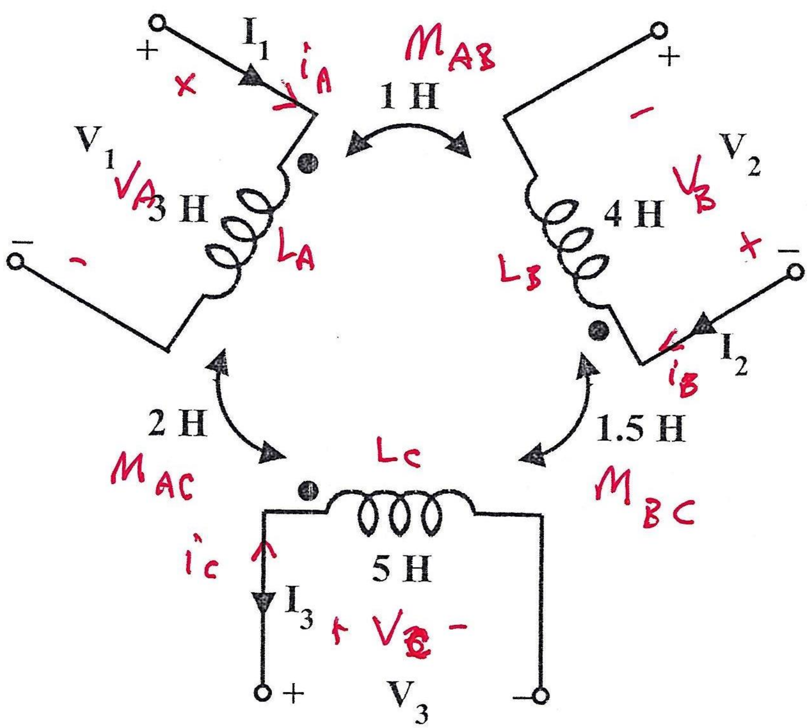
EE 3340

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.



$$V_1 = \cancel{V_A} = j2\cdot 3\,\overset{I_1}{\cancel{I_A}} + j2\cdot 1\,\overset{I_2}{\cancel{I_B}} \overset{-}{\cancel{+}} j2\cdot 2\,\overset{I_3}{\cancel{I_C}} =$$

$$-V_2 = \cancel{V_B} = j2\cdot 4\cdot\overset{I_2}{\cancel{I_B}} + j2\cdot 1\cdot\overset{I_1}{\cancel{I_A}} \overset{-}{\cancel{+}} j2\cdot 1.5\,\overset{I_3}{\cancel{I_C}}$$

$$V_3 = \cancel{V_C} = -j2\cdot 5\cdot\overset{I_3}{\cancel{I_C}} + j2\cdot 2\cdot\overset{I_1}{\cancel{I_A}} + j2\cdot 1.5\,\overset{I_2}{\cancel{I_B}}$$

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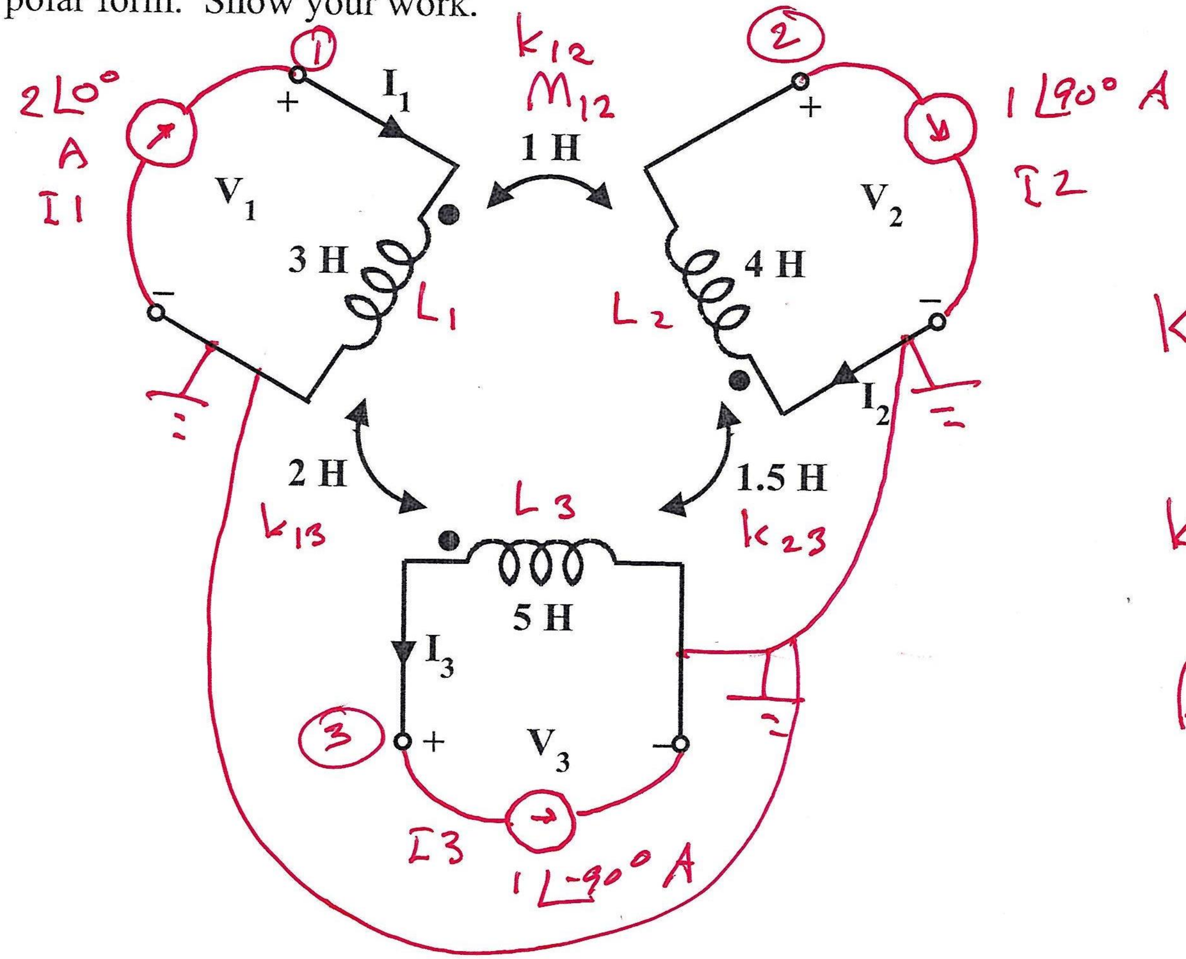
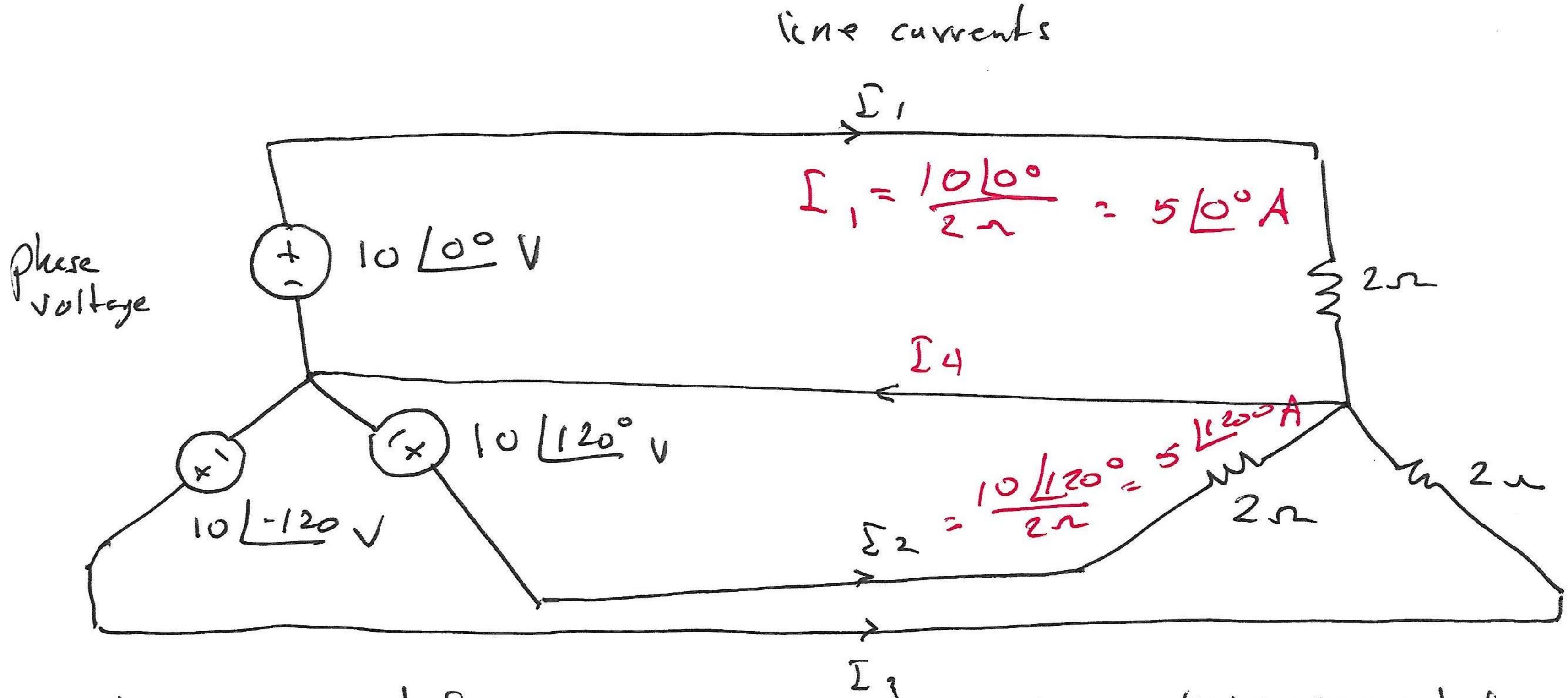


$$K12 = \frac{M_{12}}{\sqrt{L_1 L_2}}$$

$$k23 = \frac{M_{23}}{\sqrt{L_2 L_3}}$$

$$k13 = \frac{M_{13}}{\sqrt{L_1 L_3}}$$

```
L1   1  0  3                    {2*3}
L2   0  2  4
L3   3  0  5
k12  L1  L2  {1/sqrt(3*4)}
k23  L2  L3  {1.5/sqrt(4*5)}
k13  L1  L3  {2/sqrt(3*5)}
I1   0  1  AC  2  0
I2   2  0  AC  1  90
I3   3  0  AC  1  -90
.AC  LIN  1  {2/(2*pi)}  {2/(2*pi)}
```



wye-connected source

$I_3 = \frac{10\angle -120°}{2\Omega} = 5\angle -120°$ A

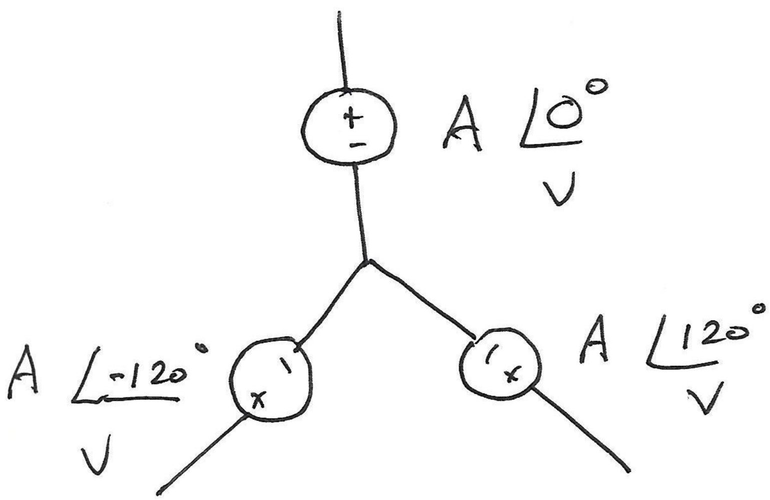
wye-connected load

all same magnitude and evenly-spaced angles, the system is "balanced"

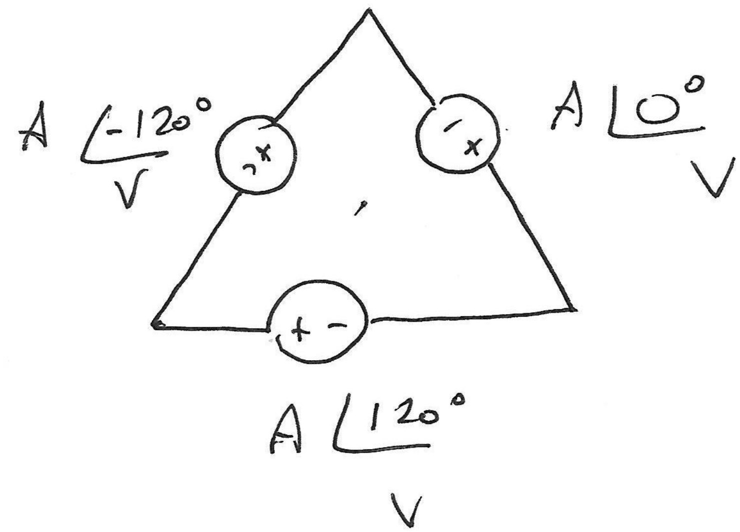
equal impedances ⇒ balanced load

$$I_4 = I_1 + I_2 + I_3$$
$$= 5\angle 0° + 5\angle 120° + 5\angle -120°$$
$$=$$

3 phase

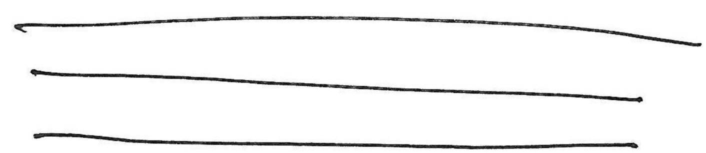


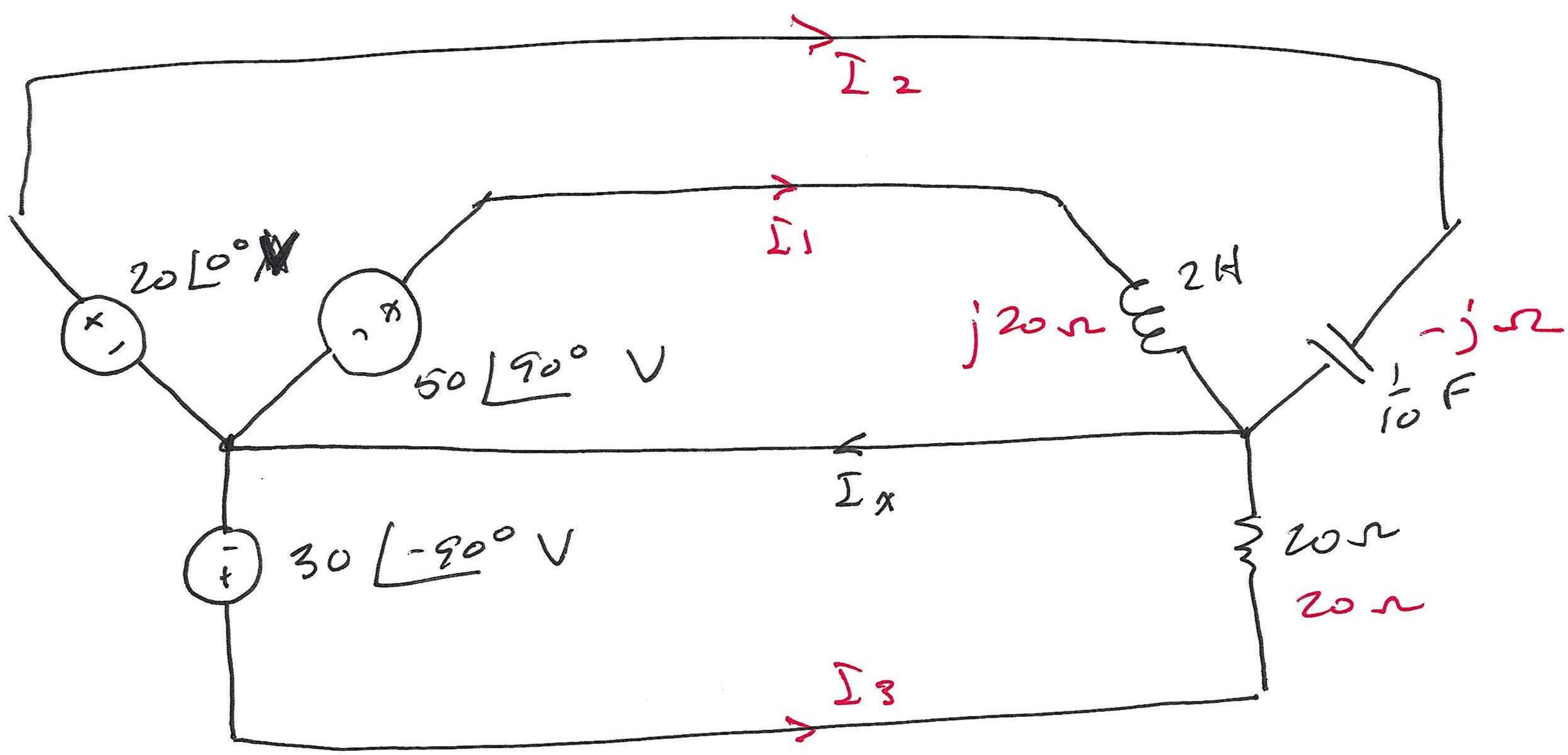
star
wye



delta

Source





$\omega = 10 \frac{rad}{s}$

$I_x = ?$

$I_1 = \frac{50\angle 90°}{j20} = 2.5\angle 0°$ A

$I_2 = \frac{20\angle 0°}{-j} = 20\angle 90°$ A

$I_3 = \frac{30\angle -90°}{20} = 1.5\angle -90°$ A

$$I_4 = I_1 + I_2 + I_3$$

$$= 2.5\angle 0^\circ + 20\angle 90^\circ + 1.5\angle -90^\circ$$

$$= 2.5 + j20 - j1.5$$

$$= 2.5 + j18.5 \quad A$$