EE 340L

EXP: 2 – THREE-PHASE AC CIRCUITS

A. Determining the Phase Sequence

One way to determine the phase sequence is to use two light bulbs and a capacitor connected in Wye as shown in Fig. 1.

1. Let the phase voltage be 120 V, the capacitor value with a reactance of 600 Ω, and each of the light bulbs is represented by a resistance of 600 Ω. Further assume that the phase sequence is A-B-C (i.e., phase B lags phase A by 120 deg.). Calculate the voltage V_{Nn} (i.e., voltage of node N with respect to the neutral point of the 3-phase source), the voltage across the capacitor, the voltage across the light bulb connected to phase B, and the voltage across the light bulb connected to phase C.
   V_{Nn} = ……… V
   V_{AN} = ……… V
   V_{BN} = ……… V
   V_{CN} = ……… V
   Which of the two bulbs should be brighter (i.e., the one with a higher voltage across its terminals)?

2. Repeat 1) above by assuming the phase sequence is A-C-B (i.e., phase C lags phase A by 120 deg.)
   V_{Nn} = ……… V
   V_{AN} = ……… V
   V_{BN} = ……… V
   V_{CN} = ……… V
   From the results of 1) and 2), one can conclude that the phase sequence is in the following order: bright lamp – dim lamp – capacitor.

3. Verify the above experiment in the laboratory.
   A-B-C Sequence:
   V_{Nn} = ……… V
   V_{AN} = ……… V
   V_{BN} = ……… V
   V_{CN} = ……… V
   A-C-B Sequence:
   V_{Nn} = ……… V
   V_{AN} = ……… V
   V_{BN} = ……… V
   V_{CN} = ……… V

B. Power Measurement by 2-Wattmeter Method.

A three-phase 208 V circuit supplies power to an unbalanced 3-wire, delta connected resistive load. The resistance branches are as follows:

R1 = 170 Ω, R2= 240 Ω, and R3 = 300 Ω (see

1) Calculate the total power delivered to the load.
2) Two watt-meters are used to measure the power above (using one of the phases as a reference to the voltage). Calculate the power measured by each of these meters.

P_{total} = ………… W,

P12 = …………. W, P32 = ……….. W

3) Verify your calculations above through laboratory tests.

P12 = …………. W, P32 = ……….. W

4) Calculate the active and reactive power supplied by each phase.

P1 = ………. W, Q1 = …………. VAR

P2 = ………..W, Q2 = …………. VAR

P3= ……….. W, Q3 = ………… VAR

4) Verify your calculations above through laboratory tests.

P1 = ………. W, Q1 = …………. VAR

P2 = ………..W, Q2 = …………. VAR

P3= ……….. W, Q3 = ………… VAR

C. Load Balancing.

When a single-phase resistive (R) load is connected across two phases of a three-phase source, it creates a highly unbalanced system (i.e., two of the line currents are equal but opposite in phase, while the third line current is zero). It is possible to balance this circuit perfectly (i.e., all line currents are equal, and in phase with their respective phase voltages) by using an inductor and capacitor with specific values as shown in Fig. 3 . Further, it is essential that the phase sequence should be 1-2-3.

1) Suppose that the three-phase source is 208 V (line-to-line) and positive sequence, and R = 100 Ω. Calculate the magnitude and phase angle of each phase current and resulting reactive and reactive power when (a) the single-phase load is connected alone, and (b) when the balancing L-C circuit is added.

Without L-C: I_A = ………… A, I_B = ………… A, I_C = ……….. A

P_A = ………… W, P_B = ………… W, P_C = ……….. W

Q_A = ………… VAR, Q_B = ………… VAR, Q_C = ……….. VAR

With L-C: I_A = ………… A, I_B = ………… A, I_C = ……….. A

P_A = ………… W, P_B = ………… W, P_C = ……….. W

Q_A = ………… VAR, Q_B = ………… VAR, Q_C = ……….. VAR

2) Verify the above through a laboratory experiment (use the combinations of available L and C values in the Laboratory that closely match the desired values).

Without L-C: I_A = ………… A, I_B = ………… A, I_C = 0 A

P_A = ………… W, P_B = ………… W, P_C = 0 W

Q_A = ………… VAR, Q_B = ………… VAR, Q_C = 0 VAR

With L-C: I_A = ………… A, I_B = ………… A, I_C = ……….. A

P_A = ………… W, P_B = ………… W, P_C = ……….. W

Q_A = ………… VAR, Q_B = ………… VAR, Q_C = ……….. VAR

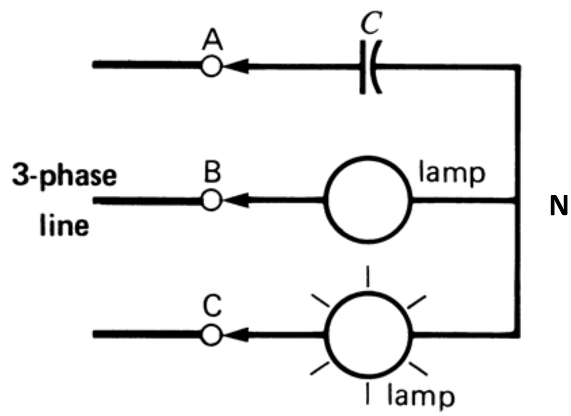

Figure 1

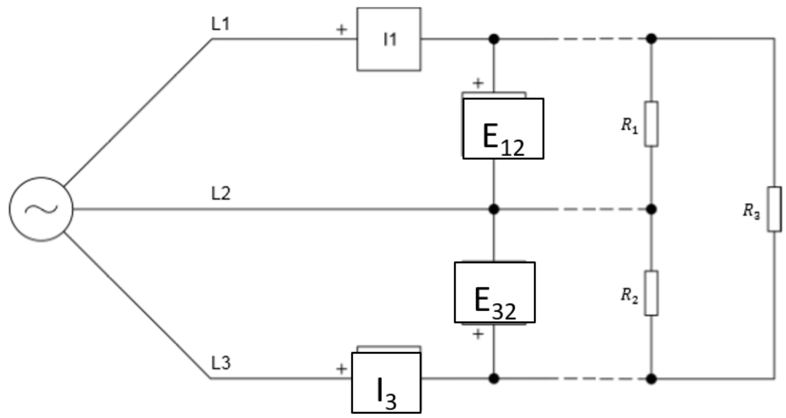

Figure 2

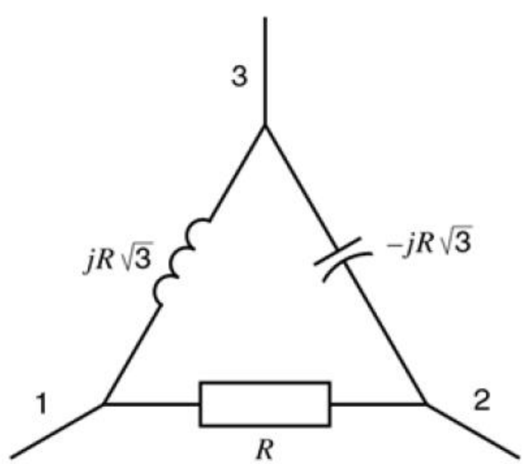

Figure 3

The following table gives impedance values which can be obtained using either the Resistive Load, Model 8311, the Inductive Load, Model 8321, or the Capacitive Load, Model 8331. Figure C-1 shows the load elements and connections. Other parallel combinations can be used to obtain the same impedance values listed.

Table C-1. Impedance table for the load modules.

Impedance (Ω)			Position of the switches								
120 V 60 Hz	220/230 V 50 Hz/60 Hz	240 V 50 Hz	1	2	3	4	5	6	7	8	9
1200	4400	4800	I								
600	2200	2400		I							
300	1100	1200			I						
400	1467	1600	I	I							
240	880	960	I		I						
200	733	800		I	I						
171	629	686	I	I	I						
150	550	600	I			I	I	I			
133	489	533		I		I	I	I			
120	440	480			I		I	I			
109	400	436			I	I	I	I			
100	367	400	I		I	I	I	I			
92	338	369		I	I	I	I	I			
86	314	343	I	I	I	I	I	I			
80	293	320	I			I	I	I	I	I	I
75	275	300		I		I	I	I	I	I	I
71	259	282			I		I	I	I	I	I
67	244	267			I	I	I	I	I	I	I
63	232	253	I		I	I	I	I	I	I	I
60	220	240		I	I	I	I	I	I	I	I
57	210	229	I	I	I	I	I	I	I	I	I