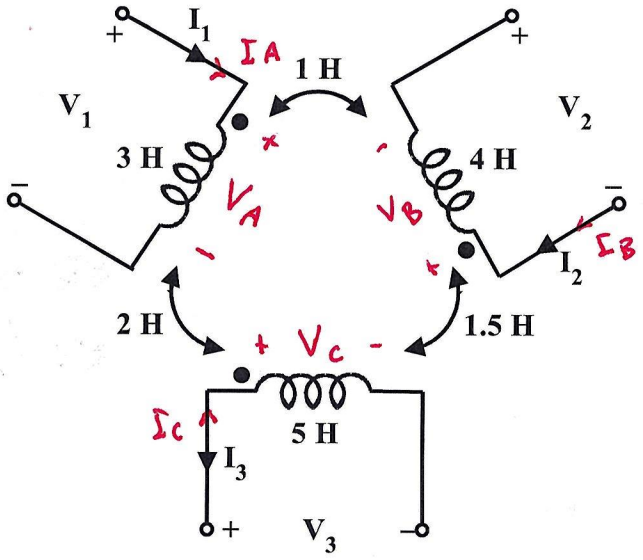
EE 3340

Homework Problem #038

If $\mathbf{I}_1 = 2\angle 0°$ A, $\mathbf{I}_2 = 1\angle 90°$ A, $\mathbf{I}_3 = 1\angle -90°$ A and $\omega = 2$ rad/s for all three, determine $\mathbf{V}_1$, $\mathbf{V}_2$ and $\mathbf{V}_3$ in polar form. Show your work.



$$V_A = j2.3 \cdot I_A + j \cdot 2.1 \cdot I_B + j \cdot 2.2 \cdot I_C$$

$$V_B = j \cdot 2.4 \cdot I_B + j \cdot 2.1 \cdot I_A + j \cdot 2 \cdot 1.5 \cdot I_C$$

$$V_C = j \cdot 2.5 \cdot I_C + j \cdot 2.2 \cdot I_A + j \cdot 2.1.5 \cdot I_B$$

But $V_A = V_1$, $V_B = -V_2$, $V_C = V_3$

$I_A = I_1$, $I_B = I_2$, $I_C = -I_3$

So,

$$V_1 = j6 I_1 + j2 I_2 - j4 I_3$$

$$V_2 = -j8 I_2 - j2 I_1 + j3 I_3$$

$$V_3 = -j10 I_3 + j4 I_1 + j3 I_2$$

Given $I_1 = 2\angle 0^\circ$ A, $I_2 = 1\angle 90^\circ$ A, $I_3 = 1\angle -90^\circ$ A.

or $I_1 = 2$ A, $I_2 = j$ A, $I_3 = -j$ A

Then

$$V_1 = j12 - 2 - 4 = -6 + j12$$

$$V_2 = 8 - j4 + 3 = 11 - j4$$

$$V_3 = -10 + j8 - 3 = -13 + j8$$

$$V_1 \approx 13.4\angle 116.6^\circ \text{ V}$$

$$V_2 \approx 11.7\angle -19.98^\circ \text{ V}$$

$$V_3 \approx 15.26\angle 148.4^\circ \text{ V}$$

See the attached pages for solutions using MATLAB and LTspice.

```
>> I1=2;
>> I2=j;
>> I3=-j;
>> IA=I1;
>> IB=I2;
>> IC=-I3;
>> VA=j*2*3*IA+j*2*1*IB+j*2*2*IC;
>> VB=j*2*4*IB+j*2*1*IA+j*2*1.5*IC;
>> VC=j*2*5*IC+j*2*2*IA+j*2*1.5*IB;
>> V1=VA

V1 =

  -6.0000 +12.0000i

>> V2=-VB

V2 =

  11.0000 - 4.0000i

>> V3=VC

V3 =

 -13.0000 + 8.0000i

>> V1_mag=abs(V1)

V1_mag =

   13.4164

>> v1_angle_deg=angle(V1)*180/pi

v1_angle_deg =

  116.5651

>> V2_mag=abs(V2)

V2_mag =

   11.7047

>> V2_angle_deg=angle(V2)*180/pi

V2_angle_deg =

  -19.9831

>> V3_mag=abs(V3)

V3_mag =

   15.2643

>> V3_angle_deg=angle(V3)*180/pi

V3_angle_deg =

  148.3925
```

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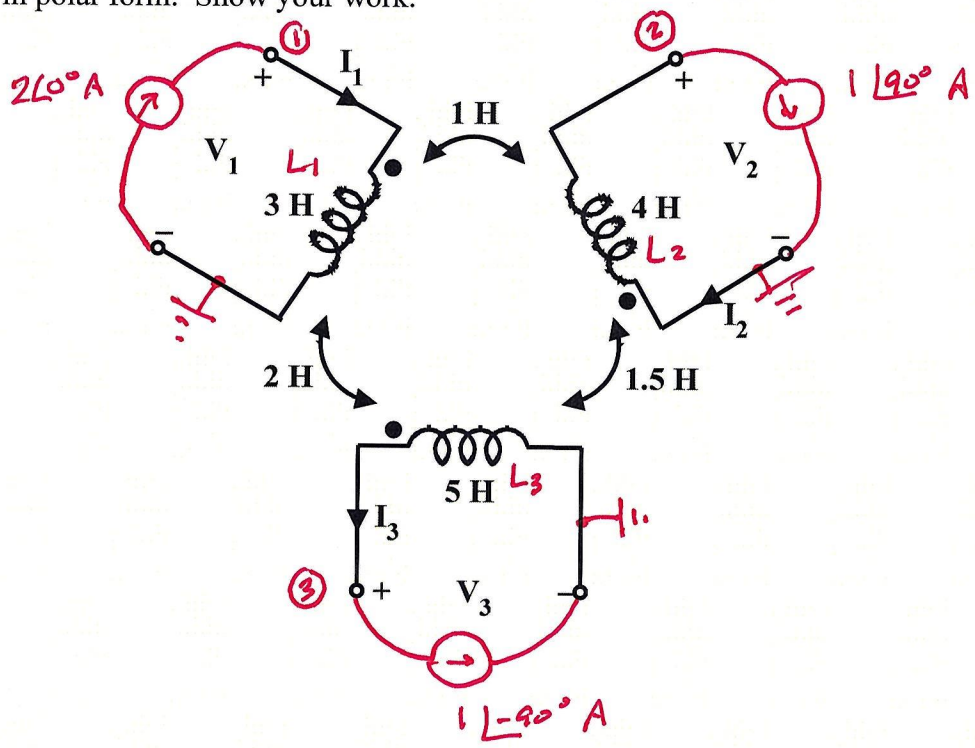
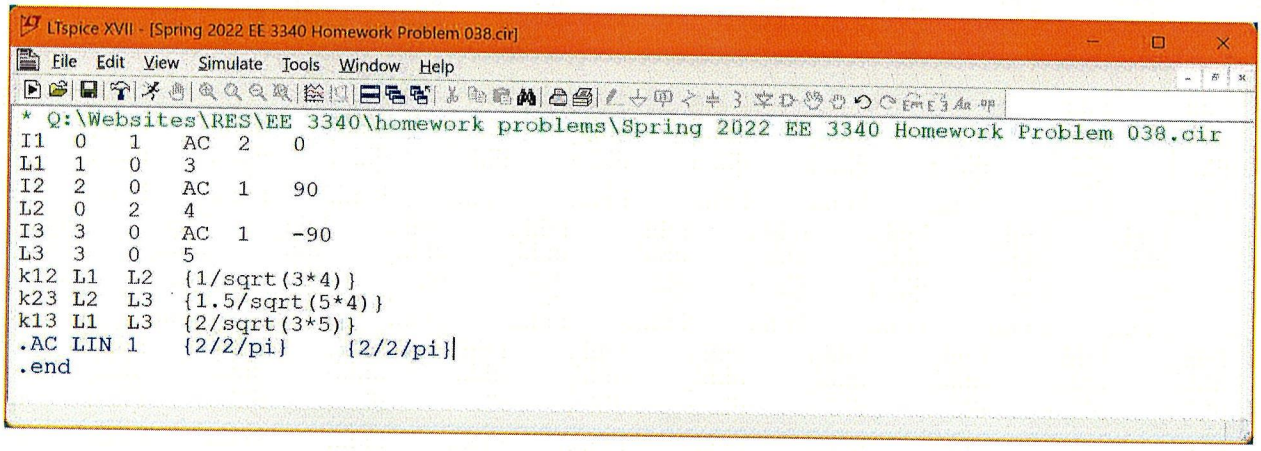
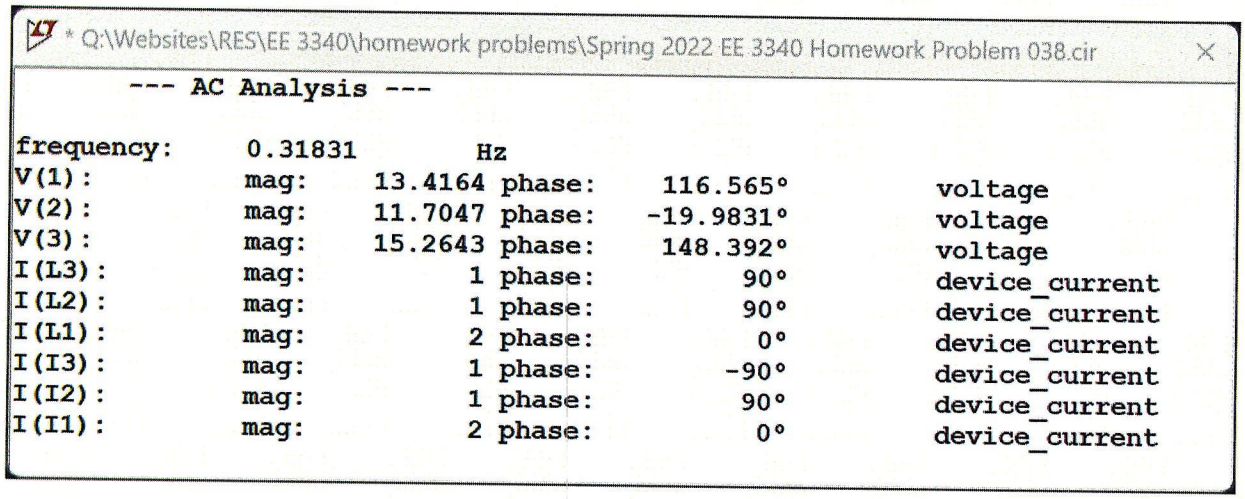


$$k_{12} = \frac{1}{\sqrt{3 \cdot 4}}$$

$$k_{23} = \frac{1.5}{\sqrt{5 \cdot 4}}$$

$$k_{13} = \frac{2}{\sqrt{3 \cdot 5}}$$


LTspice XVII - [Spring 2022 EE 3340 Homework Problem 038.cir]
File Edit View Simulate Tools Window Help
* Q:\Websites\RES\EE 3340\homework problems\Spring 2022 EE 3340 Homework Problem 038.cir
I1 0 1 AC 2 0
L1 1 0 3
I2 2 0 AC 1 90
L2 0 2 4
I3 3 0 AC 1 -90
L3 3 0 5
k12 L1 L2 {1/sqrt(3*4)}
k23 L2 L3 {1.5/sqrt(5*4)}
k13 L1 L3 {2/sqrt(3*5)}
.AC LIN 1 {2/2/pi} {2/2/pi}
.end


* Q:\Websites\RES\EE 3340\homework problems\Spring 2022 EE 3340 Homework Problem 038.cir
--- AC Analysis ---
frequency: 0.31831 Hz
V(1): mag: 13.4164 phase: 116.565° voltage
V(2): mag: 11.7047 phase: -19.9831° voltage
V(3): mag: 15.2643 phase: 148.392° voltage
I(L3): mag: 1 phase: 90° device_current
I(L2): mag: 1 phase: 90° device_current
I(L1): mag: 2 phase: 0° device_current
I(I3): mag: 1 phase: -90° device_current
I(I2): mag: 1 phase: 90° device_current
I(I1): mag: 2 phase: 0° device_current