B

ELCE Department, Ryerson University

MIDTERM TEST

October 27, 2006

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Read all questions carefully ! Use opposing pages for rough work

Round off final answers to 3 significant digits, attach proper units and copy all final answers to the indicated space

TIME AVAILABLE: 90 minutes

For marking use only (do not fill):

Question 1 (Max. 8)	8
Question 2 (Max.10)	10
Question 3 (Max. 5)	5
Question 4 (Max.7)	7
Total (out of 30):	30

B

(1) Given three resistors

$R_1 = 20\ \Omega$ rated 2.5 W

$R_2 = 40\ \Omega$ rated 1.5 W

$R_3 = 60\ \Omega$ rated 1.0 W

~~ ~~ 7,071

→ 7,75

P_{max}

→ 7,75.

$E\ I_{max}$

$V_S = E\ I_{max}$

E

$E = 22.571V.$

(a) What is the largest voltage V_S that can be safely applied to the **series** combination of these three resistors ?

(b) What is the largest current I_S that can be safely passed through the **series** combination of these three resistors ?

(c) What is the largest voltage V_P that can be safely applied to the **parallel** combination of these three resistors ?

(d) If resistor R_2 dissipates 2.5 J of energy in 2 seconds, what is the voltage V_2 applied across this resistor ?

a) V

$$V_S = R_T I_{max}$$
$$= (120\Omega)(0.129A)$$
$$\boxed{V_S = 15.48V}$$

b) $I_{max,1} = \sqrt{\frac{2.5}{20}}$ $= 0.354A$

$I_{max_2} = \sqrt{\frac{1.5}{40}}$ $= 0.194A$

$I_{max_3} = \sqrt{\frac{1.0}{60}}$ $= 0.129A.$

c) $V_{max,1} = \sqrt{2.5(20)}$ $= 7.071V$

$V_{2\,max} = \sqrt{1.5(40)}$ $= 7.75$

$V_{3\,max} = \sqrt{60(1.0)}$ $= 7.75V.$

d) $P = \frac{W}{t}$

$= \frac{2.5J}{2s}$

$P = 1.25W = \frac{V^2}{R}$

$1.25 = \frac{V^2}{40}$

$\boxed{V = 7.071V}$

Attach proper units !

(2 points each)

V_S = 15.48V.
I_S = 0.129A
V_P = 7.071V. 6
V_2 = 7.071V

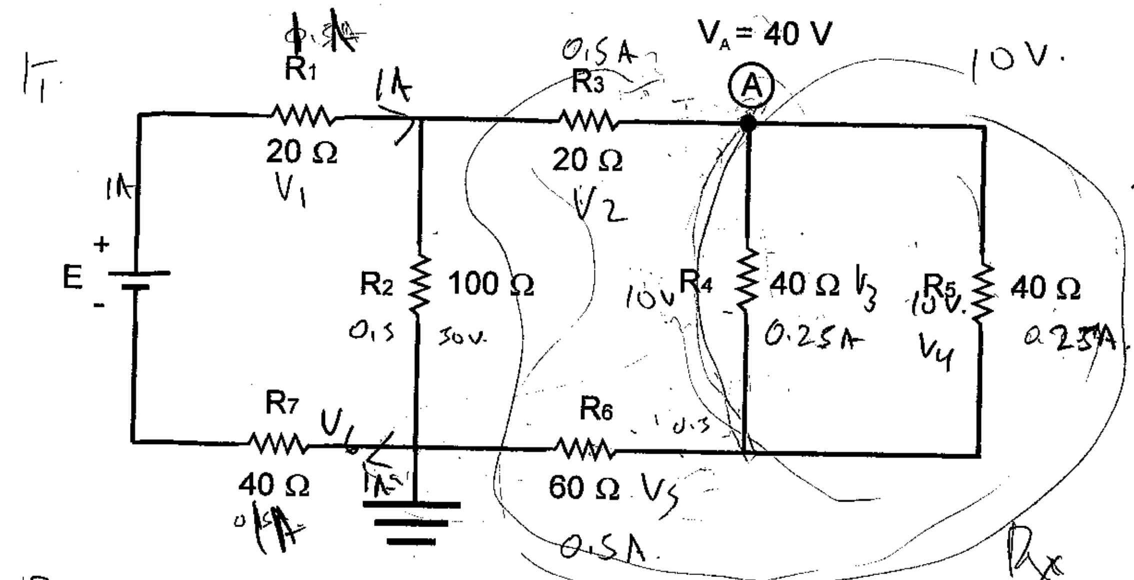
B

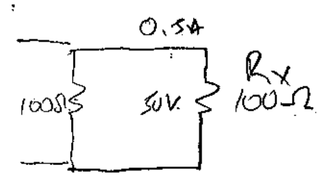
(2) The voltage at node A is + 40 V (with respect to the ground). Analyze the following circuit and find the values indicated below **(cross-check all your answers !)**

$I_3 = I_4 + I_5$

$V_3 = V_4$

$I_3 = I_6$





$R_{45} = \frac{40 \cdot 40}{80}$

$= 20\Omega \quad + 60$

$R_{456} = 80\,\Omega$

$V = R_{456} I_{456}$

$I_{456} = \frac{40}{80}$

$= 0.5A$

$V_{456} = 20(0.5)$

$= 10V$

$R_{2x} = \frac{100 \cdot 100}{200}$

$= 50\Omega$

$V_{2x} = 50\Omega\,(1)$

$[V_{2x} = 50V.]$

$V_1 = R_1 I_T$

$= 20\Omega(1)$

$\boxed{V_1 = 20V.}$

$I_x = I_T \frac{R_x}{R_2 + R_x}$

$0.5A = I_T \frac{100\Omega}{200\Omega}$

$\boxed{I_T = 1A}$

$V_2 = R_2 I_2$

$= 100(0.5)$

$\boxed{V_2 = 50V}$

$40(0.25)^2$

$P_{R_4} = 2.5W$

$R_7 = 4_7(1)$

$= 40V$

$E = 20 + 50 + 40$

$= 110V$

Attach proper units !

(1 point each)

V drop across R_1 = 20V.

Current through R_3 = 0.5A.

V drop across R_2 = 50V.

Current through R_6 = 0.5A.

E = 110V.

Power in R_4 = 2.5W

Total power delivered by E = 110W

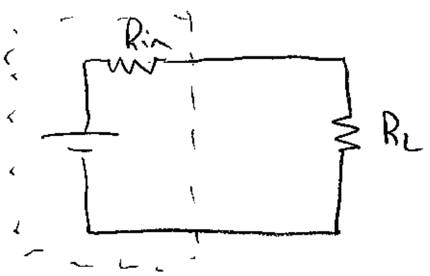
Current through R_5 = 0.25A.

V drop across R_3 = 10V.

Total current delivered by E = 1A.

B

(3) Real power supply delivers 4 W of power into a load R_L = 30 Ω with 60% efficiency.
Draw the circuit diagram and find:
(a) The terminal voltage V_{AB} when no load is connected ($R_L = \infty$)
(b) The current through R_L when R_L= 0 (short circuit)
(c) The internal resistance R_i
(d) The power that would be delivered into a 10 Ω load.



$$\eta = \frac{R_L}{R_i + R_L}$$

$$0.6 = \frac{30}{R_i + 30}$$

$$\boxed{R_i = 20\Omega}$$

$$V_{sc} = E$$

$$V = E - R_i I$$

$$10.95 = E - 20(0.365)$$

$$\boxed{E = 18.25V}$$

$$\therefore V_{oc} = E$$
$$= 18.75V$$

$$I_{sc} = \frac{E}{R_i}$$

$$= \frac{18.25V}{20\Omega}$$

$$\boxed{I_{sc} = 0.913 A}$$

$$P_L = \frac{V^2}{R_L}$$

$$4(30) = V^2$$

$$\boxed{V = 10.95V.}$$

$$P_L = \left(\frac{E}{R_i + R_L}\right)^2 R_L$$

$$= \left(\frac{18.25V}{20 + 10}\right)^2 * 10$$

$$\boxed{P : 3.70 W}$$

$$V = R_L I$$

$$\frac{10.95}{30} = I$$

$$\boxed{I = 0.365 A}$$

Attach proper units !

(a) V_{AB} = 18.75V (2 points)

(b) I = 0.913 A (1 poins)

(c) R_i = 20Ω (1 point)

(d) P = 3.70 W (1 point)

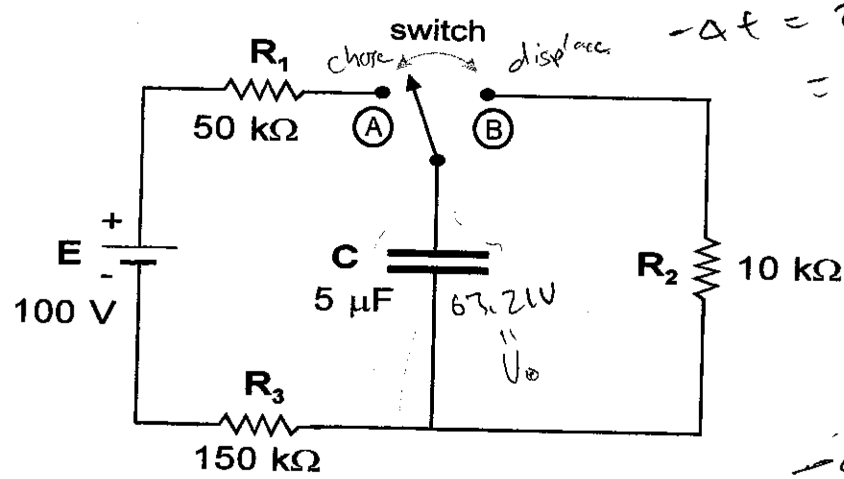
B

– for 1 sec charges C

$-\Delta t = 2-1$

$= 1$ sec.

(4)



– allowed to discharge for $\underline{1s}$

In the capacitor circuit above, the switch has been in position **B** for a long time. At time t = 0, the switch is placed in position **A**, and at time t = 1 sec the switch is placed back in position **B** where it remains. Find the values of the quantities indicated below:

(a) The current i_3 through resistor R_3 at time $t = 0^+$

(b) The voltage across C at t = 1 sec

(c) The current i_2 through resistor R_2 at time t = 2 sec

(d) The voltage across C at time t = 2 sec

$\tau = \overset{R}{200k\Omega}\ \overset{C}{5\mu F}$

$= 1s$

a) $I_c(0^+) = I_0$

I_0 = total current

$= \frac{E}{R_T}$

$= \frac{100V}{200k\Omega}$

$\boxed{I_0 = 0.0005A}$

$I_{(1)} = \frac{63.21}{200k\Omega}$

$I_0 = 0.00032A$

$\tau_d = R\ C$

$= 10k\Omega\ 5\mu F$

$= 0.05s$

∴ after 1s the charge on C is 63.21V of charge on C.

b) $V_c(1) = V_f(1 - e^{-t/\tau})$

$V_0 = 0$

$V_f = E$

$= 100V(1 - e^{-1/1})$

$\boxed{V_c(1) = 63.21V} = V_0$

→ $V_f = 0$ allowed neutralized

d) $V_c(2) = V_0 e^{-t/\tau_d}$

$= (63.21V) e^{-1/0.05}$

$= 1.3 \times 10^{-7} V$

c) $I(2) = I_0 e^{-1/0.05}$ Δt

$= (0.00032A)e^{-20}$

$= 6.59 \times 10^{-13} A.$

Attach proper units !

(a) $i_3(0^+) =$ $\underline{0.0005A}$ *(2 points)*

(b) $v_c(1) =$ $\underline{63.21V}$ *(2 points)*

(c) $i_2(2) =$ $\underline{6.59 \times 10^{-13} A}$ *(2 points)*

(d) $v_c(2) =$ $\underline{1.3 \times 10^{-7} V}$ *(4 point)*