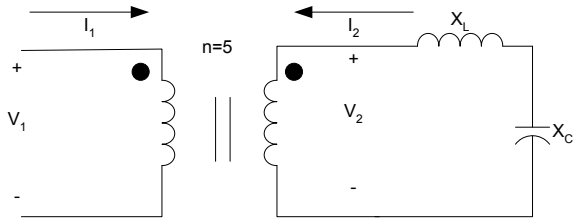
ECE 232
2014-2015 SPRING SEMESTER
FINAL (22-05-2015)

Q1) For the circuit below, a transformer is used to reflect the series connection of impedances of the capacitor and the inductor in the secondary side to the primary side. The transformer equations in phasor domain are given as $V_1 = nV_2$ and $I_2 = -nI_1$ where n = 5.



a) Assume X_L = j ohm and X_C = -j Ohm. What is the impedance observed from the primary side (Find $\frac{V_1}{I_1}$) **(10 points)**

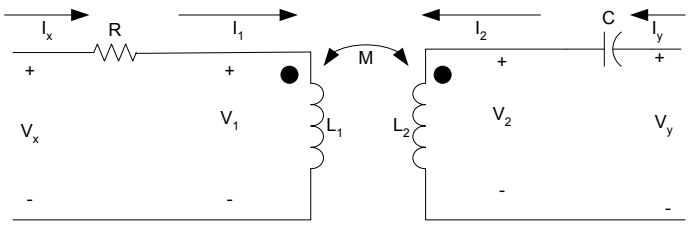
b) Assume X_L = j ohm and X_C = -2j Ohm. What is the impedance observed from the primary side (Find $\frac{V_1}{I_1}$) **(10 points)**

Q2) For the circuit below there is a coupled inductor and its equation in Laplace domain can be given as

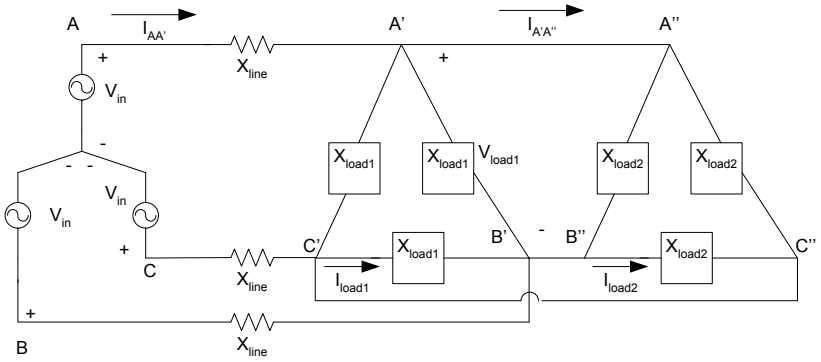
$$\begin{bmatrix} V_1(s) \\ V_2(s) \end{bmatrix} = \begin{bmatrix} sL_1 & sM \\ sM & sL_2 \end{bmatrix} \begin{bmatrix} I_1(s) \\ I_2(s) \end{bmatrix}$$

The impedance values of the capacitor C and the resistor R are $X_C = \frac{1}{sC}$ Ohm and $X_R = R$ Ohm in Laplace domain respectively. Find the parameters of the port equation z_{11}, z_{12}, z_{21} z_{22}, where the port equation is as shown below: **(25 points)**

$$\begin{bmatrix} V_x(s) \\ V_y(s) \end{bmatrix} = \begin{bmatrix} z_{11} & z_{12} \\ z_{21} & z_{22} \end{bmatrix} \begin{bmatrix} I_x(s) \\ I_y(s) \end{bmatrix}$$



Q3) The circuit of a three-phase balanced system is given below



For this circuit the following information are given

For the input side:
- V_{in} is the **phase voltage** (in Volt) in the input side (rms value of the voltage is given)
- Total **complex power** is $S_{in} = P_{in}+jQ_{in}$ VA where P_{in} is the **total average power** (in Watt) and Q_{in} is the total **reactive power** (in VAR) of the input

For the line:
- The line impedance is equal to $X_{line} = X_R$ Ohm (as seen the line impedance only has a resistive effect)

For load1:
The total complex power of load1 is $S_1 = -jQ_1$ VA where $-Q_1$ is the **total reactive power** (in VAR) of load1 (as seen load1 has a purely capacitive effect)

a) Find $|I_{AA'}|$ in terms of V_{in}, P_{in} and Q_{in}. **(10 points)**
b) Find $|I_{A'A''}|$ in terms of V_{in}, P_{in} and Q_{in}, X_R, Q_1.) **(10 points)**
c) Find S_2 **total complex power** (in VA), P_2 **total average power** (in Watt) and Q_2 **total reactive power** (in VAR) for **load2** in terms of V_{in}, Pin, Qin, X_R, Q_1. **(10 points)**

Q4) The impulse response of a LTI (linear time-invariant) system is given by the formula,

$$h(t) = u(t)$$

This system is excited by an input,

$$x(t) = u(t)-2u(t-1)+u(t-2)$$

Using convolution integral, find the output,

$$y(t) = x(t)*h(t)$$

Note: u(t) in the equations stands for unit step input **(25 points)**