Benha University
Benha Faculty of Engineering
Electrical Engineering and Circuit Analysis (a) (E1101)
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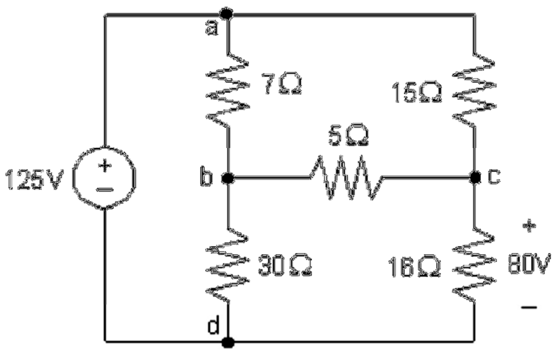
Electrical Department
1st Year Electrical
Time: 3 Hrs

Model Answer

Q1

Solved exactly in lecture.

Q2



$$i_{cd} = 80/16 = 5\,\text{A}$$

$v_{ac} = 125 - 80 = 45$ so $i_{ac} = 45/15 = 3\,\text{A}$

$i_{ac} + i_{bc} = i_{cd}$ so $i_{bc} = 5 - 3 = 2\,\text{A}$

$v_{ab} = 15i_{ac} - 5i_{bc} = 15(3) - 5(2) = 35\,\text{V}$ so $i_{ab} = 35/7 = 5\,\text{A}$

$i_{bd} = i_{ab} - i_{bc} = 5 - 2 = 3\,\text{A}$

Calculate the power dissipated by the resistors using the equation $p_R = Ri_R^2$:

$p_{7\Omega} = (7)(5)^2 = 175\,\text{W}$ $p_{30\Omega} = (30)(3)^2 = 270\,\text{W}$

$p_{15\Omega} = (15)(3)^2 = 135\,\text{W}$ $p_{16\Omega} = (16)(5)^2 = 400\,\text{W}$

$p_{5\Omega} = (5)(2)^2 = 20\,\text{W}$

[b] Calculate the current through the voltage source:

$$i_{ad} = -i_{ab} - i_{ac} = -5 - 3 = -8\,\text{A}$$

Now that we have both the voltage and the current for the source, we can calculate the power supplied by the source:

$$p_g = 125(-8) = -1000\,\text{W} \qquad \text{thus} \qquad p_g\ (\text{supplied}) = 1000\,\text{W}$$

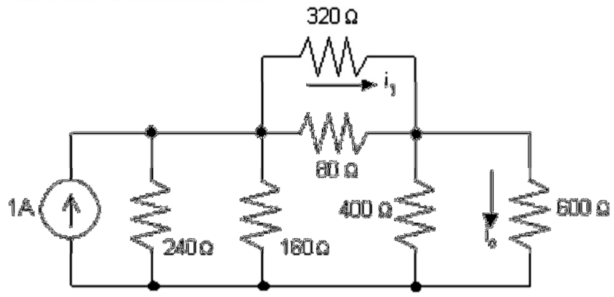
[c] $\sum P_{dis} = 175 + 270 + 135 + 400 + 20 = 1000\,\text{W}$

Therefore,

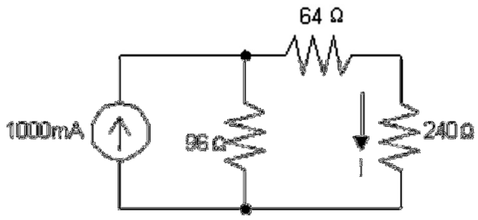
$$\sum P_{supp} = \sum P_{dis}$$

Q3

After the $20\,\Omega$—$100\,\Omega$—$50\,\Omega$ wye is replaced by its equivalent delta, the circuit reduces to

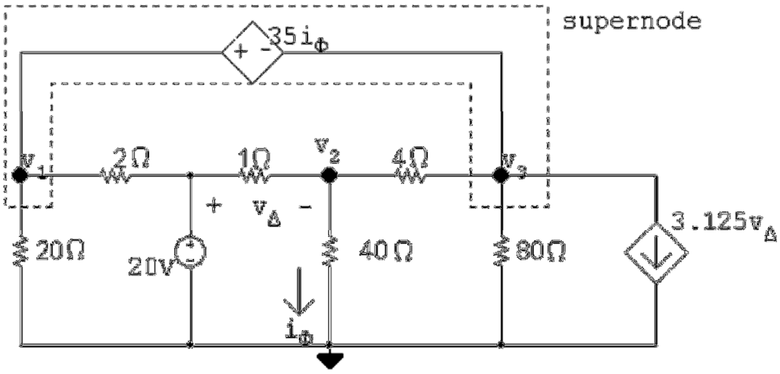


Now the circuit can be reduced to



Then Rtotal = 96*304 / 400 =

Q4



Node equations:

$$\frac{v_1}{20} + \frac{v_1 - 20}{2} + \frac{v_3 - v_2}{4} + \frac{v_3}{80} + 3.125 v_\Delta = 0$$

$$\frac{v_2}{40} + \frac{v_2 - v_3}{4} + \frac{v_2 - 20}{1} = 0$$

Constraint equations:

$$v_\Delta = 20 - v_2$$

$$v_1 - 35 i_\phi = v_3$$

$$i_\phi = v_2/40$$

Solving, $v_1 = -20.25$ V; $v_2 = 10$ V; $v_3 = -29$ V

Let i_g be the current delivered by the 20 V source, then

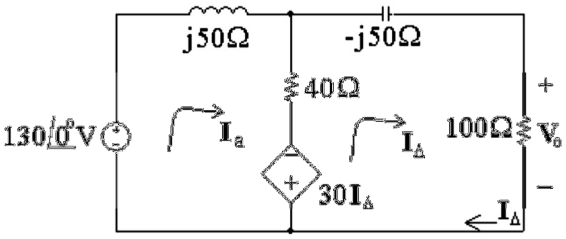
$$i_g = \frac{20 - (20.25)}{2} + \frac{20 - 10}{1} = 30.125 \text{ A}$$

$$p_g \text{ (delivered)} = 20(30.125) = 602.5 \text{ W}$$

Q5

$$j\omega L = j10{,}000(5 \times 10^{-3}) = j50\,\Omega$$

$$\frac{1}{j\omega C} = \frac{-j}{(10{,}000)(2 \times 10^{-6})} = -j50\,\Omega$$



$$130\underline{/0^\circ} = (40 + j50)\mathbf{I}_a - 40\mathbf{I}_\Delta + 30\mathbf{I}_\Delta$$

$$0 = -40\mathbf{I}_a + 30\mathbf{I}_\Delta + (140 - j50)\mathbf{I}_\Delta$$

Solving,

$$\mathbf{I}_\Delta = (400 - j400)\,\text{mA}$$

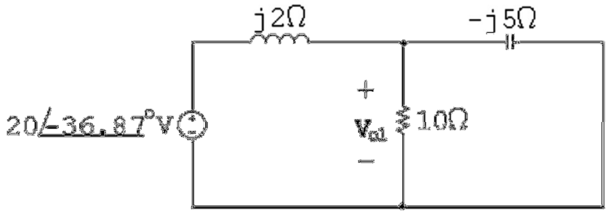
$$\mathbf{V}_o = 100\mathbf{I}_\Delta = 40 - j40 = 56.57\underline{/-45^\circ}$$

$$v_o = 56.57\cos(10{,}000t - 45^\circ)\,\text{V}$$

Q6

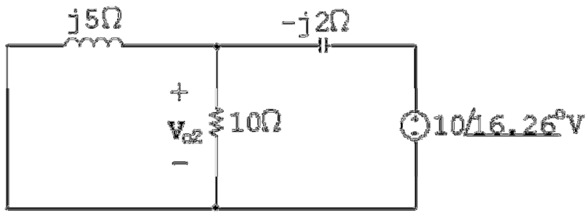
[a] Superposition must be used because the frequencies of the two sources are different.

[b] For $\omega = 2000$ rad/s:



$$10 \| -j5 = 2 - j4\,\Omega \quad \text{so} \quad \mathbf{V}_{o1} = \frac{2 - j4}{2 - j4 + j2}(20\angle -36.87^\circ = 31.62\angle -55.3^\circ\ \text{V}$$

For $\omega = 5000$ rad/s:



$$j5 \| 10 = 2 + j4\,\Omega$$

$$\mathbf{V}_{o2} = \frac{2 + j4}{2 + j4 - j2}(10\angle 16.26^\circ) = 15.81\angle 34.69^\circ\ \text{V}$$

Thus,

$$v_o(t) = [31.62\cos(2000t - 55.3^\circ) + 15.81\cos(5000t + 34.69^\circ)]\ \text{V}, \quad t \geq 0$$