Homework 7

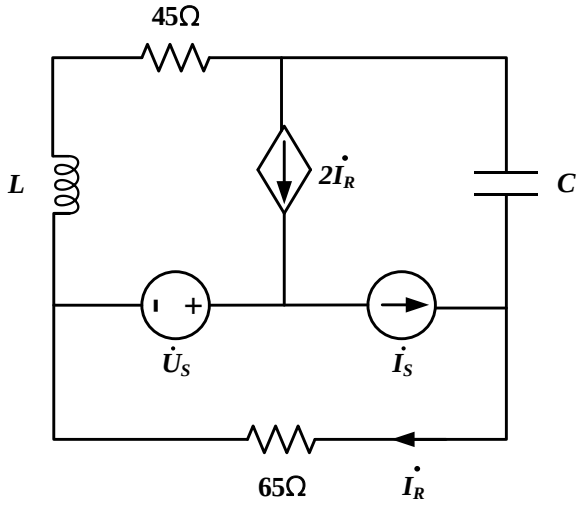
Due date: Jan. 2nd, 2024

Turn in your hard-copy hand-writing homework in class

Rules:

- Work on your own. Discussion is permissible, but extremely similar submissions will be judged as plagiarism.
- Please show all intermediate steps: a correct solution without an explanation will get zero credit.
- Please submit on time. No late submission will be accepted.
- Please prepare your submission in English only. No Chinese submission will be accepted.

1. For the circuit below, U_S=100∠0° V (rms), I_S=2∠0° A, ωL=30 Ω, $1/\omega C$ =90 Ω, find the complex power delivered by **voltage and current source**.



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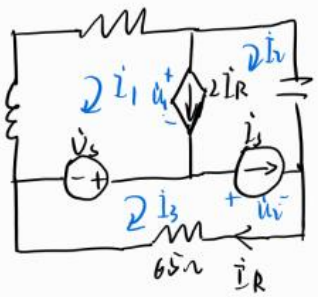


$\dot{I}_3 = \dot{I}_R$

$Z_L = j\omega L = 30j\,\Omega$ $Z_C = \frac{1}{j\omega C} = -90j\,\Omega$ 2'

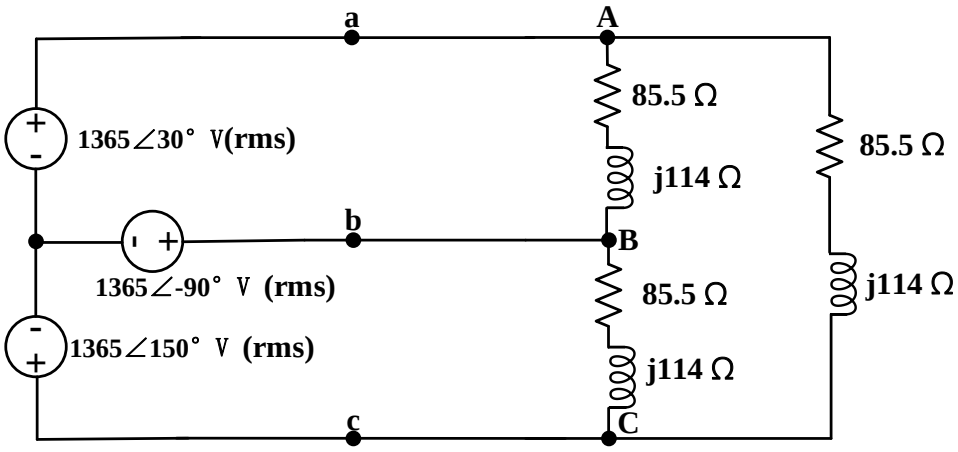
$$\begin{cases} \dot{U}_S + (45+30j)\dot{I}_1 + \dot{u}_1 = 0 \\ -\dot{u}_1 - \dot{u}_v - 90j\,\dot{I}_v = 0 \\ -\dot{u}_S + \dot{u}_v + 65\dot{I}_R = 0 \\ \dot{I}_1 - \dot{I}_v = 2\dot{I}_R \\ \dot{I}_S = \dot{I}_R - \dot{I}_v = 2\angle 0^\circ \end{cases}$$ 5'

$$\Rightarrow \begin{cases} \dot{I}_1 = -0.65 - 1.8j \\ \dot{I}_v = -1.55 - 0.6j \\ \dot{I}_R = 0.45 - 0.6j \end{cases} \quad \begin{cases} \dot{u}_1 = -174.75 + 100.5j \\ \dot{u}_v = 70.75 + 39j \end{cases}$$ 4'

delivered power: $P_u = 100(1.1 - j1.2) = (110 - 120j)$ VA 2'

$P_C = (-70.75 - 39j) \times 2 = (141.5 - 78j)$ V·A 2'

2.For the circuit below, find I_{AB}, I_{BC}, I_{CA}, V_{CA} and in the circuit.



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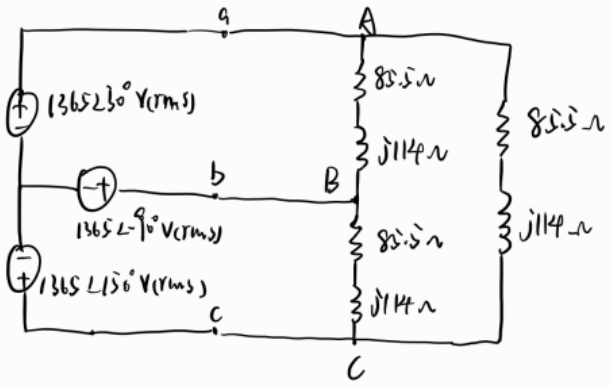


$\dot{I}_{AB}(85.5+114j) = 1365\angle 30° - 1365\angle -90°$

$\dot{I}_{BC}(85.5+114j) = 1365\angle -90° - 1365\angle 150°$ 6'

$\dot{I}_{CA}(85.5+114j) = 1365\angle 150° - 1365\angle 30° = \dot{V}_{CA}$

$$\Rightarrow \begin{cases} \dot{I}_{AB} = 16.5\angle 6.87° A = 16.41 + 1.98j\ A \\ \dot{I}_{BC} = 16.5\angle -113.13° A = -6.51 - 15.16j\ A \\ \dot{I}_{CA} = 16.5\angle 126.87° A = -9.93 + 13.17j\ A \end{cases}$$ 6'

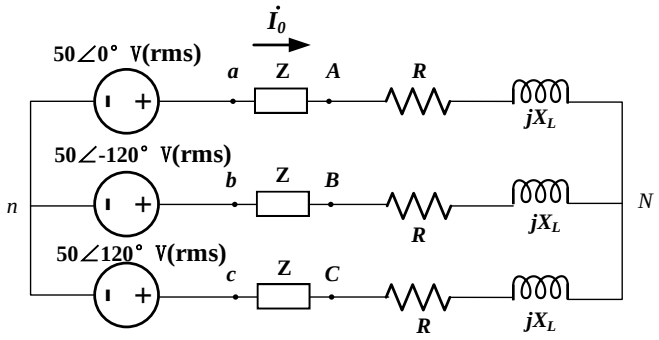
$\dot{V}_{CA} = 2364.75\angle 180° V$ 3'

3. Consider the following three-phase circuit. R=20 Ω, jX_L = j5 Ω, Z= （1+j0.5） Ω.

(1) Calculate the **line current I_0**.

(2) Calculate **the voltage U_{AB}**.

(3) Calculate the total complex power absorbed by **all the loads including Z, R and jX_L**.



3.(1) Using KCL $\begin{cases} 50\angle 0^\circ - \dot{I}_0(21+5.5j) - (\dot{I}_0-\dot{I}_1)(21+5.5j) - 50\angle -120^\circ = 0 \\ 50\angle -120^\circ - (\dot{I}_1-\dot{I}_0)(21+5.5j) - \dot{I}_1(21+5.5j) - 50\angle 120^\circ = 0 \end{cases}$ 5'

2' $\Rightarrow \begin{cases} \dot{I}_0 = 2.30\angle -14.68^\circ = 2.22 - 0.58j \\ \dot{I}_1 = 2.3\angle -74.68^\circ \end{cases}$

4' (2) $\dot{U}_{AB} = (20+j5)(3.52\angle 34.48^\circ - 1.33\angle 135.52^\circ) = 82.28\angle 25.36^\circ V = 74.71 + 40.34j$ V

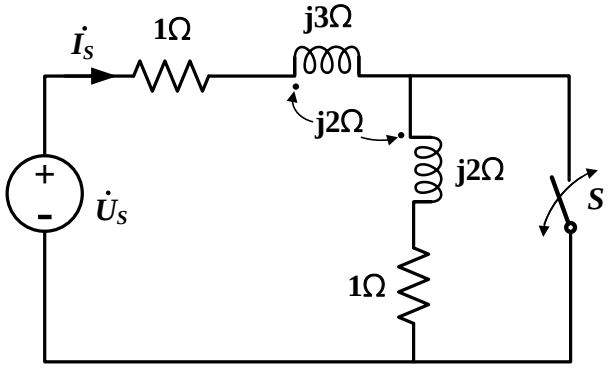
4' (3) $\tilde{S}_{total} = 3\cdot 50\angle 0^\circ \cdot (2.30\angle -14.68^\circ)^* = 354.22 + 87.55j$ V·A

4. For the circuit below, U_S=80∠30° V (***phasor expressed by amplitude***), find

(1) The current I_S for switch ***S is* off** .

(2) The complex power delivered by **voltage source** when ***S is* off.**

(3) The current I_S when the switch ***S is* on**.



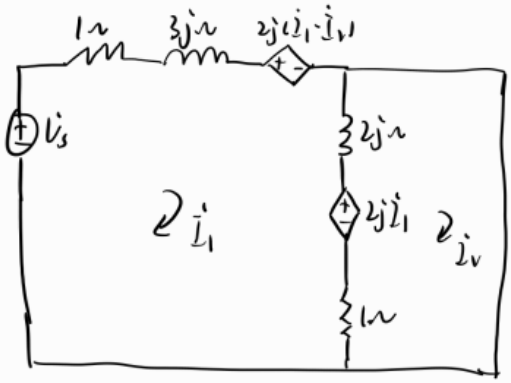
4. (1) $L = L_1 + L_2 + 2M = 9j\ \Omega$ 2'

$\dot{I}_S = \frac{80\angle 30^\circ}{2+9j} = 8.68\angle -47.47^\circ$

$= 5.87 - 6.39j$ A 3'

(2) $\dot{S} = \frac{1}{2}\dot{U}_S \cdot \dot{I}_S^* = 75.54 + 338.76j$ V·A 4'

(3)



1'

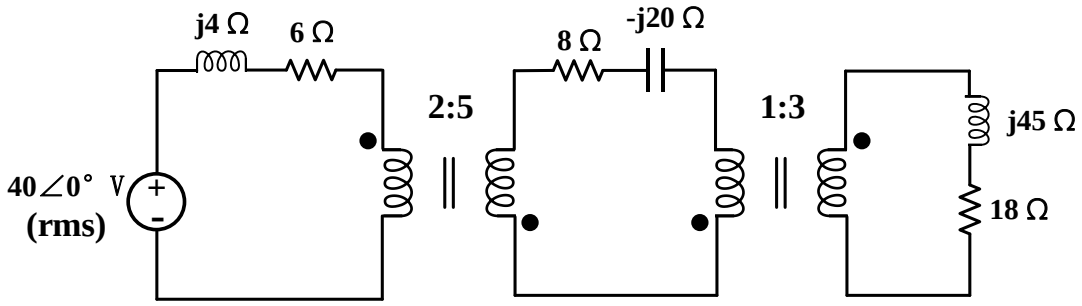
$$\begin{cases} -\dot{U}_S + (1+3j)\dot{I}_1 + 2j(\dot{I}_1 - \dot{I}_V) + (\dot{I}_1 - \dot{I}_V)(2j+1) + 2j\dot{I}_1 = 0 \\ -2j\dot{I}_1 + (\dot{I}_V - \dot{I}_1)(2j+1) = 0 \end{cases}$$ 6'

$\Rightarrow \dot{I}_S = 35.08\angle -7.81^\circ A = 34.75 - 4.89j$ A. 4'

5. For the circuit below, please find:

(a) The average power released by the source.

(b) The average power delivered to the 18Ω resistor.



5. (a) $Z_L' = 8-20j + \underbrace{(18+45j)}_{3^2} = 10-15j$ 2'

$Z_{in} = 6+4j + \frac{10-15j}{n^2} = 7.6+1.6j = 7.77\angle 11.8°$, $n = \frac{5}{2} = 2.5$ 2'

$\dot{I}_1 = \frac{40}{Z_{in}} = 5.15\angle -11.8°$ 2'

$\dot{S} = V_s \dot{I}_1^* = 206\angle 11.8° \text{ V·A} = 201.58+42.44j \text{ V·A}$ 3'

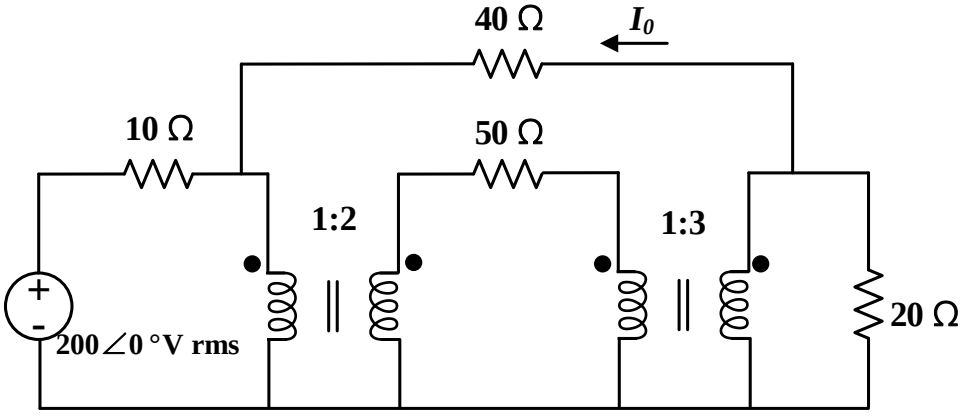
$P = \text{Re}[\dot{S}] = 201.58\text{W}$ 1'

(b) $\dot{I}_2 = \frac{-\dot{I}_1}{n}$, $n=2.5$

$\dot{I}_3 = \frac{-\dot{I}_2}{n'}$ $n=3$

$\therefore \dot{I}_3 = 0.69\angle -11.8°$ $P = |I_3|^2 \cdot 18 = 8.49\text{ W}$ 5'

6. For the following circuit, please find current I_0



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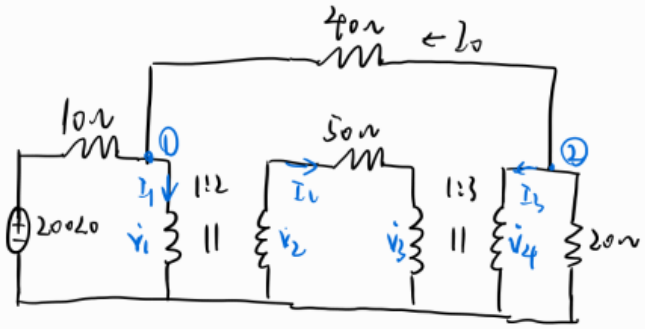

$\frac{V_2}{V_1} = \frac{2}{1}$ $\frac{I_2}{I_1} = \frac{1}{2}$ $\frac{V_4}{V_3} = \frac{3}{1}$ $\frac{I_3}{I_2} = \frac{1}{3}$ 2'

$\frac{200 - V_1}{10} = \frac{V_1 - V_4}{40} + I_1$

$\Rightarrow 200 = 1.25V_1 - 0.25V_4 + 10I_1$

8' $\frac{V_1 - V_4}{40} = \frac{V_4}{20} + I_3$

$V_1 = 3V_4 + 40I_3$

$V_3 = V_2 - 50I_2$

$$\begin{cases} 200 = 1.25V_1 - 0.25V_4 + 10I_1 \\ V_1 = 3V_4 + 40 \cdot \frac{1}{6} I_1 \\ \frac{V_4}{3} = 2V_1 - 25I_1 \end{cases}$$

6' $\Rightarrow$ $\begin{cases} V_1 = 107.54\ V \\ V_4 = 53.58\ V \\ I_1 = 7.89\ A \end{cases}$

$I_0 = \frac{V_4 - V_1}{40} = -1.35\ A$ 4'