Carleton University
Department of Electronics
ELEC 3605 Test 1
October 16, 2019

Instuctors, C. Plett, T, Forzley Duration: 60 mins

Instructions: Attempt all questions. Solutions may be continued on the back of the page if required.

Authorized memoranda : Hambley Text book, Course Pack with annotations but no additional sheets of paper allowed. Scientific calculator.

Cell phones are not allowed

Name:	Student No.

PA Section: Circle one

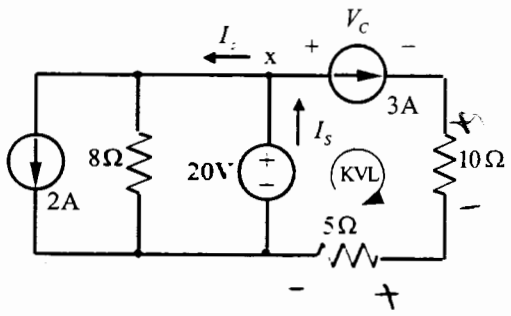
L1	L2	L3	L4	L5	L6	L7	L8	L9	L10

PA Sections:

Day Time Room Sec
Mon 10:00 TB 446 L6
Mon 2:30 PA 115 L3
Mon 4:00 SA 311 L8
Tue 8:30 CO 214 L9
Tue 11:30 ME 3174 L2
Tue 4:00 UC 182 L10
Thu 8:30 SA 402 L5
Thu 10:00 PA 201 L7
Thu 2:30 ME 4236 L1
Fri 8:30 CO 210 L4 For faculty use only:

Q1 (10)	Q2 (10)	Q3 (10)	Total (30)
Graded by:			

1) Circuit analysis and power calculations



a) Calculate the power absorbed by the 8 ohm resistor. [2]
b) Calculate I_o. [2]
c) Apply KCL at node x to solve for I_S. [1]
d) Apply KVL to determine the voltage V_c across the 3 A current source. [2]
e) Calculate the power of the 2A and 20V sources, Indicated if they are supplying or absorbing power. [3]

a) $P = V^2/R = \frac{20^2}{8} = 50\,W$ [2]

b) $I_o = 3 + \frac{20}{8} = 5.5\,A$ [2]

c) $I_s = I_o + 3 = 5.5 + 3 = 8.5\,A$

d) $-20 + V_c + 3 \cdot 10 + 3 \cdot 5 = 0$

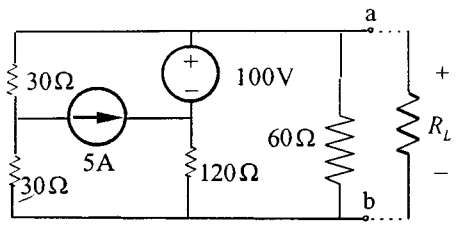
$V_c = 20 - 30 - 15 = -25\,V$ [2]

e) $P_{2A} = VI = 20 \cdot 2 = +40\,W$ absorb [1.5]

$P_{20V} = VI = 20(-8.5) = -170\,W$ supplied [1.5]

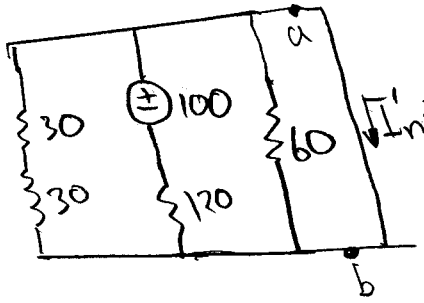
2) Norton circuit analysis

a) With R_L removed, determine R_t[2]
b) With R_L removed, solve for the Norton current I_n using superposition. [6] 6.5
c) Draw the Norton circuit and specify the value for R_L for maximum power transfer [2]

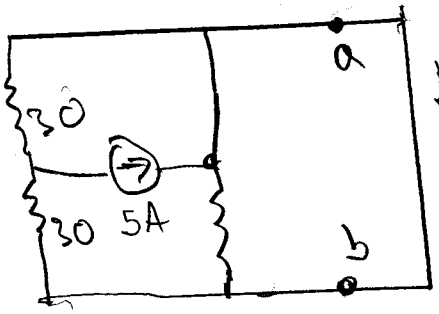


a) $R_t = 60 \| 120 \| (30+30) = 24\Omega$ [2]

b)



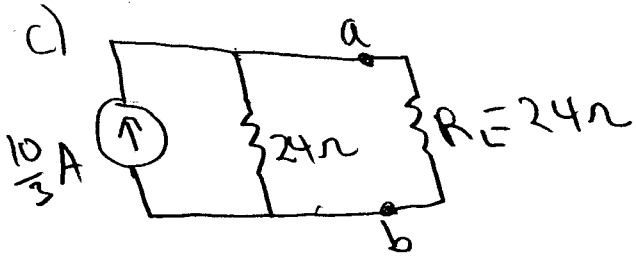
$I_n' = \frac{100}{120} = 5/6 = 0{,}833A$ [3]



$I_n'' = \frac{30}{30+30} \cdot 5 = 2.5A$ [3]

$I_n = I_n' + I_n'' = 2.5 + 5/6 = \frac{20}{6} = \frac{10}{3}A$ [1/2]

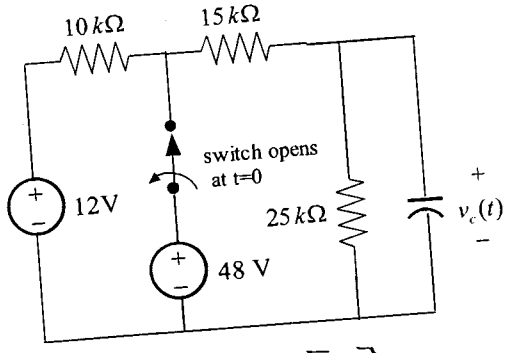
c)



3) Transient analysis

The switch is closed for a very long time such that the circuit has reached steady state. At t=0 the switch is open. The capacitor value is 2 uF.

a) Determine the time constant τ . [2]
b) What is the initial capacitor voltage $v_c(0+)$? [2]
c) What is the final capacitor voltage $v_c(\infty)$? [2]
d) Find an expression for $v_c(t)$ for $t > 0$ [4]



a) $\tau = R_{Th}C = [(10+15)\|25]\,2\mu = (12.5k)(2\mu) = 25ms$ [2]

b) $V_c(0^-) = \frac{25}{25+15} \cdot 48 = 30V$ $V_c(0^+) = V_c(0^-) = 30V$ [2]

c) $V_c(\infty) = \frac{25}{25+(10+15)} \cdot 12 = 6V$ [2]

d) $V_c(t) = k_1 + k_2 e^{-t/\tau} + 70$

$V_c(0) = k_1 + k_2 = 30$

$V_c(\infty) = k_1 = 6 \rightarrow \therefore k_2 = 24$

$V_c(t) = 6 + 24e^{-t/.025} + 70$ [4]

1a) $P = \frac{V^2}{R} = \frac{20^2}{8} = 50\,W$

b) $I_o = 4 + \frac{20}{8} = 6.5\,A$

c) $I_s = I_o + 3 = 6.5 + 3 = 9.5\,A$

d) $V_c = -25\,V$

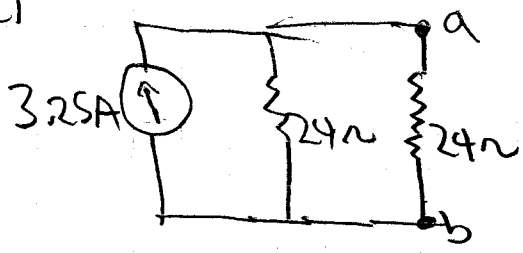
e) $P_{4A} = VI = 20(4) = 80\,W$ absorb $\quad P_{20V} = VI = (20)(-9.5) = -190\,W$ supplied

2 a) $R_t = 24\,\Omega$

b) $I_n' = \frac{90}{120} = 3/4\,A \quad I_n'' = 2.5\,A$

$I_n = I_n' + I_n'' = 0.75 + 2.5 = 3.25\,A$

c)



3) a) $T = R_t C = (12.5k)(5m) = 62.5\,ms$

b) $V_c(0^+) = 30\,V$

c) $V_c(\infty) = 6\,V$

d) $V_c(t) = 6 + 24\exp(-t/62.5m) \quad t > 0$