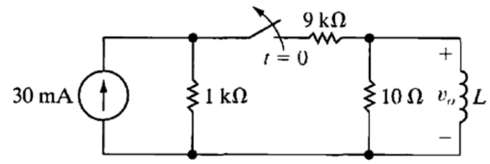
Benha University | 2nd Term 2014 تخلفات
Benha Faculty of Engineering | Electrical Department
Electrical Engineering and Circuit Analysis(b) (E1102) | 1st Year Electrical
Dr.Wael Abdel-Rahman Mohamed | Time: 3 Hrs

Exam with Model Answer

Question (1): **[10 Marks]**

In the circuit in Fig.1, the switch has been closed for a long time before opening at $t=0$. Write the expression for $v_o(t)$ and find v_o at $t=1ms$. ($L = 14.43\ mH$)



Solution:

The switch was closed for very long time and the inductor was a short circuit and it the inductor current equals

$i_L(0^-) = i_L(0^+) = 30mA * 1K\Omega / (1K\Omega + 9K\Omega) = 3\ mA$

After the switch is opened:

The inductor will dissipate its energy into the 10Ω resistor as follows,

Final $i_L = 0$, *initial* $i_L = 3mA$, $\tau = L/R = 14.43\ mH / 10\ \Omega = 1.443\ mSec.$

$i_L(t) = 3\ e^{-t/\tau}\ mA$

$v_L = v_R = v_o\ (t) = -30\ e^{-t/\tau}\ mV$

$v_o(1ms) = -15\ mV$

Question (2): **[15 Marks]**

For the circuit shown in Fig.2,

a) Write the node voltage equations needed to find the voltage $\mathbf{V_o}$. (***write both the main equations and the auxiliary equations***).

b) Write the mesh current equations needed to find the voltage $\mathbf{V_o}$. (***write both the main equations and the auxiliary equations***).

c) Which way is preferred and why?

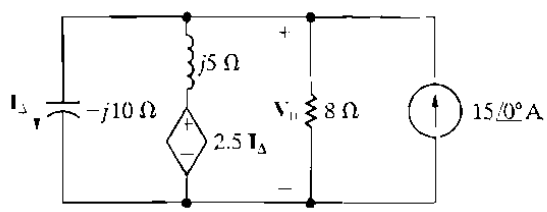


Fig.2

Solution:

a) Write the node equation (only one) with the auxiliary equation of the dependent source control I_Δ.
b) Write the two mesh equations (the third mesh is known with 15A value) with the auxiliary equation of the dependent source control I_Δ.
c) The node voltage method is preferred because it is only one equation with one unknown.

<u>Question (3):</u> [15 Marks]

The load impedance Z_L for the circuit shown in Fig.3 is adjusted until maximum average power is delivered to Z_L.
Find Z_L and the maximum average power delivered to Z_L.

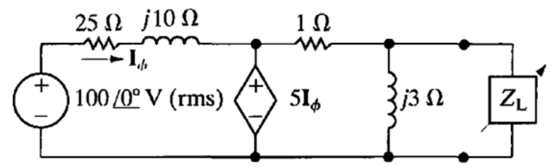
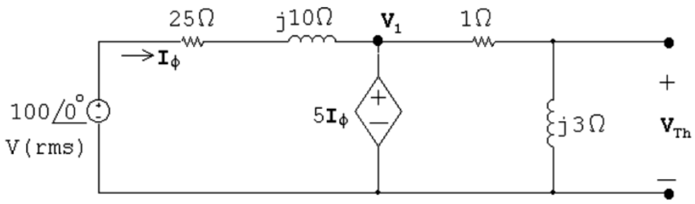


Fig.3

Open circuit voltage:



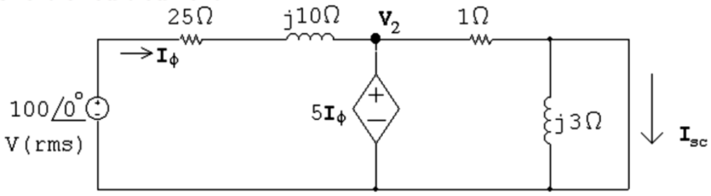
$$\mathbf{V}_1 = 5\mathbf{I}\phi = 5\frac{100 - 5\mathbf{I}_\phi}{25 + j10}$$

$$(25 + j10)\mathbf{I}_\phi = 100 - 5\mathbf{I}\phi$$

$$\mathbf{I}_\phi = \frac{100}{30 + j10} = 3 - j\ \text{A}$$

$$\mathbf{V}_{\text{Th}} = \frac{j3}{1 + j3}(5\mathbf{I}_\phi) = 15\ \text{V}$$

Short circuit current:



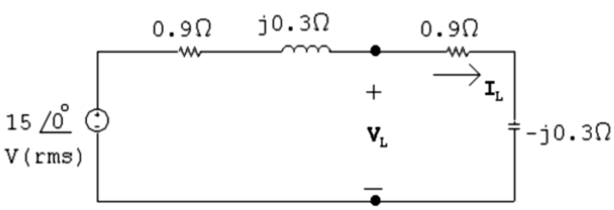
$$\mathbf{V}_2 = 5\mathbf{I}_\phi = \frac{100 - 5\mathbf{I}_\phi}{25 + j10}$$

$$\mathbf{I}_\phi = 3 - j1\ \text{A}$$

$$\mathbf{I}_{\text{sc}} = \frac{5\mathbf{I}_\phi}{1} = 15 - j5\ \text{A}$$

$$Z_{\text{Th}} = \frac{15}{15 - j5} = 0.9 + j0.3\,\Omega$$

$$Z_L = Z^*_{\text{Th}} = 0.9 - j0.3\,\Omega$$



$$\mathbf{I}_{\text{L}} = \frac{0.3}{1.8} = 8.33\,\text{A(rms)}$$

$$P = |\mathbf{I}_L|^2(0.9) = 62.5\,\text{W}$$

Question (4): [10 Marks]

The impedance Z in the balanced three-phase circuit in Fig.4 is $100 - j75\ \Omega$. Find
a) I_{AB}, I_{BC} and I_{CA},
b) I_{aA}, I_{bB} and I_{cC},
c) I_{ba}, I_{cb}, and I_{ac}.

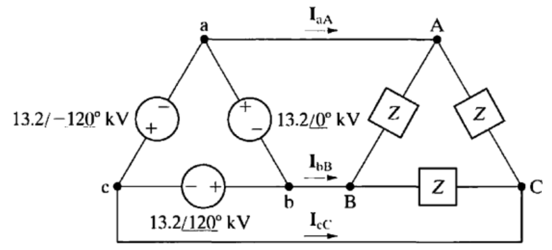


Fig.4

$$[\text{a}]\ \ \mathbf{I}_{AB} = \frac{13{,}200\angle 0^\circ}{100 - j75} = 105.6\angle 36.87^\circ \text{ A (rms)}$$

$$\mathbf{I}_{BC} = 105.6\angle 156.87^\circ \text{ A (rms)}$$

$$\mathbf{I}_{CA} = 105.6\angle -83.13^\circ \text{ A (rms)}$$

$$[\text{b}]\ \ \mathbf{I}_{aA} = \sqrt{3}\angle -30^\circ \mathbf{I}_{AB} = 182.9\angle 66.87^\circ \text{ A (rms)}$$

$$\mathbf{I}_{bB} = 182.9\angle -173.13^\circ \text{ A (rms)}$$

$$\mathbf{I}_{cC} = 182.9\angle -53.13^\circ \text{ A (rms)}$$

$$[\text{c}]\ \ \mathbf{I}_{ba} = \mathbf{I}_{AB} = 105.6\angle 36.87^\circ \text{ A (rms)}$$

$$\mathbf{I}_{cb} = \mathbf{I}_{BC} = 105.6\angle 156.87^\circ \text{ A (rms)}$$

$$\mathbf{I}_{ac} = \mathbf{I}_{CA} = 105.6\angle -83.13^\circ \text{ A (rms)}$$

Question (5): [10 Marks]

Two 480 V (rms) loads are connected in parallel. The two loads draw a total average power of 40,800 W at a power factor of 0.8 lagging. One of the loads draws 20 kVA at a power factor of 0.96 leading. What is the power factor of the other load?

$$S_T = 40{,}800 + j30{,}600 \text{ VA}$$

$$S_1 = 20{,}000(0.96 - j0.28) = 19{,}200 - j5600 \text{ VA}$$

$$S_2 = S_T - S_1 = 21{,}600 + j36{,}200 = 42{,}154.48\angle 59.176^\circ \text{ VA}$$

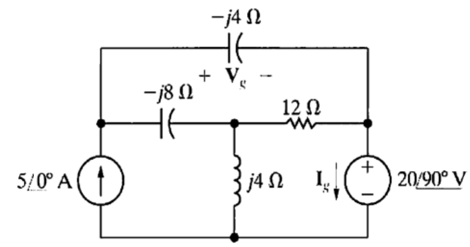
$$\text{rf} = \sin(59.176^\circ) = 0.8587$$

$$\text{pf} = \cos(59.176^\circ) = 0.5124 \text{ lagging}$$

Question (6): **[15 Marks]**

For the circuit shown in Fig.6, Use the superposition principle to find V_g.

Fig.6 →



Solution:
Solve two circuits with one source in each of them:
The first circuit with only the current source and replace the voltage source with short circuit.
The second circuit with the voltage source after replacing the current source with open circuit.

Question (7): **[15 Marks]**

In the circuit in Fig.7: Load 1 is a 240 Ω resistor in series with an inductive reactance of 70 Ω; load 2 is a capacitive reactance of 120 Ω in series with a 160 Ω resistor;

- Find the power factor for load 1 and load 2.
- Find the value of load 3 to get a unity power factor for the whole circuit.

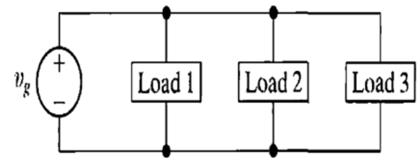


Fig.7

Solve by yourself

With best wishes

Dr. Wael Abdel-Rahman Mohamed