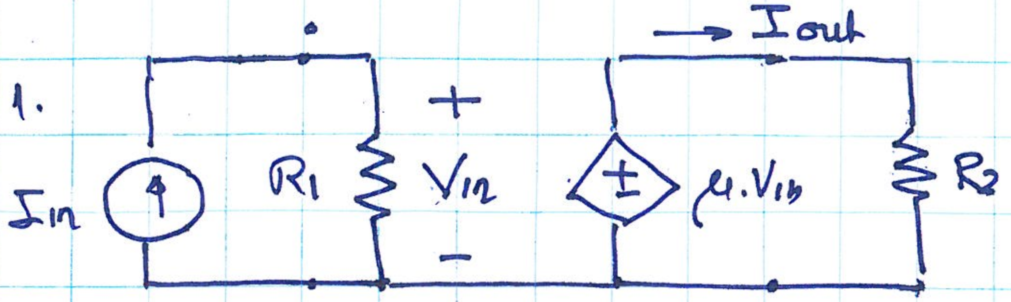
ENSC 220 Fall 2014

Midterm #1

1

1.



$$V_{in} = R_1 \cdot I_{in}$$

$$\mu \cdot V_{in} - R_2 \cdot I_{out} = 0 \; ; \quad I_{out} = \frac{\mu}{R_2} \cdot V_{in}$$

$$I_{out} = \mu \cdot \frac{R_1}{R_2} \cdot I_{in}$$

Power absorbed by R_2:

$$P_{R_2} = V_{R_2} \times I_{R_2}$$

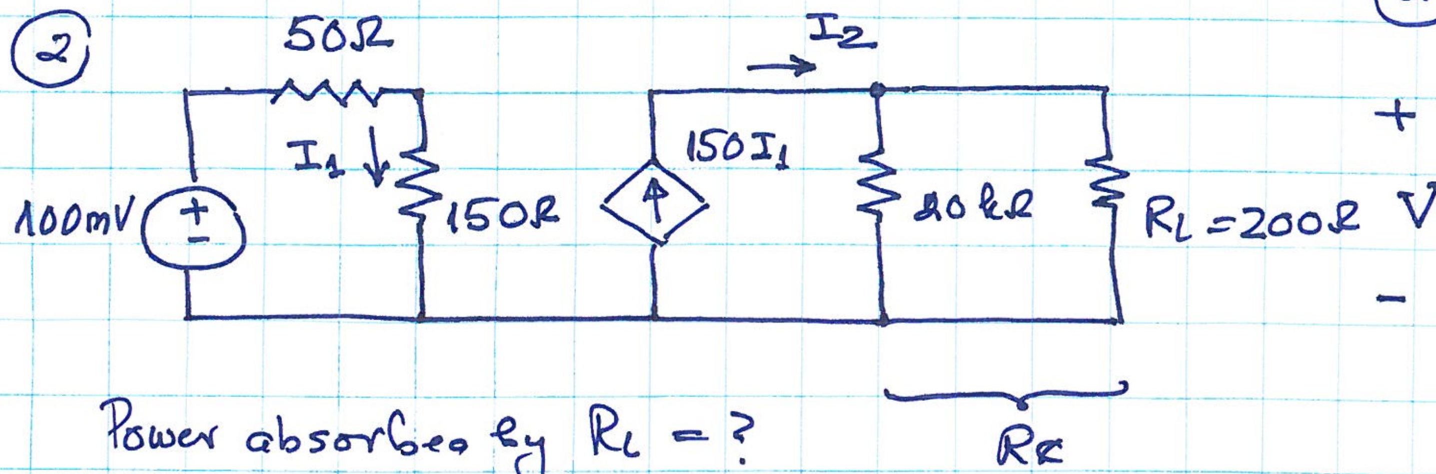
$$P_{R_2} = R_2 \cdot (I_{R_2})^2$$

$$P_{R_2} = R_2 \cdot (I_{out})^2$$

$$P_{R_2} = R_2 \cdot \left(\mu \cdot \frac{R_1}{R_2}\right)^2 \cdot I_{in}^2$$

$$P_{R_2} = \mu \cdot \frac{R_1^2}{R_2} \cdot I_{in}^2 \; (\text{Watts})$$

2



Power absorbed by R_L = ?

$I_1 = \frac{100\times10^{-3}}{50+150}$; $I_1 = \frac{100}{200}\times10^{-3}$

$I_1 = 0.5\times10^{-3}$

$I_1 = 0.5\,mA$

$R_e = \frac{20\times10^3\times200}{20\times10^3+200}$

$R_e = \frac{4000\times10^3}{20.2\times10^3}$; $R_e = \frac{4000}{20.2}$

$V = I_2\times R_e$; $I_2 = 150\,I_1$

$V = 150\times I_1\times R_e$

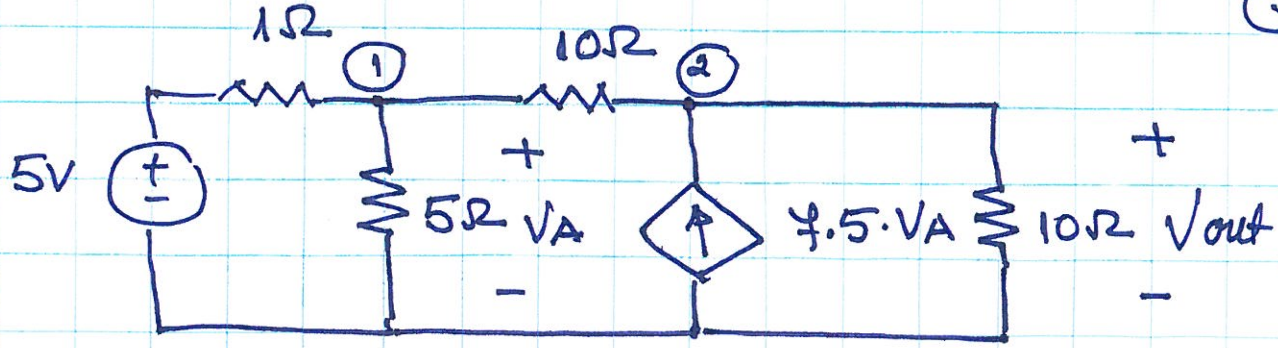
$V = 150\times0.5\times10^{-3}\times\frac{4000}{20.2}$; $V = \frac{300}{20.2}$

$V = \frac{1500}{101}$ (V)

$P = I_L.V_L$; $V_L = V$; $I_L = \frac{V}{R_L}$

$P = \frac{V^2}{R_L}$; $P = \left(\frac{1500}{101}\right)^2\times\frac{1}{200}$; $P = \frac{450\times10^2}{(202)^2}$ (W)

3



Nodal equations:

$$\frac{V_1-5}{1}+\frac{V_1}{5}+\frac{V_1-V_2}{10}=0$$

$$\frac{V_2-V_1}{10}-7.5\cdot V_A+\frac{V_2}{10}=0$$

Note: $V_A = V_1$

Hence: $V_1\left(\frac{1}{1}+\frac{1}{5}+\frac{1}{10}\right)-V_2\times\frac{1}{10}=5$

$$V_1\left(-\frac{1}{10}-7.5\right)+V_2\left(\frac{1}{10}+\frac{1}{10}\right)=0$$

or: $1.3V_1 - 0{,}1\,V_2 = 5$

$-7.6\,V_1 + 0.2\,V_2 = 0 \quad ; \quad V_1 = \frac{1}{38}\cdot V_2$

Then:

$$1.3\times\frac{1}{38}\cdot V_2 - 0.1\,V_2 = 5$$

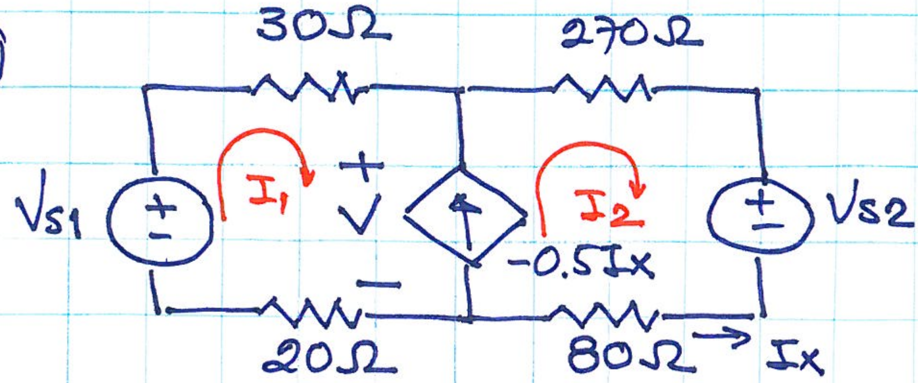
$$V_2\cdot\left(\frac{1.3}{38}-0.1\right)=5;\quad V_2=\frac{5\times 38}{1.3-3.8}$$

$$V_2 = -\frac{5\times 38}{2.5}\ ;V_2=-76\,(V)$$

Then: $V_1=\frac{1}{38}\cdot(-76)\,;\,V_1=-2\,(V)$

$V_A=-2V\ ;\ \frac{V_{out}}{5}=\text{gain};\ \text{gain}=-\frac{76}{5}\ ;\ \text{gain}=-15.2$

4



$V_{s1} = 225V$
$V_{s2} = 15V$

Mesh equations:

$$V_{s1} - 30 \cdot I_1 - V - 20 \cdot I_1 = 0$$
$$V_{s2} + 270 I_2 + 80 \cdot I_2 - V = 0$$

Hence:

$$(20 + 30)I_1 + V = V_{s1}$$
$$(270 + 80) I_2 - V = -V_{s2}$$

or:

$$50 I_1 + V = V_{s1}$$
$$350 I_2 - V = -V_{s2}$$

Note that: $-0.5 I_x = I_2 - I_1$

While: $I_x = -I_2$

Hence: $0.5 I_2 = I_2 - I_1$

or: $I_2 = 2 I_1$

From mesh equations by adding the two equations:

$$50 I_1 + 350 I_2 = V_{s1} - V_{s2}$$

or: $50 I_1 + 350 I_2 = 225 - 15$

and: $50 I + 350 I_2 = 210$

$50 I_1 + 350 \cdot (2 I_1) = 210$; $I_1 = \frac{210}{750}$; $I_1 = \frac{7}{25}$ A

And: $I_2 = 2\times\frac{7}{25}$; $I_2 = \frac{14}{25}$ A

Power delivered by the dependent current source:

$$P = V \times (-0.5 I_x)$$

where: $V = V_{s1} - 50\cdot I_1$

$I_x = -I_2$

Hence, $V = 225 - 50\times\frac{7}{25}$; $V = 211$ (V)

$I_x = -\frac{14}{25}$ (A)

$$P = 211 \times (-0.5) \times \left(-\frac{14}{25}\right)$$

$P = 211\times\frac{7}{25}$; $P = \frac{1477}{25}$; $P = 59.08$ W