 * 20$
$X_{L}=7,540 \Omega$
6. $X_{L}=2 \pi f L$
$X_{L}=2 \pi 50 * 20$
$X_{L}=6,283 \Omega$
7. For when the only resistance in the circuit is due to the non-idealities of the inductor:
$Z=\sqrt{R^{2}+X_{L}^{2}}$
$Z=\sqrt{10^{2}+7,540^{2}}$
$Z=7,540 \Omega$
8. For when the only resistance in the circuit is due to the non-idealities of the inductor:
$|I|=\frac{|E|}{|Z|}$
$|I|=\frac{120}{7,540}$
$|I|=0.0159 A$
9. $X_{C}=\frac{1}{2 \pi f C}$
$X_{C}=\frac{1}{2 \pi 60 * 100 * 10^{-6}}$
$X_{C}=26.53 \Omega$
10. For when the only resistance in the circuit is due to the non-idealities of the inductor:
$Z=\sqrt{R^{2}+X_{C}^{2}}$
$Z=\sqrt{0.5^{2}+10^{2}}$
$Z=10 \Omega$

## Additional Work for Problems 13, 14 and 19:

A1: For problems 13 and 19, the resistance of the coil (13) and that of the capacitor (19) are due to "non-idealities" in the devices. For these problems, note if the resistance has a significant effect on the total impedance of the device.
For both problems, the resistance has almost no effect on the total impedance of the device as seen by noting that the total impedance, $Z$, in each circuit is almost identical to the respective values of $X_{L}$ and $X_{C}$.

A2: For the inductor of problems 13 and 14, if a $2 k \Omega$ resistor is placed in series with the inductor, what is the impedance (magnitude) of the circuit and the current (magnitude) flowing through it? What is the power factor of the circuit? Assume a $120 \mathrm{~V}, 60 \mathrm{~Hz}$ supply.

When an additional $2 \mathrm{k} \Omega$ resistor is added in series with the inductor, the total series resistance is $2,010 \Omega$. Then,
$Z=\sqrt{R^{2}+X_{L}^{2}}$
$Z=\sqrt{2,010^{2}+7,540^{2}}$
$Z=7,803 \Omega$
Then, the current magnitude is,
$|I|=\frac{|E|}{|Z|}$
$|I|=\frac{120}{7,803}$
$|I|=0.0154 A$
The power factor for this circuit is given by:
$P F=\frac{P}{S}$, where $P$ is the true (real) power, i.e. that dissipated in the resistor, and $S$ is the apparent power.
The real power is given by: $P=|I|^{2} R$
$P=0.0154^{2} * 2,010$
$P=0.48 \mathrm{~W}$
The apparent power is given by:
$S=|I||E|$
$S=0.0154 * 120$
$S=1.85 \mathrm{VA}$
Then, power factor is:
$P F=\frac{P}{S}$
$P F=\frac{0.48}{1.85}=0.26$
A3: For the capacitor of problem 19, what is the total circuit impedance (magnitude) if a $80 \Omega$ resistor is placed in series with it? What is the current (magnitude) if a 240 V , 60 Hz supply is connected to the circuit? What is the power factor of the circuit?
When an additional $80 \Omega$ resistor is added in series with the capacitor, the total series resistance is $80.5 \Omega$. Then,
$Z=\sqrt{R^{2}+X_{C}^{2}}$
$Z=\sqrt{80.5^{2}+10^{2}}$
$Z=81.1 \Omega$
Then the current magnitude is,

$$
\begin{aligned}
|I| & =\frac{|E|}{|Z|} \\
|I| & =\frac{240}{81.1} \\
|I| & =2.96 A
\end{aligned}
$$

The power factor for this circuit is given by:
$P F=\frac{P}{S}$, where $P$ is the true (real) power, i.e. that dissipated in the resistor, and $S$ is the apparent power.
The real power is given by: $P=|I|^{2} R$
$P=2.96^{2} * 80.5$
$P=705 \mathrm{~W}$
The apparent power is given by:
$S=|I||E|$
$S=2.96 * 240$
$S=710.4 \mathrm{VA}$
Then, power factor is:
$P F=\frac{P}{S}$
$P F=\frac{705}{710.4}=0.99$

