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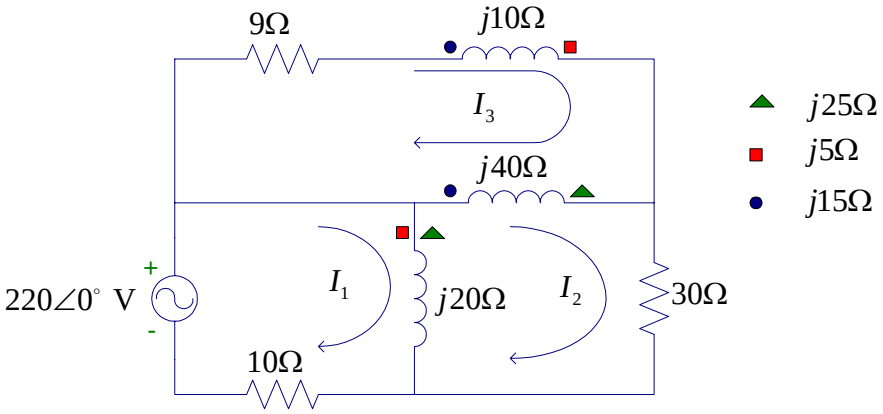
Exercise on writing mesh equations in a magnetically coupled circuit
EE-230 (H. Saadat)

For the circuit shown write the mesh equations. Solve the equations and obtain the phasor values of currents.



Mesh #1 $j20(I_1 - I_2) - j25(I_2 - I_3) - j5I_3 + 10I_1 = 220\angle 0^\circ$

Mesh #2 $30I_2 + j20(I_2 - I_1) + j25(I_2 - I_3) + j5I_3 + j40(I_2 - I_3) - j25(I_1 - I_2) + j15I_3 = 0$

Mesh#3 $(9 + j10)I_3 - j15(I_3 - I_2) - j5(I_1 - I_2) + j40(I_3 - I_2) + j25(I_1 - I_2) - j15I_3 = 0$

Reducing the above equations we get

$$(10 + j20)I_1 - j45I_2 + j20I_3 = 220\angle 0^\circ$$
$$-j45I_1 + (30 + j110)I_2 - j45I_3 = 0$$
$$j20I_1 - j45I_2 + (9 + j20)I_3 = 0$$

or in matrix notation we have

$$\begin{bmatrix} 10 + j20 & -j45 & j20 \\ -j45 & 30 + j110 & -j45 \\ j20 & -j45 & 9 + j20 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} 220 + j0 \\ 0 \\ 0 \end{bmatrix}$$

Using MATLAB the solution is

$$I_1 = 16.4447\angle -5.1000^\circ \text{ A}$$
$$I_2 = 4.1813\angle -1.6807^\circ \text{ A}$$
$$I_3 = 6.4526\angle -165.420^\circ \text{ A}$$

We use the following statements:

```
Z = [10+20j     -45j    20j
       -45j  30+110j   -45j
       20j     -45j 9+20j];
V = [220; 0; 0];
I = inv(Z)*V    % Solution in Rectangular form
disp(['       Mag.   Phase Degree'])
disp([abs(I), angle(I)*180/pi]) % Polar form
```

The result is

```
  I =
        16.3796 - 1.4618i
        4.1795 - 0.1226i
        -6.2448 - 1.6243i

           Mag.     Phase Degree
       16.4447    -5.1000
       4.1813     -1.6807
       6.4526     -165.4205
```