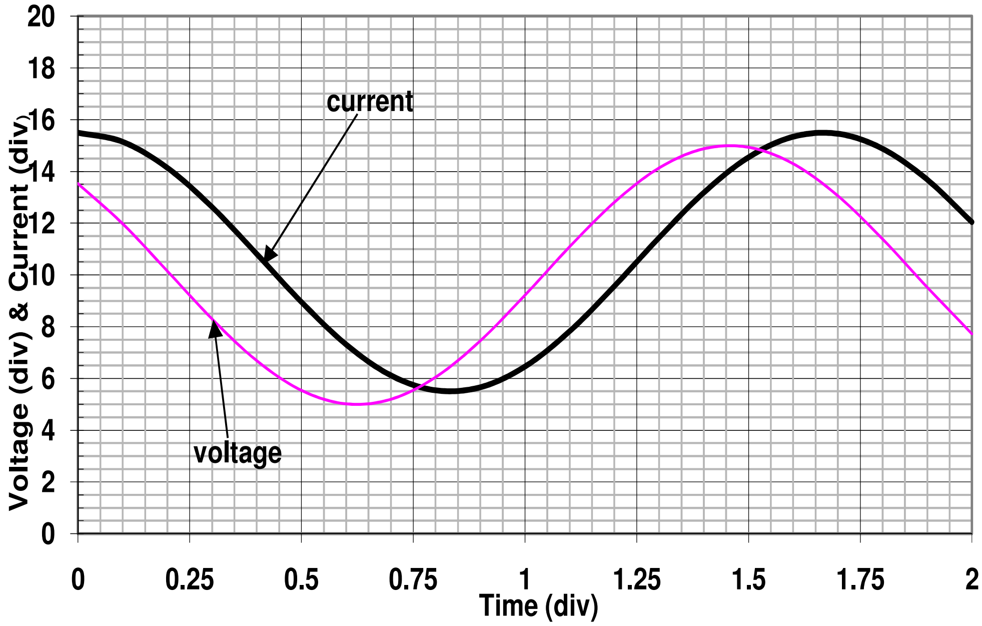
ECE204—AC Circuits
Review for Test 2

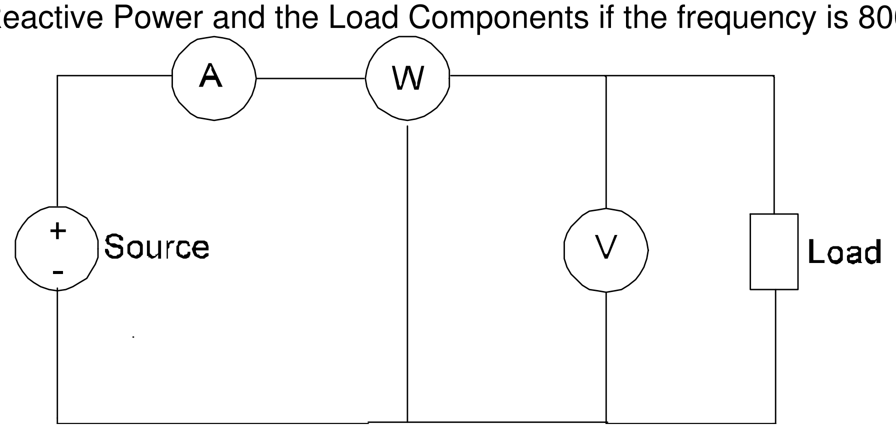
1. A trace from an oscilloscope is shown below. The voltage channel was set on 5 V/div, while the current channel was set on 2 A/div, and the time base was set on 2 msec/div (the integer numbers on each scale are 1 div). Determine:

a) Real power
b) Reactive power
c) Apparent power
d) Complex power
e) Power factor
f) Frequency
g) Thevenin impedance of the circuit



(P = 80.35W, Q = 95.76 VAR, |S|=125 VA, S = 125∠50° VA, pf = 0.643, lag, f=300Hz, ZL = 1.61+j1.92 Ω)

2. In the circuit shown below the readings are: voltmeter—250 V, ammeter—12 A, wattmeter—2.4 kW. The load is a resistor and capacitor in series. Determine the Reactive Power and the Load Components if the frequency is 800 Hz.



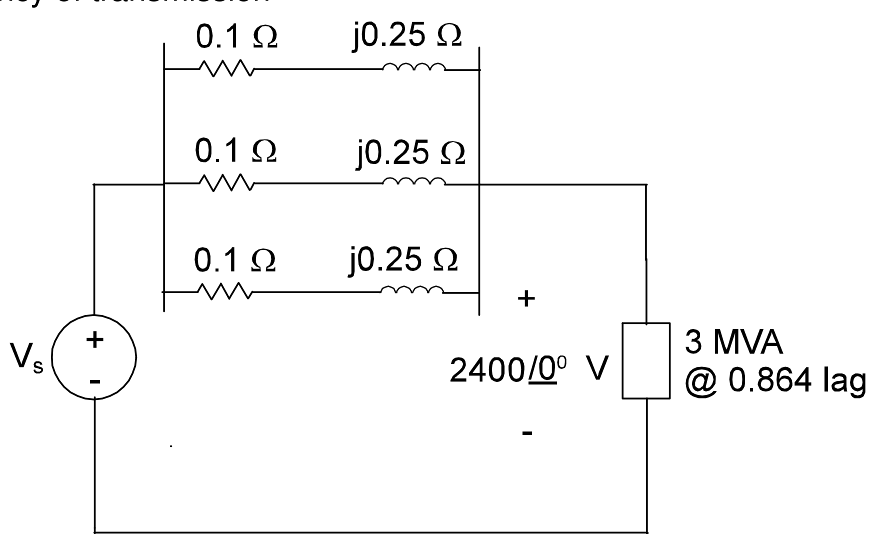
(Q=1.8kVAR, R=16.67 Ω, X = -12.5 Ω, C = 15.9 μF)

3. An engineer (who did not graduate from Rose-Hulman) used an oscilloscope (just like Q1) to measure voltage and current phasors associated with a resistor in series with an inductor; his results (which are correct) were: $\boldsymbol{V} = 210\angle 30$ V and $\boldsymbol{I} = 5\angle 15$ A. He used this to calculate the power and impedance of the circuit and got:
P = 742.5 W, Q = 742.5 VAR, pf = 0.707 lag, R = 40.57 Ω, X = 10.87 Ω
He wanted to check his results so he connected a voltmeter, ammeter and a wattmeter (just like Q2) and took the following (also correct) readings:
V = 210 V, I = 5 A, P = 1014 W. He used these to calculate the following:
Q = 271.8 VAR, pf = 0.9659 lag, R = 43.49 Ω, X = 162.25 Ω
Confused, he passed the data over to an intern (a Rose-Hulman student who had just completed ECE204) and asked which set was correct. The intern quickly informed him both were wrong and pointed out the errors in each set of analysis. What are the correct values and what mistakes did the engineer make?

(S=1050∠15°VA, Z=40.57+j10.87Ω, in case 1 forgot to take the complex conjugate of the impedance, in case 2 incorrectly used P= |V|^2/R – this is incorrect in this case because are in series, not parallel and therefore don't share the same voltage)

4. The following figure shows a load that is fed from a 60 Hz supply via three parallel feeders each with impedance 0.1 + j0.25 Ω/phase. The load is 3 MVA, 0.864 pf ***lag***. The voltage at the load is 2.4 kV.
Determine:

a) Magnitude of the supply voltage (V_S)
b) Percent Voltage Regulation (VR)
c) Real power drawn from the supply
d) Real power lost in the feeder
e) Efficiency of transmission



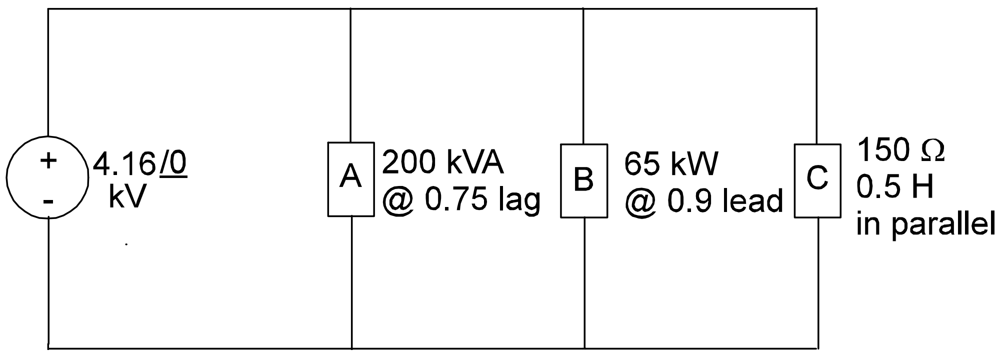
(Vs=2489∠1.6°V, VR=3.7%, Psupply=2.644MW, Pline=52.08kW, η=98%)

5. Three loads A, B & C are supplied at 4.16 kV, 60 Hz, from an ideal source, as shown below. Load A is 200 kVA at 0.75 lag, load B is 65 kW at 0.9 lead, and load C is a 150 Ω resistor in parallel with a 0.5 H inductor. Determine:

a) The complex power drawn from the source

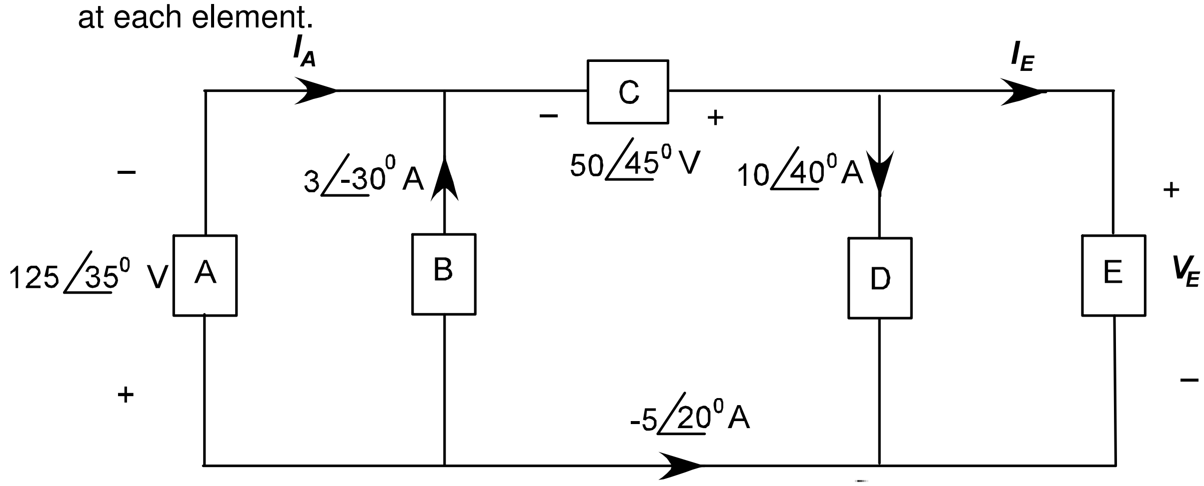
b) The capacitive kVAR required to improve the source power factor to 0.925 lag.

c) The value of capacitance (μF) that has to be placed in parallel with the loads to make the overall power factor 0.925 lag.



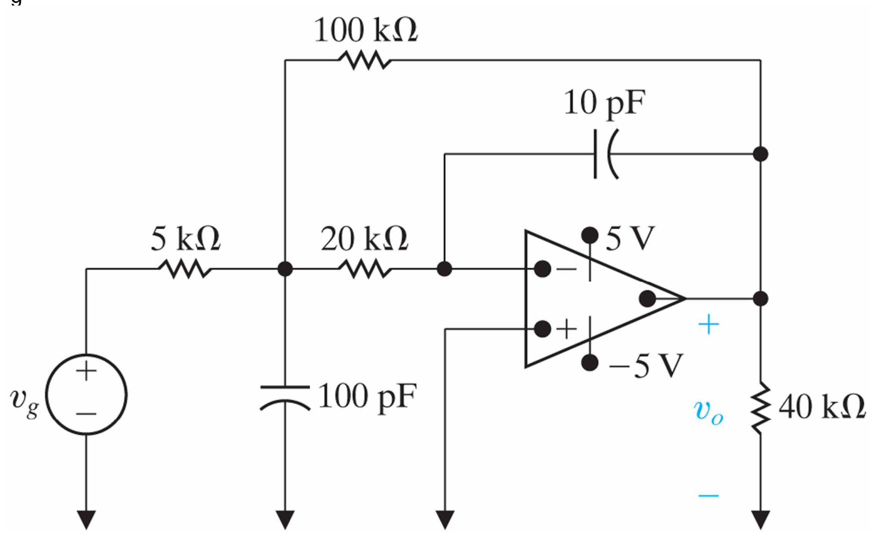
(St=(330+j192)kVA, C=8.72μF)

6. Determine the complex power dissipated by each element and the power factor at each element.



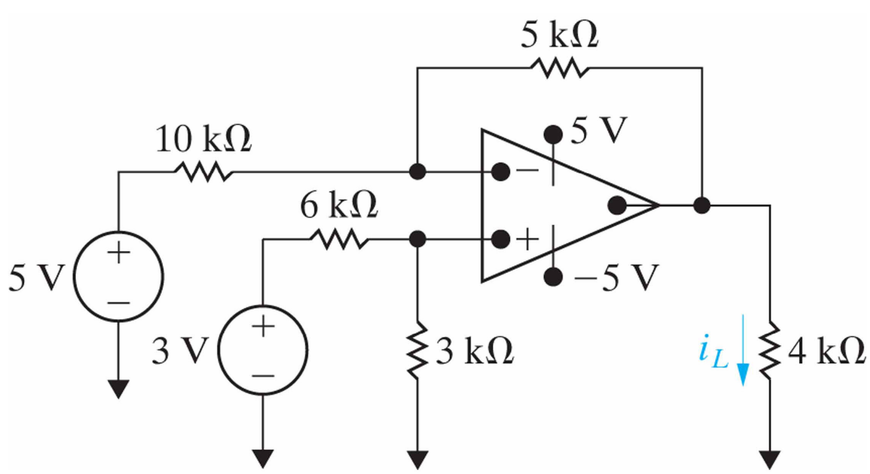
(SA=479.5∠-21.5 °VA, SB=375∠65°VA , SC=250∠-155°VA, SD = 762.5∠168.5°VA,SE= 424.8∠-29.4°VA, check that power balances)

7. The op amp in the circuit below is ideal. Find the steady-state expression of $v_o(t)$ when $v_g = 2\cos 10^6 t$ V.



(ANS: between 5V and -5V $v_o(t) = 7.55\cos(10^6 t + 79.1°)$ V, saturated above and below ±5V)

8. In the following circuit, find the value of RMS value of $I_L(t)$ if the 5V DC source is replaced with an AC source with peak value 5V, frequency 1kHz, and a phase offset of 45 degrees. The 3V DC source is replaced with an AC source with peak value 3V, frequency 1kHz, and a phase offset of -10 degrees.



(ANS: $V_o = 2.05\angle{-98.2°}$ V)