NAME ________________________________ ID# ______________________

FINAL EXAM

EE221

May 3, 2002

10:30 a.m. – 12:30 p.m.

Instructions: Write your name and ID# where indicated. You are allowed to have a calculator and writing instrument. All other materials are prohibited. The examination consists of 14 problems worth a total of 100 points. Read each question *carefully* and follow its instructions. Do all work within the space provided on this exam. *Show all work* and indicate the units of your answers as needed. *Circle your final answer for each question. If it is not circled it is assumed that you do not have a final answer.*

AC Circuit Analysis and Power:

P1. For the circuit in Fig. P1: a) determine the current I_x. b) Determine the average power delivered by the source.

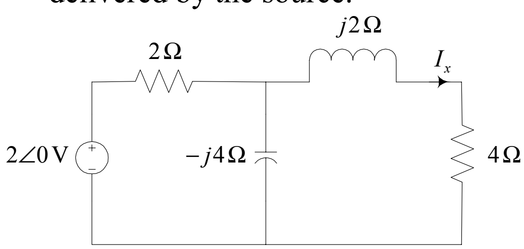

Fig. P1

P2. For the circuit in Fig. P2, the voltage across a 20 kW, 0.8 pf lagging load is measured to be $110\angle 0$ Vrms for a 60 Hz source. Given a line impedance of $1 + j\Omega$, Determine:

a) the current through the load,

b) the source voltage.

c) the average power delivered by the source.

Next, a reactive element is to be placed in parallel with the 20 kW load to correct the power factor.

d) Determine the type of reactive element needed for the power factor correction: capacitive, inductive, or it is not possible (*circle one*)

e) If possible, determine the capacitance or the inductance.

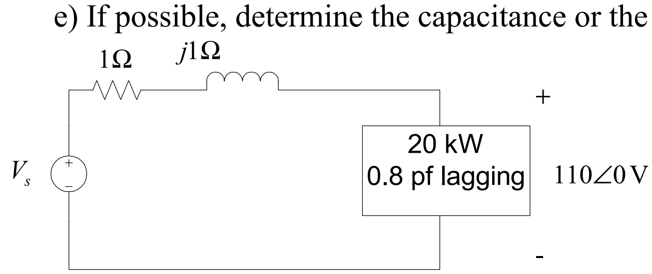

Fig. P2

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Transfer functions:

P3. For the circuit in Fig. P3, find the transfer function $H(p) = \dfrac{V_o(p)}{V_{in}(p)}$.

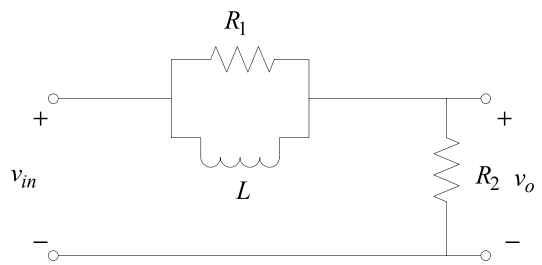


Fig. P3

P4. For the circuit in Fig. P2, determine the transfer function $H(p) = \dfrac{V_o(p)}{V_{in}(p)}$.

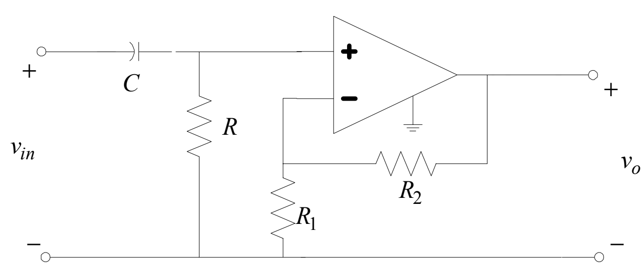


Fig. P4

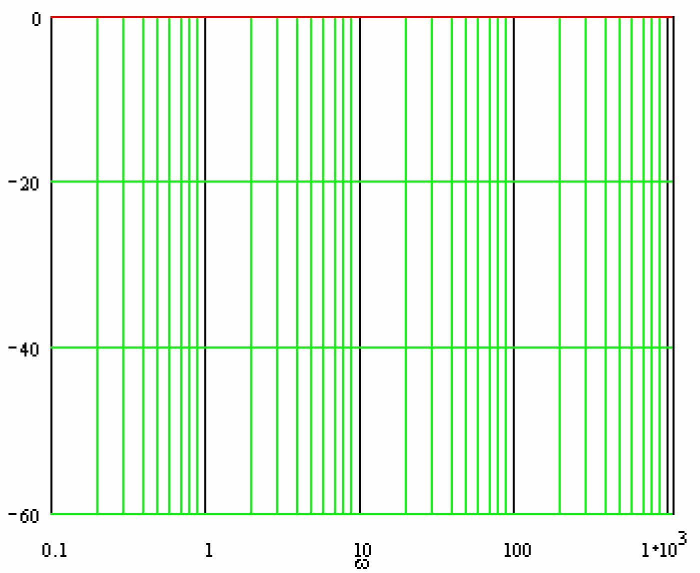
Name ________________________

Bode Plots:

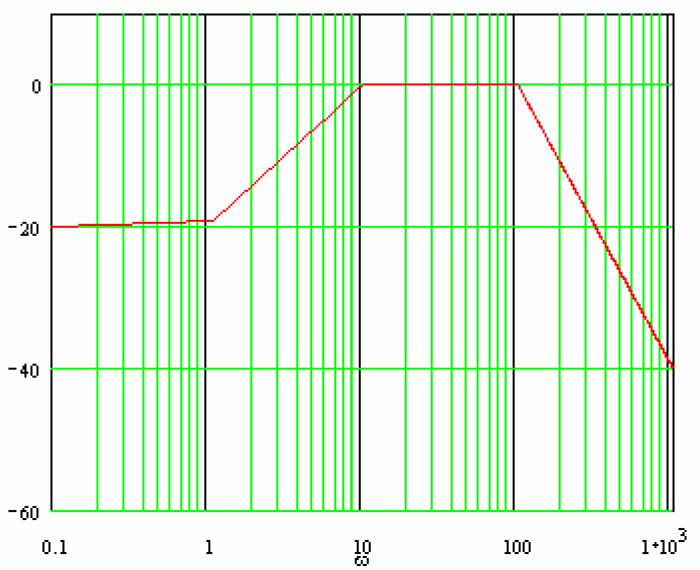
P5. A particular circuit yields the transfer function

$$H(s) = 1000 \frac{s^2}{(s+1)^2(s+10)(s+100)}$$

Sketch the Bode Plot for $|H(j\omega)|$ on the semi-log graph below.



P6. Given the magnitude Bode Plot below, determine the transfer function.



Name ______________________

Filters

P7. a) Given the circuit in Fig. P7, Determine by inspection if this is a Low Pass Filter, High Pass Filter, Band Pass Filter, or Band Reject Filter? (*Circle One*).

b) Given the transfer function of a filter:

$$H(s) = \frac{1+\frac{1}{s}}{2s+6+\frac{1}{s^2}}$$

Determine if this is a Low Pass Filter, High Pass Filter, Band Pass Filter, or Band Reject Filter? (*Circle One*).

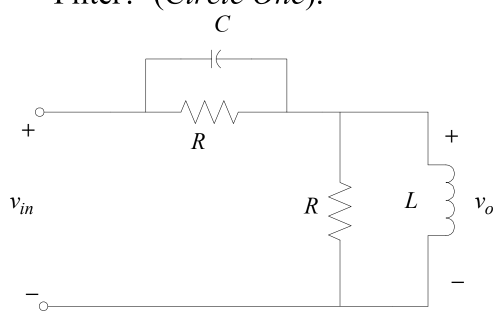


Fig. P7

P9. The transfer function of a second-order bandpass filter is described as:

$$H(s) = \frac{V_o(s)}{V_{in}(s)} = \frac{15s}{9s^2+3s+36}$$

Determine the resonant frequency ω_o, the voltage gain A_V at ω_o, and the Q.

Name ________________________

Two-port network theory

P9. For the two-port network in Fig. P9, compute the first column of the Z-parameter matrix (i.e., compute Z_{11} and Z_{21}).

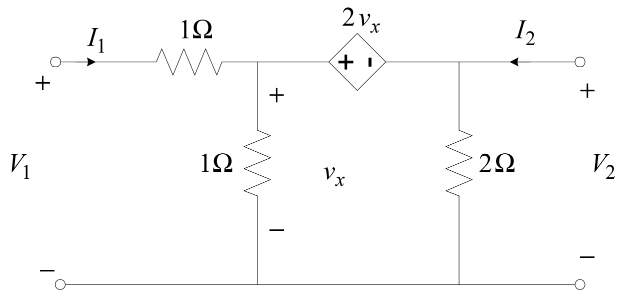


Fig. P9

P10 Given the *Y* matrix for a two-port network:

$$\begin{pmatrix} I_1 \\ I_2 \end{pmatrix} = \begin{pmatrix} \frac{4}{3} & -\frac{1}{3} \\ -\frac{6}{5} & \frac{1}{3} \end{pmatrix} \begin{pmatrix} V_1 \\ V_2 \end{pmatrix}$$

Determine the second column of the *ABCD*-matrix (i.e., determine *B* and *D*).

P11. You are given the *ABCD* matrices for two independent two-port networks *Na* and *Nb*:

$$Na: \begin{pmatrix} V_{1_a} \\ I_{1_a} \end{pmatrix} = \begin{pmatrix} 1 & 0 \\ 1 & 1 \end{pmatrix} \begin{pmatrix} V_{2_a} \\ -I_{2_a} \end{pmatrix}, \qquad Nb: \begin{pmatrix} V_{1_b} \\ I_{1_b} \end{pmatrix} = \begin{pmatrix} 2 & 3 \\ 1 & 1 \end{pmatrix} \begin{pmatrix} V_{2_b} \\ -I_{2_b} \end{pmatrix}.$$

If the two networks are cascaded as illustrated in Fig. P10, determine the resulting *ABCD* matrix representing

$$\begin{pmatrix} V_{1_a} \\ I_{1_a} \end{pmatrix} = \begin{pmatrix} a & b \\ c & d \end{pmatrix} \begin{pmatrix} V_{2_b} \\ -I_{2_b} \end{pmatrix}.$$

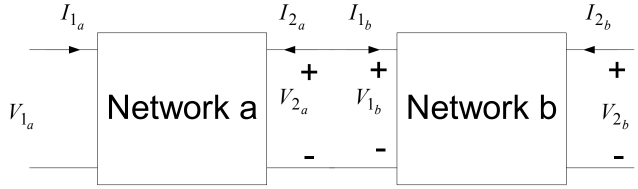


Fig. P11

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Mutual Inductance and Transformers

P12 Given the mutual inductor circuit in Fig. P12, determine the current I_o.

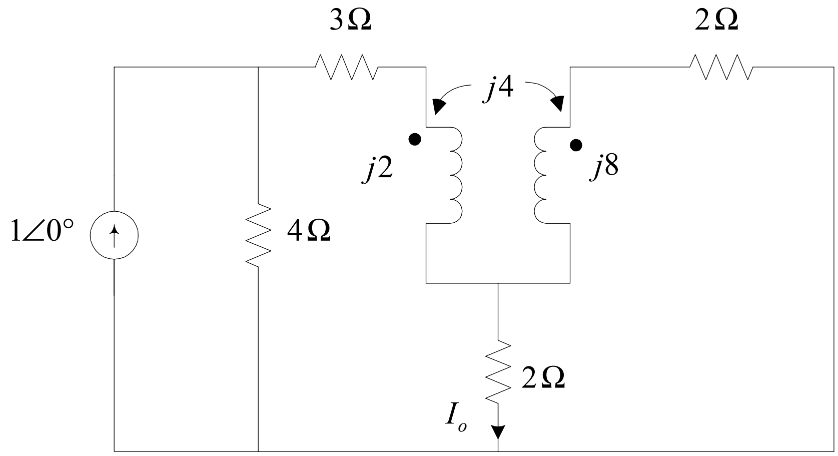

Fig. P12

P13. For the transformer circuit in Fig. P13, determine the current through the load I_L and the voltage across the load V_L.

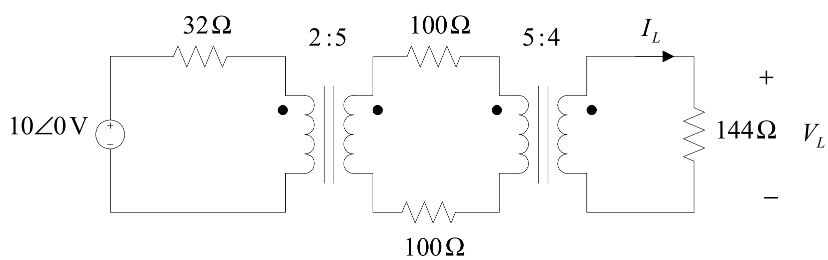

Fig. P13

3 Phase Power

P14. A balanced Delta connected source is connected to a balanced Delta connected load with an *abc* sequence set of phase voltages. Given that $V_{ab} = 110\angle 0°$ Vrms, $Z_{\Delta} = 30 + j15\,\Omega$ and a line impedance $Z_{\ell} = 5 + j5\,\Omega$, determine:

a) the line and phase currents
b) the average power dissipated by the three-phase Delta-connected load