UWA – ENSC2003 Engineering Electrical Fundamental

Please complete your details below:

Surname: Wilson Given Name: Adam

Student ID: 23100559 Signature:

12:00PM, Thursday, September 15

Class Test 2 (OPEN BOOK)

Time allowed: 40 minutes Max mark: **30** Assessment Weight: **7%**	This paper contains: 3 short questions and 4 calculation questions

Candidates should attempt **all** questions and show **all** working with numerical answers to **2** decimal places, show as much working as possible to gain maximum marks. You can use the blank pages for rough working, but these pages will not be marked.

Your test paper will be returned back to you in the week 9 practical class. Indicate below the day and time of your practical class. Select ONE only.

- ☑ Tuesday 3-5PM
- ☐ Wednesday 8-10AM
- ☐ Wednesday 11AM-1PM
- ☐ Thursday 10AM-12PM
- ☐ Friday 11AM-1PM
- ☐ Friday 2-4PM
- ☐ Friday 4-6PM
- ☐ I don't know

Test Marker Use Only

Short Questions			Calculation Questions				Total	Marker
Q1(/2)	Q2(/2)	Q3(/2)	Q1(/6)	Q2(/6)	Q3(/6)	Q4(/6)	(/30)	
	3		5	4	3.5	3	18.5	

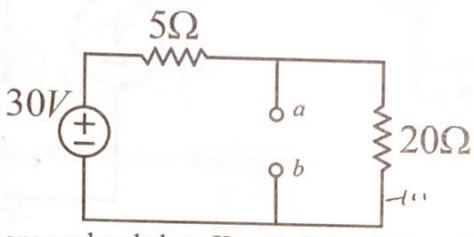
Part A: Short Questions

Short Question 1. A capacitor has a stored energy of $500\mu J$ and a capacitance of $0.15\mu F$. Calculate the voltage (in volts) across this capacitor. **(2 marks)**

Write your answer(s) in the answer box below. Keep 2 decimal places in numeric answer. No unit is needed

Short Question 1 Answer:	82 V

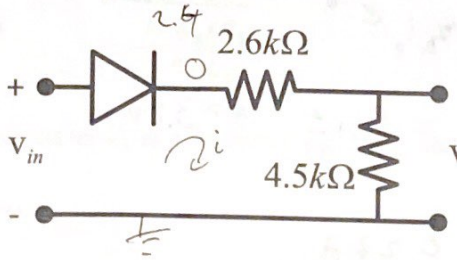
Short Question 2. In the circuit shown below**Error! Reference source not found.**, calculate the Thevenin equivalent resistance R_{Th}, the Thevenin equivalent voltage V_{Th} and the Norton equivalent current I_N with respect to the open terminals a and b. **(2 marks)**



Write your answer(s) in the answer box below. Keep 2 decimal places in numeric answers.

Short Question 2 Answer:		
	R_{Th}: 4	Ω
	V_{Th}: 6	volts
	I_N: 1.5	amperes

Short Question 3. Consider the circuit below. Assuming the piecewise linear model for the diode and $V_{D,on} = 0.6V$, determine the value of v_{out} for each of the values of (a) $v_{in} = +0.6$V, and (b) $v_{in} = +3.0$V. **(2 marks)**



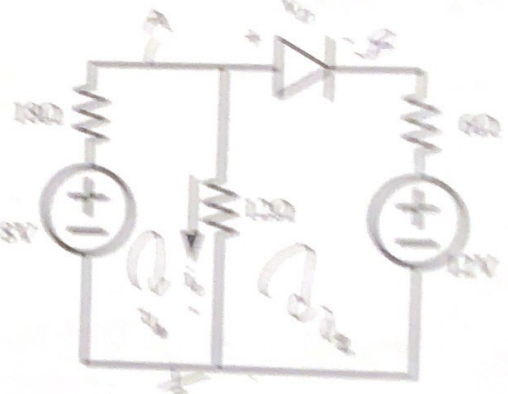
Write your answer(s) in the answer box below. Keep 2 decimal places in numeric answers.

Short Question 3 Answer:		
	(a) when $v_{in} = +0.6$V, v_{out}: 0	volts
	(b) when $v_{in} = +3.0$V, v_{out}: 1.5	volts

Part B: Calculation Questions

Calculation Question 1. Assuming the piecewise linear model for the diode and $V_{D,on} = 0.6V$, determine the voltage across the diode v_D and the current through the 12Ω resistor i_0 in the circuit given below. (6 marks)

Note: State all assumptions explicitly, show all your works clearly, sketch necessary circuit diagram(s) and label all details in sketch(-es). Keep 2 decimal places in numeric answers.



4/6

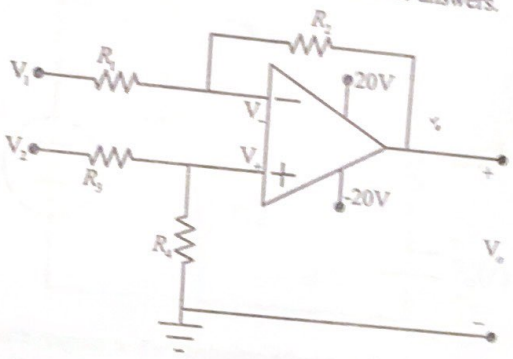
Calculation Question 2. Given the operational amplifier circuit shown below, answer the following questions. Assume that the operational amplifier is ideal. **(6 marks)**

Note: State assumptions and rules clearly and explicitly. Show all your works, sketch necessary circuit diagram(s) and label all details in sketch(-es). Keep 2 decimal places in numeric answers.

Assume

$V_+ = V_-$

$I_+ = I_- = 0$



(a) Determine an expression for V_- as a function of V_1, V_2, V_o and the circuit resistance. (2 marks)

$\frac{V_1 - V_-}{R_1} = \frac{V_- - V_o}{R_2} + I_-$ or $I_- = 0$ from assume

$\frac{V_1}{R_1} + \frac{V_o}{R_2} = \frac{V_-}{R_2} + \frac{V_-}{R_1}$

$V_- = \frac{\frac{V_1}{R_1} + \frac{V_o}{R_2}}{\frac{1}{R_1} + \frac{1}{R_2}} = \frac{\frac{R_2 V_1 + R_1 V_o}{R_1 R_2}}{\frac{R_1 R_2 + R_2}{R_1 R_2}} = \frac{R_2 V_1 + R_1 V_o}{R_1 R_2} \times \frac{R_1 R_2}{R_1 + R_2} = \frac{R_2 V_1 + R_1 V_o}{R_1 + R_2}$

/2

(b) Determine an expression for V_+ as a function of V_1, V_2, V_o and the circuit resistance. (2 marks)

$V_+ = V_-$ $\quad \frac{V_2 - V_+}{R_3} = \frac{V_+ - 0}{R_4}$

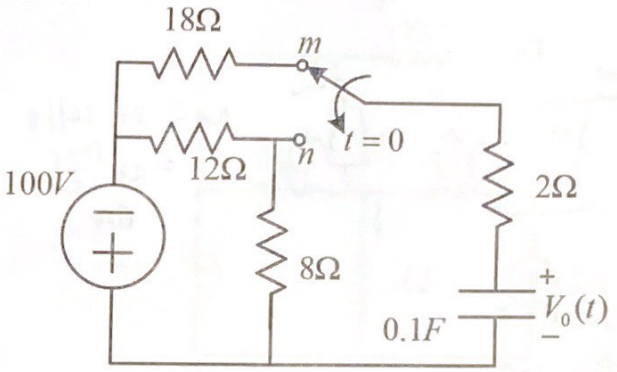
$\frac{V_2}{R_3} = \frac{V_+}{R_4} + \frac{V_+}{R_3}$ $\quad V_+ = \frac{\frac{V_2}{R_3}}{\frac{1}{R_4} + \frac{1}{R_3}} = \frac{\frac{V_2}{R_3}}{\frac{R_3 + R_4}{R_3 R_4}} = \frac{V_2}{R_3} \frac{R_3 R_4}{R_3 + R_4}$

$= \frac{V_2 R_4}{R_3 + R_4}$ /2

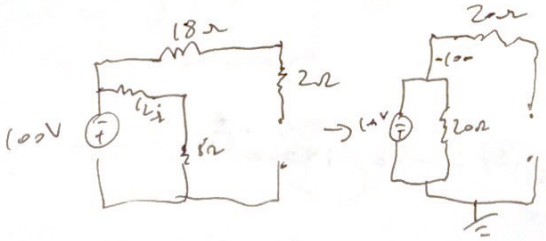
(c) Determine V_o given that $\frac{R_2}{R_1} = \frac{R_4}{R_3} = 1000$, $V_1 = 0.1V$ and $V_2 = 0.15V$. (2 marks)

3.5/6

Calculation Question 3. In the circuit shown below, the switch has been in the position m for a very long time. The switch moves to the position n at t=0 and remains there indefinitely. **(6 marks)**
Note: Show all your works, sketch necessary circuit diagram(s) and label all details in sketch(-es). Keep 2 decimal places in numeric answers.



(a) Determine the Thevenin equivalent circuit with respect to the capacitor when $t < 0$. (2 marks)



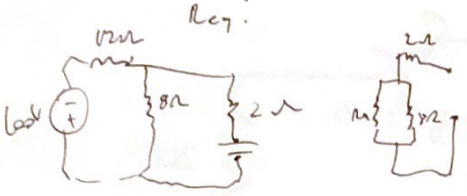
$R_{eq} = 20 + 20 = 40\,\Omega$

$V_{Th} : \frac{-100 - V_{Th}}{20} = 0 \quad V_{Th} = -100V$

(b) Determine the mathematical expression of the voltage across the capacitor, i.e. $V_0(t)$, for $t \geq 0$. (4 marks)

τ: $t>0$ $\quad C_{eq} = 0.1\ F$ $\quad \tau = RC = 0.68$

R_{eq}:

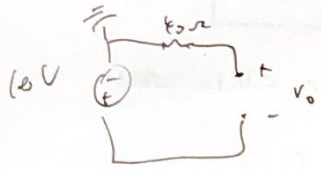


$R_{eq} = 2 + 12 \| 8$

$= 2 + \frac{12 \times 8}{20}$

$= 6.8\ \Omega$

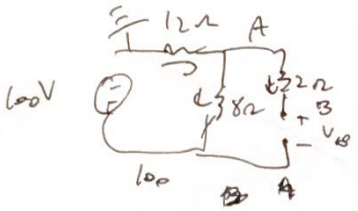
V_0: $t<0$



$V_0 = -100\ V$

V_∞: $t \gg 0$

$V_{0(t)}(t) = -40 - 140\, e^{-\frac{t}{0.68}}$



+2.5

@A $\quad \frac{0-A}{12} = \frac{A-100}{8} + \frac{A-B}{2}$

@B $\quad \frac{A-B}{2} = 0$

$A = B$ $\qquad -\frac{A}{12} = \frac{A-100}{8} + 0$

$\frac{100}{8} = \frac{A}{8} + \frac{A}{12}$

$A = 60\ V$

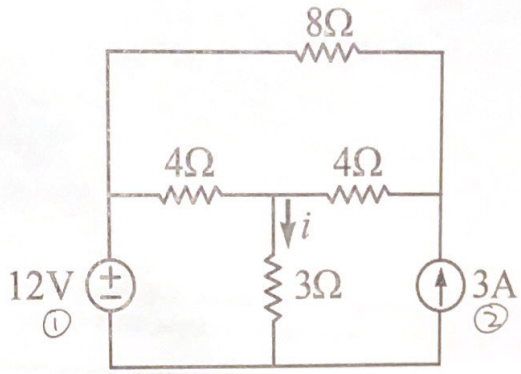
$V_\infty = 60 - 100$

$= -40\ V$

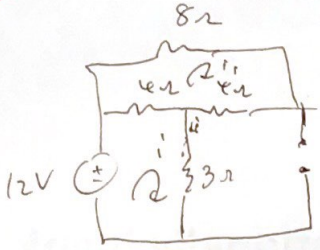
3/6

Calculation Question 4. For the circuit shown below, use the superposition theorem to find current *i*. **(6 marks)**

Note: Show all your works, sketch necessary circuit diagram(s) and label all details in sketch(-es). Keep 2 decimal places in numeric answers.



@1:



+1

@i : $-12 + 4(i - i_1) + 3i = 0$ $\quad 7i = 12 + i_1$

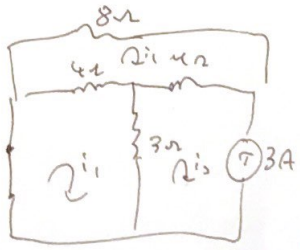
+1

@i_1 : $4i_1 + 4(i_1 - i) + 8i_1 = 0$

$16i_1 = i$ $\quad 112i = 12 + i_1$

$i = 1.73\ A$ $\quad i_1 = 0.108$

@2



$i_3 = -3A$

+1