ECE 2210 Homework #20   Due: Thur 11/16/06   b.2
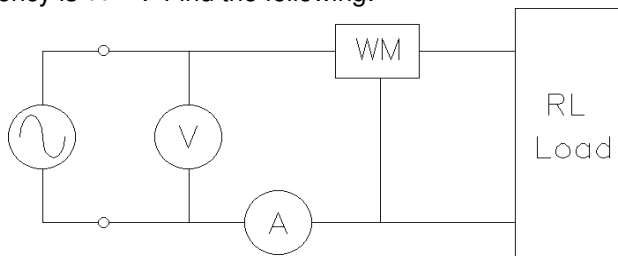
Read the section on AC power in your book (section 6.2, p 288 in the textbook).

Note: In the following problems, you may assume voltages and currents are RMS unless stated otherwise
or given as a function of time. Transformers are ideal unless stated otherwise.

1.   An ideal transformer has 330 turns on the primary winding and 36 turns on the secondary. If the primary is
     connected across a 110 V (rms) generator, what is the rms output voltage?

2.   A transformer has N_1 = 320 turns and N_2 = 1000 turns. If the input voltage is v(t) = (255 V)cos(ωt), what rms voltage
     is developed across the secondary coil?

3.   A step-up transformer is designed to have an output voltage of 2200 V (rms) when the primary is connected
     across a 240 V (rms) source.

     a) If there are 150 turns on the primary winding, how many turns are required on the secondary?

     b) If a load resistor across the secondary draws a current of 1.2 A, what is the current in the primary, assuming
     ideal conditions?

4.   The primary current of an ideal transformer is 8.5 A and the primary voltage is 80 V. 1.0 A is delivered to a load
     resistor connected to the secondary.   Calculate the voltage across the secondary.

5.   An ideal transformer has a turns ratio (N = N_1/N_2) of 1.5 . It is desired to operate a 200 Ω resistive load at 150 V (rms).

     a) Find the secondary and primary currents.

     b) Find the source voltage ($\mathbf{V_1}$).

     c) Find the power dissipated in the load resistor and the power delivered to the primary from the source.

     d) Find the impedance the source sees looking into the primary winding by calculating $\mathbf{Z_{eq}} = N^2\,\mathbf{Z_L}$ and again by
     calculating $\mathbf{V_1}\,/\,\mathbf{I_1}$.

6.   For the ideal transformer shown in the figure,
     find v_o(t) if v_s(t) is 320Vcos(377t).
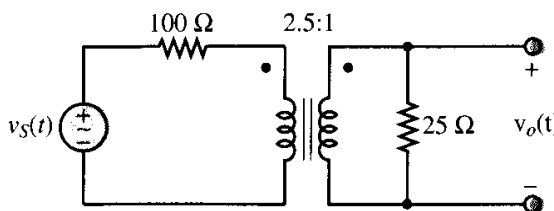
7. Compute the power factor for an inductive load consiting of $L := 20 \cdot mH$ and $R := 6 \cdot \Omega$ in series. $\omega := 377 \cdot \dfrac{rad}{s}$

8. The complex power consumed by a load is 620 /29° VA. Find:

   a) Apparent power (as always, give the correct units).   b) Real power.   c) Reactive power.

   d) Power factor.   e) Is the power factor leading or lagging?   f) Draw a phasor diagram.

9. In the circuit shown, the voltmeter measures 120V, the ammeter measures 6.3A and the wattmeter measures 560W.
   The load consists of a resistor and an inductor. The frequency is 60Hz. Find the following:

   a) Power factor   b) Leading or lagging?

   c) Real power.

   d) Apparent power.

   e) Reactive power.

   f) Draw a phasor diagram.

   g) The load is in a box which cannot be opened. Add another component to the circuit above to correct the
      power factor (make pf = 1). Draw the correct component in the correct place and find its value. This
      component should not affect the real power consumption of the load.
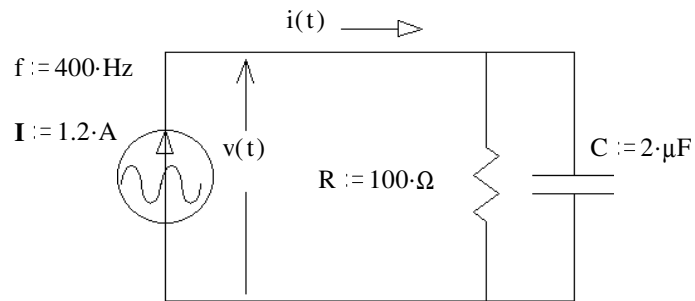
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ECE 2210 Homework #21   Due: Tue 11/21/06

Note: In the following problems, you may assume voltages and currents are RMS unless stated otherwise or given as a function of time. Transformers are ideal unless stated otherwise.

1. For the circuit shown, find the following:
   (as always, give the correct units)

   a) The complex power.

   b) Real power.

   c) Reactive power.

   d) Apparent power.

   e) Draw a power phasor diagram.

   $f := 400 \cdot Hz$

   $I := 1.2 \cdot A$

   $i(t) \longrightarrow$

   $v(t)$

   $R := 100 \cdot \Omega$

   $C := 2 \cdot \mu F$

2. A load draws $12kVA$ at 0.8 pf, lagging when hooked to $480V$. A capacitance is hooked in parallel with the load and the power factor is corrected to 0.9, lagging.

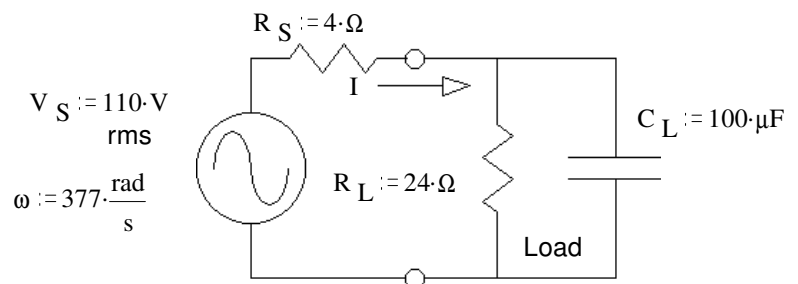   a) Find the reactive power (VAR) of the capacitor.   Draw a phasor diagram as part of the solution.

   b) Find the value of the capacitor assuming $f = 60Hz$.

3. Consider the circuit at right. The resistor and capacitor together make up the load.

   a) Find the load impedance of the circuit.

   b) Compute the average power dissipated by the load.

   $v_S := 155.6 \cdot V \cdot \cos(377 \cdot t)$

   $i(t) \longrightarrow$

   $R := 4.6 \cdot \Omega$

   Load

   $C := 800 \cdot \mu F$
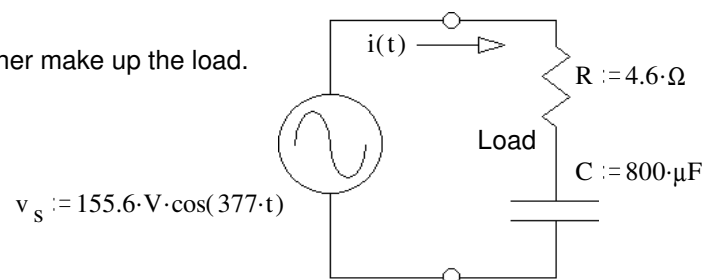
4. a) Compute the average power dissipated by the load (R_L and C_L taken together).

   b) Compute the power dissipated by the internal source resistance (R_S) in this circuit.

   $R_S := 4 \cdot \Omega$

   $V_S := 110 \cdot V$ rms

   $\omega := 377 \cdot \dfrac{rad}{s}$

   $I \longrightarrow$

   $R_L := 24 \cdot \Omega$

   $C_L := 100 \cdot \mu F$

   Load

Read section 6.3, p 301 in your textbook.

5. A transformer is rated at $13,800/480$ V, 60 kVA, 60 Hz. (Note: kVA stands for kilo-Volt-Amp, in this case it is the transformer's voltage rating times its current rating.) Find the allowable primary and secondary currents at a supply voltage of $12,000$ V at 100% power factor. Repeat for a power factor of 50%.

6. An ideal transformer has a rating of $500/125$ V, 10 kVA, 60 Hz. It is loaded with an impedance of 5Ω at 80% pf (0.80). The source voltage applied to the primary winding is 440 V (rms). Find:

   a) the load voltage
   b) the load current
   c) the kVA delivered to load
   d) the power delivered to load
   e) the primary current
   f) the power factor of primary
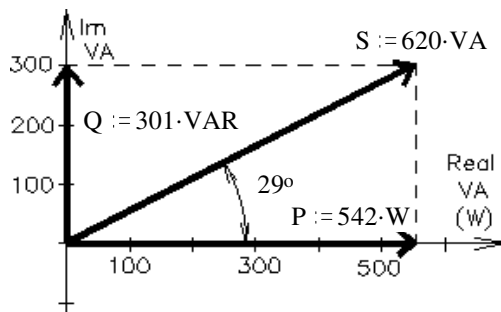   g) the impedance the source sees looking into primary.

7. An ideal transformer is rated to deliver $400\,\text{kVA}$ at $460\,\text{V}$ to a customer.

   a) How much current can the transformer supply to the customer?

   b) If the customer's load is purely resistive (i.e. if the pf = 1), what is the maximum power the customer can recieve?

   c) If the customer's power factor is 0.8 (lagging), what is the maximum usable power the customer can recieve?

   d) What is the maximum power if the power factor is 0.7 (lagging)?

   e) If the customer requires $300\,\text{kW}$ to operate, what is the minimum allowable power factor given the rating of this transformer?

HW 20 Answers

1. 12 V   2. 563 V   3. a) 1375 turns   b) 11 A   4. 680 V
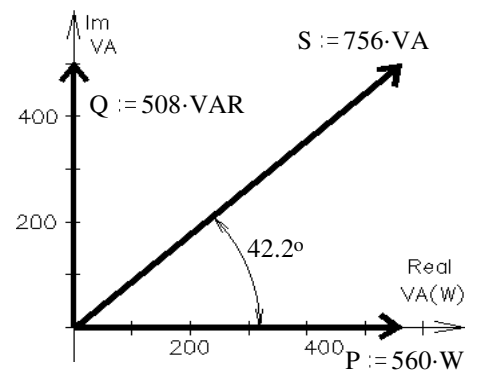5. a) 0.75 A, 0.50 A   b) 225 V   c) 112.5 W   d) 450Ω 6. 78Vcos(377t)   7. pf $:= 0.623$

8. a) $620 \cdot \text{VA}$ 9. a) 0.741

    b) $542 \cdot \text{W}$

    c) $301 \cdot \text{VAR}$

    d) 0.875

    e) lagging

    f) ------->

9. a) 0.741

    b) lagging

    c) $560 \cdot \text{W}$

    d) $756 \cdot \text{VA}$

    e) $508 \cdot \text{VAR}$

    f) ------->

    g) $93.6 \cdot \mu\text{F}$ capacitor in parallel with load
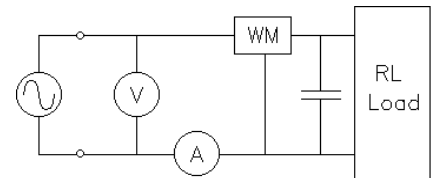
HW 21 Answers

1. a) $(115 - 57.8 \cdot \text{j}) \cdot \text{VA}$

    b) $115 \cdot \text{W}$

    c) $-57.8 \cdot \text{VAR}$

    d) $128.7 \cdot \text{VA}$

2.
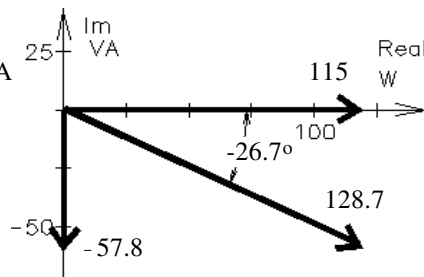
3. a) $\mathbf{Z} := 5.67 \cdot \Omega \cdot e^{-\text{j} \cdot 35.8 \cdot \text{deg}}$ b) $\text{P}_{\text{av}} := 1.73 \cdot \text{kW}$

4. a) $\text{P}_{\text{av}} := 364 \cdot \text{W}$ b) $110 \cdot \text{W}$

5. 4.35 A, 125 A any pf, (Using the transformer at a lower voltage does not increase its current rating.)

6. a) 110 V   b) 22 A   c) 2.42 kVA   d) 1.94 kW
    e) 5.5 A   f) 0.80   g) 80 Ω

    a) $-2.55 \cdot \text{kVA}$ b) $29.4 \cdot \mu\text{F}$

7. a) $870 \cdot \text{A}$ b) $400 \cdot \text{kW}$ c) $320 \cdot \text{kW}$ d) $280 \cdot \text{kW}$ e) 0.75