Chapter I - Problems

Blinn College - Physics 2426 - Terry Honan

Problem I.1

The voltage from an AC source varies with time as
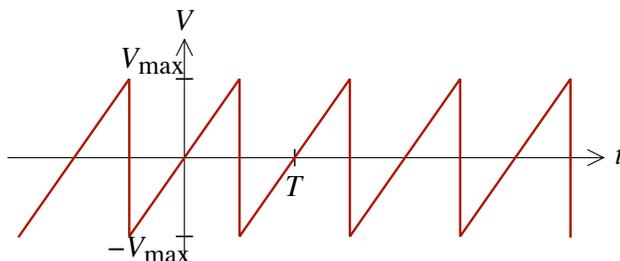
$$V(t) = V_{max} \cos(\omega t + \phi)$$

where $V_{max} = 20$ V, $\omega = 80\ s^{-1}$ and $\phi = 0.6$.

(a) What is the root-mean-squared voltage, V_{rms}?

(b) What is the frequency, f ?

(c) What is the time closest to $t = 0$ when the voltage takes on its maximum value.

Problem I.2

For a sawtooth pattern voltage show that $V_{rms} = \dfrac{1}{\sqrt{3}} V_{max}$.

Problem I.3

An AC voltage source has an rms voltage of 20 V and a frequency of 40 Hz. Suppose the manufacturer's specs say that this source cannot safely put out a larger instantaneous current than 80 mA.
(a) What resistance values can be connected across this source? (Just the resistor is connected across the source.)
(b) What capacitance values can be connected across this source?
(c) What inductance values can be connected across this source?

Problem I.4

What is the maximum charge on the plates of a capacitor with capacitance C when connected across an AC source with frequency f and rms voltage V_{rms}?

Problem I.5

A voltage source of produces an output which varies as a function of time as

$$V(t) = 50 \text{ V} \cos\left[\left(300 \text{ s}^{-1}\right) t\right].$$

(a) What are the root-mean-squared voltage and frequency of the source?

(b) Suppose this voltage is connected across a series combination of a $100 \, \mu\text{F}$ capacitor and a $40 \, \Omega$ resistor. What is the rms current through the circuit and what is the phase angle?

(c) Write the current as a function of time.

Problem I.6
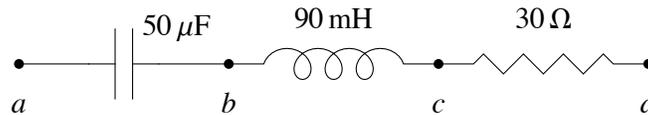
A $50 \, \mu\text{C}$ capacitor, a $90 \, \text{mH}$ inductor and a $30 \, \Omega$ resistor are connected in series across a standard outlet in the order listed, C then L then R. An AC multimeter measures the rms voltage and rms current.

(a) When the multimeter is set as an ammeter and put into the circuit, what does it read?
(b) What does the multimeter set as a voltmeter read when connected between a and b, between b and c, between c and d, between a and c, and between b and d?
(c) By what phase angle is the voltage ahead of the current?
(d) What is the average power dissipated in the capacitor, in the inductor and in the resistor?

Problem I.7

The resonance circuit of a radio tuner is uses a $1.4 \, \mu\text{H}$ inductor and a variable capacitor to tune a $99.7 \, \text{MHz}$ radio station. What value of the capacitance is needed.

Problem I.8

A $2 \, \Omega$ resistor, an $8 \, \text{mH}$ inductor and a $50 \, \mu\text{F}$ capacitor are connected in series.
(a) What is the resonant frequency?
(b) Suppose this is connected across a voltage source with a fixed $V_{\text{rms}} = 5 \text{ V}$ and a variable frequency. At what frequency is the rms current its maximum and what is the maximum value of I_{rms}?

Problem I.9

An ideal transformer is used to raise the voltage from standard household voltage to an rms voltage of 240 V. If the primary coil has 300 turns carrying an rms current of 5 A, then how many turns are in the secondary coil and what is the current through the secondary coil? What is the power delivered to the transformer?