EECS 40, Spring 2007
Prof. Chang-Hasnain

Homework #2
Solutions

Due at 6 pm in 240 Cory on Wednesday, 1/31/06
Total Points: 100

- Put (1) your name and (2) discussion section number on your homework.
- You need to put down all the derivation steps to obtain full credits of the problems. Numerical answers alone will at best receive low percentage partial credits.
- No late submission will be accepted expect those with prior approval from Prof. Chang-Hasnain.

1. Hambley, P2.6 (10pt)

Combining the resistances shown in Figure P2.6b, we have

$$R_{eq} = 1 + \frac{1}{1 + \frac{1}{R_{eq}}} + 1 = 2 + \frac{R_{eq}}{1 + R_{eq}}$$

$$R_{eq}(1 + R_{eq}) = 2(1 + R_{eq}) + R_{eq}$$

$$(R_{eq})^2 - 2(R_{eq}) - 2 = 0$$

$$R_{eq} = 2.732\Omega$$

($R_{eq} = -0.732\Omega$ is dropped)

2. Hambley, P2.11 (10pt)

For operation at the lowest power, we have

$$P = 300 = \frac{120^2}{R_1 + R_2}$$

At the high power setting, we have

$$P = 1200 = \frac{120^2}{R_1} + \frac{120^2}{R_2}$$

Solving these equations we find $R_1 = R_2 = 24\Omega$

The intermediate power setting is obtained by operating one of the elements from 120V resulting in a power of 600W.

3. Hambley, P2.12 (10pt)

By symmetry, the currents in the resistors can be found, and the voltage between terminal a and b is:

$$V_{ab} = R_{eq} = \frac{1}{3} + \frac{1}{6} + \frac{1}{3} = \frac{5}{6}$$

4. Hambley, P2.19 (10pt)

The equivalent resistance seen by the current source is

$R_{eq} = 8 + \frac{1}{\frac{1}{6}+\frac{1}{12}} + \frac{1}{\frac{1}{12}+\frac{1}{24}} = 20\Omega$. Then, we have $v = 2R_{eq} = 40V$, $i_2 = .667A$, $i_1 = 1.333A$

5. Hambley, P2.25 (10pt)

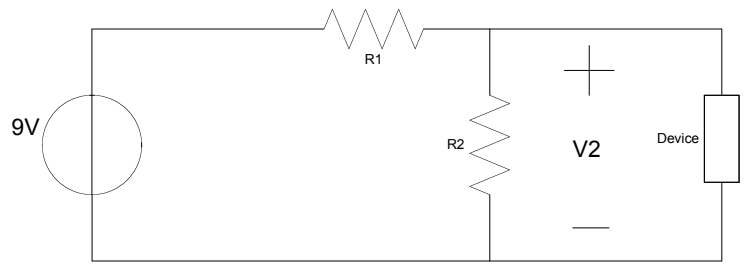
$i_2 = \frac{10}{5} = 2A$, $i_1 = i_2 - 3 = -1A$

$P_{current-source} = 3A \times 10V = 30W$, $P_{voltage-source} = 10i_1 = -10W$

Power is delivered by the current source and absorbed by the voltage source.

6. Hambley, P2.35 (10pt)

The circuit diagram is:



With $i_L = 0$ and $V_L = 5V$, we must have $\frac{R_2}{R_1 + R_2}9 = 5V$. Rearranging, this gives

$\frac{R_1}{R_2} = 0.8$ (1)

With $i_L = 25mA$ and $V_L = 4V$, we have $9 - R_1(\frac{4}{R_2} + 25mA) = 4$. Rearranging, this gives

$4\frac{R_1}{R_2} + 0.025R_1 = 5$ (2)

Solving (1) and (2) simultaneously, we obtain $R_1 = 72\Omega$, and $R_2 = 90\Omega$

Maximum power is dissipated in R_1 for $i_L = 25mA$, for which the voltage across R_1 is 5V.

Thus, $P_{\max R_1} = \frac{5^2}{72} = 347.2mW$. Thus, R_1 must be rated for at least 347.2mW of power dissipation.

Maximum power is disspated in R_2 for $i_L = 0$, in which case the voltage across R_2 is 5V. Thus, $P_{\max R_2} = \frac{5^2}{90} = 277.8mW$. (standard resistors are available in .5W ratings and would be suitable for this circuit.)

7. Hambley, P2.40 (10pt)

Writing KCL equations at nodes 1,2, and 3, we have

$\frac{V_1}{5} + \frac{V_1 - V_2}{2} + \frac{V_1 - V_3}{20} = 0$

$$\frac{V_2 - V_1}{2} + \frac{V_2 - V_3}{5} = 5$$

$$\frac{V_3}{10} + \frac{V_3 - V_2}{5} + \frac{V_3 - V_1}{20} = 0$$

Solving them simultaneously, we find:
V_1=16.97 V_2=23.85 V_3=16.06

8. Hambley, P2.47 (10pt)

First, we can write $i_x = \frac{V_1 - V_2}{5}$

Then, writing KCL equations at nodes 1 and 2, we have:

$\frac{V_1}{10} + i_x = 1$ and $\frac{V_2}{20} + 0.5i_x - i_x = 0$

Substituting for i_x and simplifying, we have

$$0.3V_1 - 0.2V_2 = 1$$

$$-0.1V_1 + 0.15V_2 = 0$$

Solving, we have V_1=6 and V_2=4.

Then, we have $i_x = \frac{V_1 - V_2}{5} = .4A$

9. Hambley, P2.55 (10pt)

We select the mesh currents as the three small loops that runs clockwise.
We write the following equations: $12i_1 + 24(i_1 - i_3) = 0$, $12i_1 + 6(i_2 - i_3) = 0$

Where i_3 is the current in the middle loop, and we have $i_3 = 2$. Solving, we obtain

$i_1 = 1.333A$, and $i_2 = 0.667A$

10. Hambley, P2.63 (10pt)

We choose the three loops as the small loops, each running clockwise. We label the top loop as i_2, the lower-left one as i_1, and lower-right one as i_3.
We write the follwing equations:

$$20i_1 - 10i_2 - 10i_3 = 1$$

$$-10i_1 + 40i_2 - 10i_3 = 0$$

$$-10i_1 - 10i_2 + 40i_3 = 0$$

Solving, we find $i_1 = 0.075A$

Finally, we have $R_{eq} = \frac{1}{i_1} = 13.33\Omega$