ECE 300
Spring Semester, 2006
HW Set #12

Due: April 4, 2006
wlg

Name Desk copy wlg
Print (last, first)

Use engineering paper. Work only on one side of the paper. Use this sheet as your cover sheet, placed on top of your work and stapled in the top left-hand corner. Number the problems at the top of the page, in the center of the sheet. **Do neat work. Underline your answers. Show how you got your equations.** **Be sure to show how you got your answers.** Each problem counts 10 points.

9.51 See text for answers

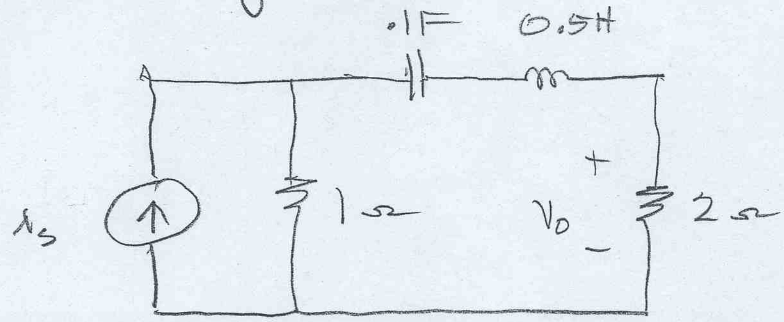
9.60 Ans: $Z = 51.1 + j9.88\ \Omega$

9.65 See text for answers

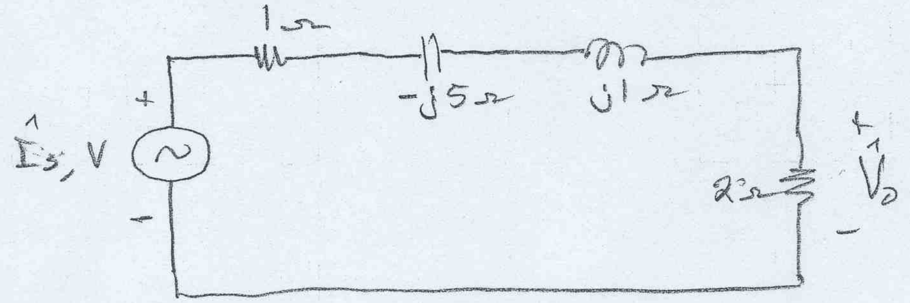
9.80 (a) $V_o = 53.89\angle 63.3° V$; (b) $V_o = 100\angle 33.55° V$; (c) $R = 25.4\ \Omega$

9.89 See text for answers

9.51 Given $v_o = 10\cos 2t$ V in the following circuit. Find i_s



With phasors, the circuit becomes



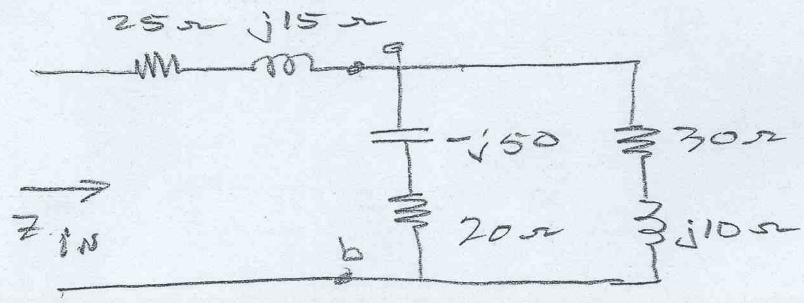
$$V_o = 10\angle 0 = \frac{2\hat{I}_s}{3-j4}$$

$$\hat{I}_s = 5(3-j4) = 25.0\angle -53.13 \text{ A}$$

$$i_s = 25\cos(2t - 53.13) \text{ A}$$

9.60

Find Z_{IN} for the following circuit.



$$Z_{ab} = \frac{(20-j50)(30+j10)}{(50-j40)}$$

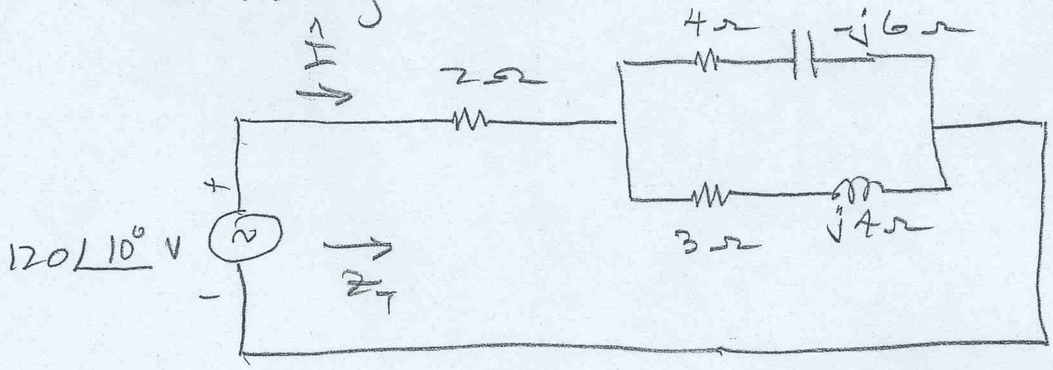
$$Z_{ab} = 26.6 \angle -11.1 \ \Omega$$

$$Z_{IN} = (25+j15) + Z_{ab}$$

$$Z_{IN} = 52.049 \angle 10.94^\circ \ \Omega$$

$$Z_{IN} = (51.1 + j9.88) \ \Omega$$

9.65 Determine Z_T and $\hat{I}$ for the following circuit.



$$Z_T = 2 + \frac{(4-j6)(3+j4)}{(4-j6)+(3+j4)}$$

$$\boxed{Z_T = 6.917\angle 9.103\,\Omega = 6.83 + j\,1.094\,\Omega}$$

$$\hat{I} = \frac{120\angle 10}{6.917\angle 9.103} = 17.35\angle .894$$

$$\boxed{\hat{I} = 17.35\angle 0.9^\circ \text{ A}}$$

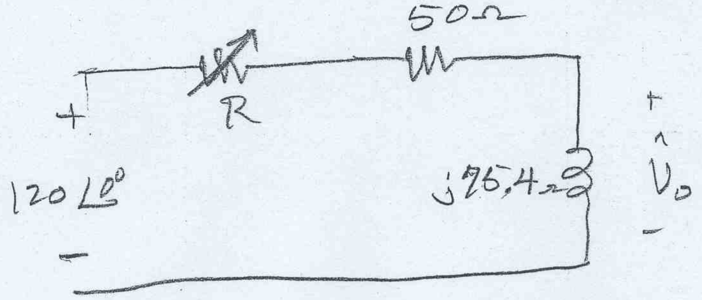
9.80

Consider the phase-shifting circuit below. Let $\hat{V} = 120\angle 0$ V operating at $f = 60$ Hz ($\omega = 377$ rad/sec). Find;

(a) $\hat{V}_o$ when R is maximum

(b) $\hat{V}_o$ when R is minimum

(c) R that will produce a phase shift of 45°.



(a)

R = 100

$$\hat{V}_o = \frac{120 \times (75.4\angle 90)}{150 + j75.4} = 53.89\angle 63.3^\circ \text{ V}$$

(b)

R = 0

$$\hat{V}_o = \frac{120 \times (75.4\angle 90)}{50 + j75.4} = 100\angle 33.55^\circ \text{ V}$$

(c)

$$\hat{V}_o = \frac{120 \times (75.4\angle 90)}{R+50 + j75.4} = |\hat{V}_o|\angle 90 - 45$$

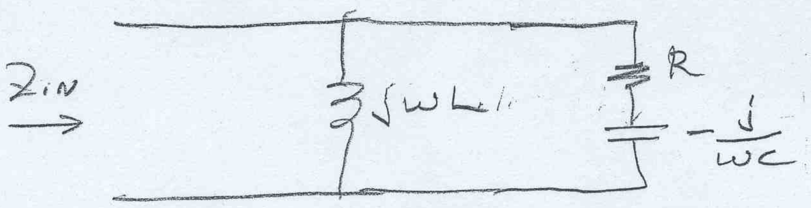
to get +45

$\therefore$ $R + 50 = 75.4$

$$\boxed{R = 25.4\ \Omega}$$

9.89

The following circuit is operated at $f = 50\,kHz$ ($\omega = 2\pi \times 50\,kHz$) $\omega = 314.16 \times 10^3$ rad/sec. Find L so that the terminal impedance is resistive



$$Z_{IN} = \frac{j\omega L\left(R - \frac{j}{\omega C}\right)}{R + j\omega L - \frac{j}{\omega C}}$$

$$= \frac{j\omega L(\omega RC - j)}{\omega RC + j(\omega^2 LC - 1)}$$

$$Z_{IN} = \frac{\omega L + j\omega^2 RLC}{\omega RC + j(\omega^2 LC - 1)}$$

To be real, $\angle Z_{IN}$ in numerator must equal $\angle Z$ in the denominator

$$\theta_{NUM} = \tan^{-1}\left(\frac{\omega^2 RLC}{\omega L}\right)$$

$$\theta_{DEN} = \tan^{-1}\left(\frac{\omega^2 LC - 1}{\omega RC}\right)$$

9.89

set $\theta_{num} = \theta_{den}$

$$\frac{\omega^2 RLC}{\omega L} = \frac{\omega^2 LC - 1}{\omega RC}$$

$$\omega RC = \frac{\omega^2 LC - 1}{\omega RC}$$

$$\omega^2 LC - 1 = \omega^2 R^2 C^2$$

$$\omega^2 LC = \omega^2 R^2 C^2 + 1$$

$$L = \frac{\omega^2 R^2 C^2 + 1}{\omega^2 C}$$

A little further simplification:

$$L = R^2 C + \frac{1}{\omega^2 C}$$

$$= 200 \times 10^{-5} + .002026 \times 10^{-1}$$

2.2 mH

$$= 2 \times 10^{-3} + .2026 \times 10^{-3}$$

$$L = 2.203 \text{ mH}$$