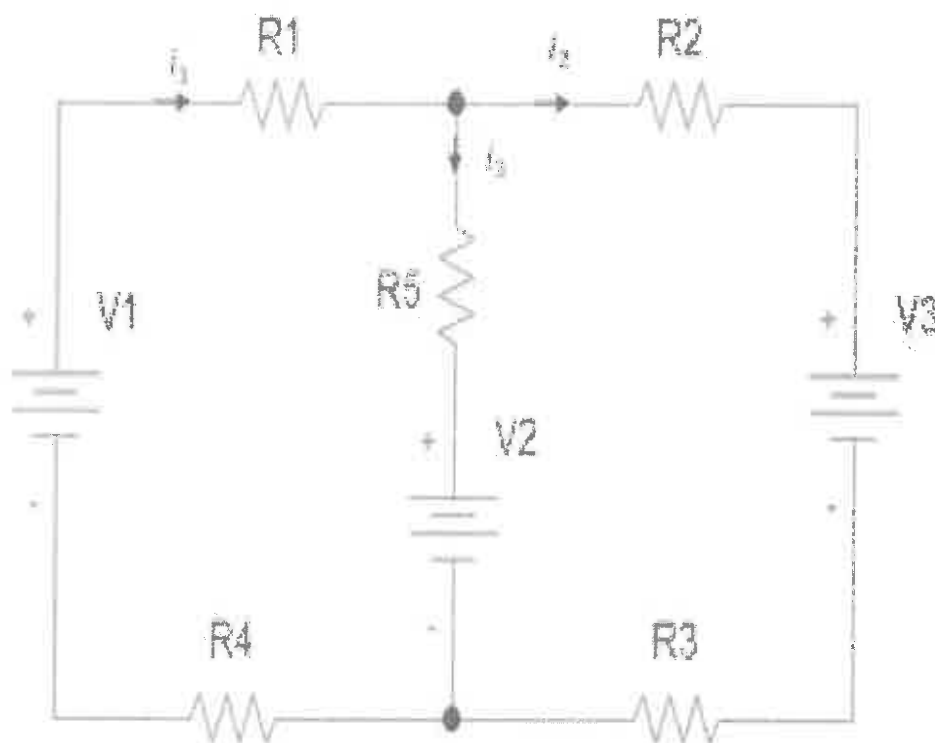


SEAN BEYNON

***PSDE4021 ELECTRICAL
TECHNOLOGY***

ASSIGNMENT 1 – DC CIRCUIT LAB



LECTURER- STEVE ROBERTS



Prifysgol Cymru
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SEMESTER 1

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School of Applied Computing ASSIGNMENT SPECIFICATION

Student name:	Sean Beynon	Student P number:	
Programme:	HND/HNC Electrical & Electronic Engineering, Instrumentation Engineering & Power Systems Engineering		
Lecturer:	Steve Roberts	Internal Verifier:	Jason Pointer
Assignment Title:	DC Circuit Lab		
Hand Out Date:	22/11/2017	Submission deadline:	10/1/2018

Referencing:	In the main body of your submission you must give credit to authors on whose research your work is based. Append to your submission a reference list that indicates the books, articles, etc. that you have read or quoted in order to complete this assignment (e.g. for books: surname of author and initials, year of publication, <u>title of book</u> , edition, publisher: place of publication).		
Disclosure:	I declare that this assignment is all my own work and that I have acknowledged all materials used from the published or unpublished works of other people. All references have been duly cited.		
Student's Signature:	<i>Hardcopy assignments will not be accepted without a signature here</i> 	Date:	9/1/17

Late submission will result in a late penalty mark, as follows:

Up to one week late, maximum mark of 40% for first attempts and 0% for resubmissions.
(Academic Quality Handbook 2017/18 7.5 (5))

**Learning Outcomes tested
(from module syllabus)**

1. Produce routine solutions to typical electrical problems.
2. Relate and apply basic electrical theory to collected data.

TASK DESCRIPTION

The Lab work involved in this activity is designed to get you up to speed on using the Electronics Lab and Equipment. All Health and Safety Rules for working in the Lab must be adhered to.

Instructions

In carrying out this work you are required to construct a number of simple circuits using standard resistors and breadboard and then to investigate features of the circuits. You are required to record measurements and observations.

AT THE END OF THE SESSION:

1. Switch off and disconnect all Power Supplies.
2. Switch off all meters.

Practical Work in the Laboratory

1. Ensure that there is evidence that you have prepared for the laboratory exercise
2. Work within the laboratory showing that you are an active participant in all exercises
3. Complete all assignment work within the allotted time recording the results in the hand-out provided

Report

4. Complete a report covering the items listed below:
 - a) Compile answers for all questions, including the conclusion sections of each laboratory exercise. These should all be written within the handbook provided.
 - b) Briefly explain the scientific properties that differentiate a conductive and resistive material. Use diagrams of the atomic structures to assist your answers.
 - c) Explain how a resistive material is affected by temperature, a general explanation will be useful, but aided with diagrams and equations to give a science base to the discussion.
 - d) Prove the voltage and current divider rules from first principles.
 - e) Show how Thevenin's Theorem is developed, from first principles, as discussed in the laboratory sessions.

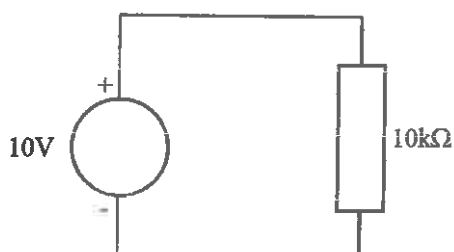
Lab 1a - Potential Division

Objective

On completion of this work the student will be able to use the concept of Potential Division in determining simple series and series/parallel circuits.

Step 1

MAKE - the following circuit:



Step 2

MEASURE using a multimeter:

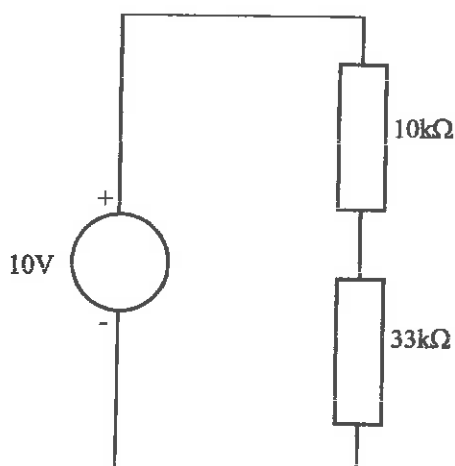
Supply Voltage = 10 V

Total Resistance = 9.75 K Ω

Current = 1.01 mA

Step 3

CONNECT:



MEASURE using a multimeter the circuit current.

RECORD your observation:

Measured Current = 234 μ A

CONFIRM that the calculated and measured circuit current agree.

$$I = V/R$$

$$I = 10 \text{ V} / 43 \text{ K}\Omega$$

$$I = 232.56 \mu\text{A}$$

Step 4

CALCULATE the Voltage across each resistor.

$$V = I \cdot R$$

$$V = 232.56 \mu\text{A} \cdot 10 \text{ K}\Omega$$

$$V = 2.33 \text{ V}$$

$$V = I \cdot R$$

$$V = 232.56 \mu\text{A} \cdot 33 \text{ K}\Omega$$

$$V = 7.674 \text{ V}$$

/SDP

RECORD your observations:

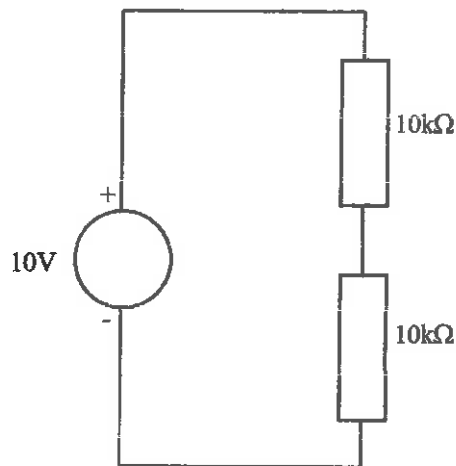
Voltage across 10k Ω resistor = measured- 2.29 V calculated- 2.33 V

Voltage across 33k Ω resistor = measured- 7.64 V calculated- 7.674 V

Supply Voltage = 10 V

Step 5

MAKE:



Step 6a

DEDUCE, without measurement, the voltages across each resistor.

$$V_{R1} = V_s \cdot R_1 / (R_1 + R_2)$$

$$V_{R1} = 10V \cdot 10k\Omega / (10k\Omega + 10k\Omega)$$

$$V_{R1} = 5V$$

$$V_{R2} = V_s \cdot R_2 / (R_1 + R_2)$$

$$V_{R2} = 10V \cdot 10k\Omega / (10k\Omega + 10k\Omega)$$

$$V_{R2} = 5V$$

These are equal resistor, so therefore have the same voltage across each resistor.

RECORD your deduction:

Voltage across the top resistor = 5 V

Voltage across the bottom resistor = 5 V

Step 6b

Measure the voltages across each resistor.

RECORD your measurement:

Voltage across the top resistor = 4.97 V

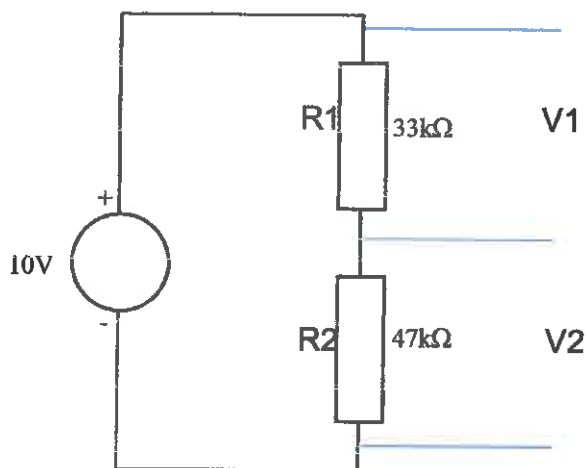
Voltage across the bottom resistor = 4.97 V

Comment upon the relationship between the voltages and resistance.

Both resistors hold the same value, so therefore the voltage is split equally between the two 10KΩ resistors. Each resistor has 5V across it.

Step 7

MAKE:



Step 8

Calculate

$$V_{R1} = V_s \cdot R_1 / (R_1 + R_2)$$

$$V_{R1} = 10V \cdot 33k\Omega / (33k\Omega + 47k\Omega)$$

$$V_{R1} = 4.125V$$

$$V_{R2} = V_s \cdot R_2 / (R_1 + R_2)$$

$$V_{R2} = 10V \cdot 47k\Omega / (33k\Omega + 47k\Omega)$$

$$V_{R2} = 5.875V$$

$$\text{Voltage across } 33k\Omega \text{ resistor} = 4.125V$$

$$\text{Voltage across } 47k\Omega \text{ resistor} = 5.875V$$

MEASURE the resistor voltages.

RECORD your observations:

$$\text{Voltage across } 33k\Omega \text{ resistor} = 4.11V$$

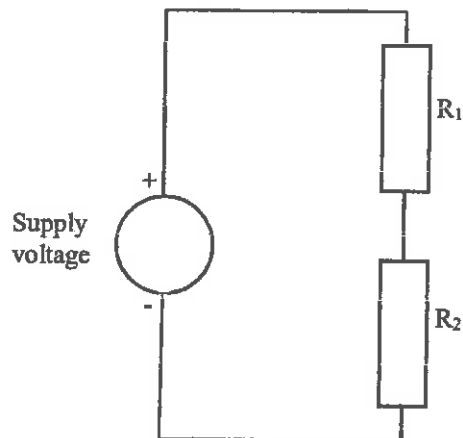
$$\text{Voltage across } 47k\Omega \text{ resistor} = 5.83V$$

CONFIRM that your calculations and the measurements agree.

There is a very slight discrepancy in the values, which could be down to the 5% tolerance in the resistors or multi-meter calibration.

Step 9

CONSIDER the following circuit diagram:



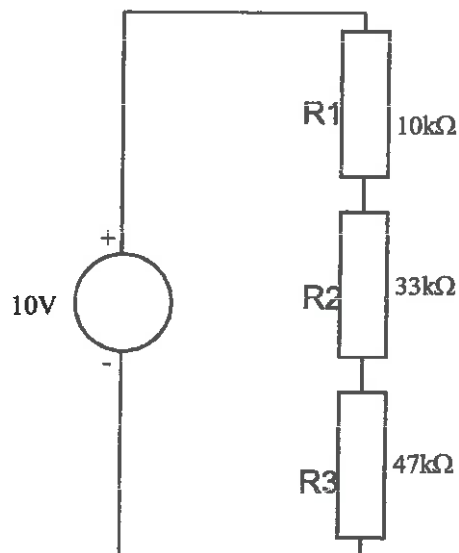
From what you have learnt about Potential Division, whereby a Supply Voltage will divide between resistances according to what proportion of the total resistance each resistor has, complete the following formulae:

$$\text{Voltage across } R_1 = \text{Supply Voltage} \times \frac{R_1}{R_1 + R_2}$$

$$\text{Voltage across } R_2 = \text{SUPPLY VOLTAGE} \times \frac{R_2}{R_1 + R_2}$$

Step 10

MAKE:



Step 11

Measure:

$$\text{Voltage across } 10k\Omega = 1.1V$$

$$\text{Voltage across } 33k\Omega = 3.65V$$

$$\text{Voltage across } 47k\Omega = 5.18V$$

CONFIRM measurements by calculation.

$$VR1 = V_s * R1 / R1 + R2 + R3$$

$$VR1 = 10V * 10K\Omega / 10K\Omega + 33K\Omega + 47K\Omega$$

$$VR1 = 1.111V$$

$$VR2 = V_s * R2 / R1 + R2 + R3$$

$$VR2 = 10V * 33K\Omega / 10K\Omega + 33K\Omega + 47K\Omega$$

$$VR2 = 3.667V$$

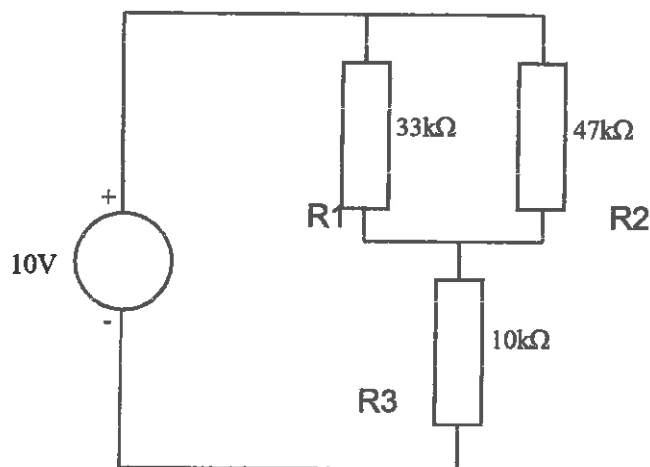
$$VR3 = V_s * R3 / R1 + R2 + R3$$

$$VR3 = 10V * 47K\Omega / 10K\Omega + 33K\Omega + 47K\Omega$$

$$VR3 = 5.222V$$

Step 12

MAKE:



Step 13

Calculate the voltage across the 10kΩ resistor and the voltage across the 47kΩ/33kΩ parallel combination.

$$1/R_T = 1/R1 + 1/R2$$

$$1/R_T = 1/33K\Omega + 1/47K\Omega$$

$$R_T = 19.3875 K\Omega$$

$$VR3 = V_s * R3 / R3 + R_T$$

$$VR3 = 10V * 10K\Omega / 10K\Omega + 19.3875K\Omega$$

$$VR3 = 3.403V$$

$$VRT = V_s * R_T / R3 + R_T$$

$$VRT = 10V * 19.3875K\Omega / 10K\Omega + 19.3875K\Omega$$

$$VRT = 6.597V$$

RECORD your calculations:

Voltage across 10kΩ = 3.403V

Voltage across parallel combination = 6.597V

CONFIRM your calculations by measurement.

Measured value across 10K Ω resistor = 3.38V

Measured value across parallel combination (RT) = 6.58V

CONCLUSION

Write down a mathematical expression that can be used to find the voltage across a resistance that is in series with other resistance if the supply voltage and resistances are known.

Use the potential divider rule:— $V_{R1} = \text{supply voltage} \times \frac{R1}{R1+R2}$

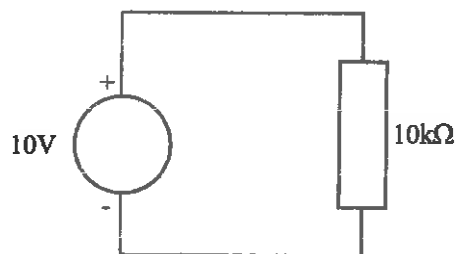
Lab 1b - Current Division

Objective

On completion of this work the student will be able to use the concept of Current Division in determining the currents in 2 branch Parallel circuits.

Step 1

MAKE the following circuit:



CALCULATE, using Ohm's Law, the current in the circuit.

$$I = V/R$$

$$I = 10V/10K\Omega$$

$$I = 1mA$$

RECORD your observations:

Calculated Current = 1mA

Step 2

MEASURE, using a multimeter the circuit current.

RECORD your observation:

Measured Current = 1.01mA

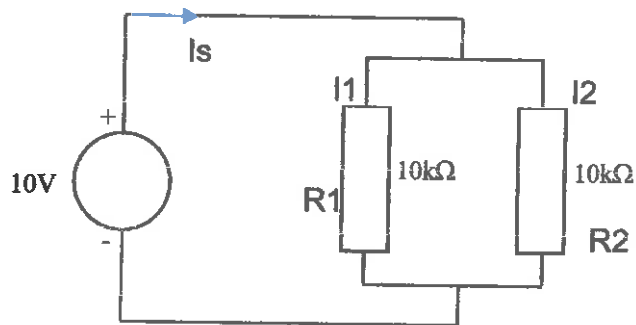
CONFIRM that the calculated and measured values of circuit current agree.

YES THEY AGREE

no need to start!

SP

Step 4
MAKE:



Step 5

DEDUCE, without measurement, the 2 branch currents.

$$I_s = V/R$$

$$I_s = 10V / 5K\Omega$$

$$I_s = 2mA$$

$$I_1 = \frac{R_2 * I_s}{R_1 + R_2}$$

$$I_1 = \frac{10K\Omega * 2mA}{10K\Omega + 10K\Omega}$$

$$I_1 = 1mA$$

$$I_2 = \frac{R_1 * I_s}{R_1 + R_2}$$

$$I_2 = \frac{10K\Omega * 2mA}{10K\Omega + 10K\Omega}$$

$$I_2 = 1mA$$

RECORD your deduction:

$$I_1 = 1mA$$

$$I_2 = 1mA$$

MEASURE the supply and branch currents using a multimeter.

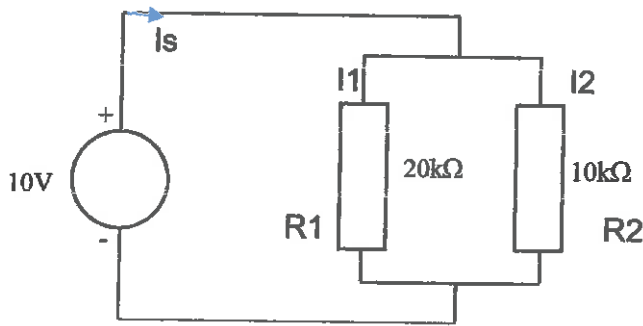
$$\text{Measured Current} = 2.02mA$$

$$\text{Measured Current in Branch 1} = 1.01mA$$

$$\text{Measured Current in Branch 2} = 1.01mA$$

/SDP

Step 6
MAKE:



Step 7

CALCULATE the 2 branch currents using Ohm's Law.

$$I_1 = V/R_1$$

$$I_1 = 10V / 20k\Omega$$

$$I_1 = 0.5mA$$

$$I_2 = V/R_2$$

$$I_2 = 10V / 10k\Omega$$

$$I_2 = 1mA$$

RECORD your results:

Current in Branch 1 = 0.5mA

Current in Branch 2 = 1mA

Supply Current = $0.5mA + 1mA = 1.5mA$

CONFIRM your results by measurement using a multimeter.

Measured current for branch 1 = 0.5mA

Measured current for branch 2 = 1.01mA

Supply current = 1.51mA

/SDP

CALCULATE the fraction of the supply current that is in the 20kΩ branch as follows:

$$\text{Fraction in } 20\text{k}\Omega \text{ resistor} = \frac{\text{Current in } 20\text{k}\Omega}{\text{Supply Current}} = \frac{0.5 \text{ mA}}{1.5 \text{ mA}} = \frac{1}{3}$$

COMPARE the FRACTION obtained with the following result:

$$\begin{aligned} \text{Fraction in } 20\text{k}\Omega \text{ resistor} &= \frac{\text{Value of R in OTHER branch}}{\text{Sum of the 2 resistances}} \\ &= \frac{10\text{k}\Omega}{10\text{k}\Omega + 20\text{k}\Omega} = \frac{1}{3} \end{aligned}$$

DEDUCE the current in Branch 2.

RECORD your deduction:

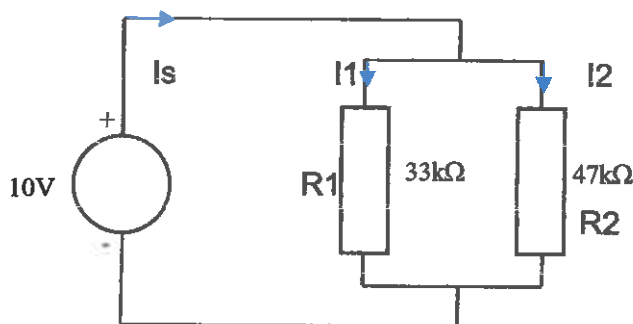
$$\text{Current in Branch 2} = \frac{2}{3} \times \text{Supply Current} = 1\text{mA}$$

and, from before:

$$\text{Current in Branch 1} = \frac{1}{3} \times \text{Supply Current} = 0.5\text{mA}$$

Step 8

MAKE:



Step 9

MEASURE the Supply Current using a multimeter.

$$\begin{aligned} \text{Supply Current} &= 522\mu\text{A} \\ \text{Current in } 47\text{k}\Omega &= 216\mu\text{A} \\ \text{Current in } 33\text{k}\Omega &= 306\mu\text{A} \end{aligned}$$

CALCULATE, using the concept of CURRENT DIVISION that was introduced at **step 7**, the 2 branch currents.

RECORD your results:

$$\begin{aligned} \frac{1}{R_T} &= \frac{1}{R_1} + \frac{1}{R_2} \\ \frac{1}{R_T} &= \frac{1}{33\text{k}\Omega} + \frac{1}{47\text{k}\Omega} \\ R_T &= 19.3875 \text{ k}\Omega \end{aligned}$$

$$\begin{aligned} I_s &= V/R \\ I_s &= 10\text{V} / 19.387\text{k}\Omega \\ I_s &= 515\mu\text{A} \end{aligned}$$

/SDP

$$I_1 = \frac{R_2 * I_s}{R_1 + R_2}$$

$$I_1 = \frac{47K\Omega * 515\mu A}{33K\Omega + 47K\Omega}$$

$$I_1 = 302\mu A$$

$$I_2 = \frac{R_1 * I_s}{R_1 + R_2}$$

$$I_2 = \frac{33K\Omega * 515\mu A}{33K\Omega + 47K\Omega}$$

$$I_2 = 212\mu A$$

Supply Current = 515μA

Current in 47kΩ = 212μA

Current in 33kΩ = 302μA

CONCLUSION

Construct a mathematical expression that can be used to find the branch current in a two branch parallel network if the supply current is known.

$$I_1 = \frac{R_2 * I_s}{R_1 + R_2} \quad \text{AND} \quad I_2 = \frac{R_1 * I_s}{R_1 + R_2}$$

/SDP

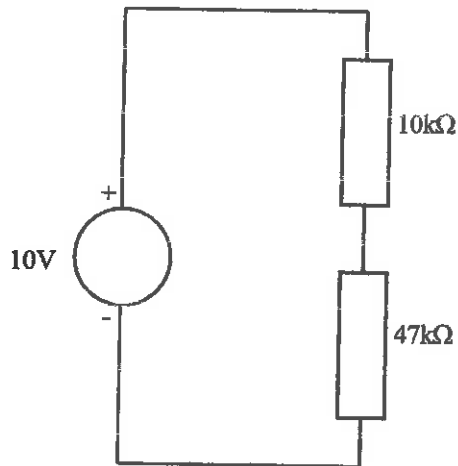
Lab 1c-The Product / Sum Rule

Objective

On completion of this work the student will be able to use the Product/Sum rule to find the equivalent resistance of two or more resistance in parallel.

Step 1

MAKE the following circuit:



Step 2

MEASURE using a multimeter the current in the circuit.

RECORD your observations:

Supply voltage = 10V ✓

Current = 176.3μA ✓

CALCULATE the circuit resistance.

RECORD your result:

$$R = \frac{V}{I} = \frac{10}{173.3\mu A} = 56.72 \text{ K}\Omega$$

Calculated resistance = 56.72 KΩ ✓

DISCONNECT the multimeter and power supply.

MEASURE the circuit resistance.

RECORD your result:

Measured resistance = 55.6 KΩ ✓

COMPARE the value calculated using Ohm's Law with the measured value.
RECORD your comparisons:

Calculated value of resistance = 56.72 KΩ ✓

Measured value of resistance = 55.6 KΩ ✓

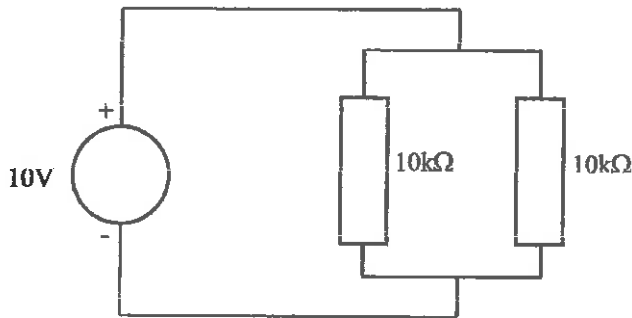
SDP

COMMENT on any discrepancy.

There is a difference of 1.12 K Ω between the calculated and measured values. This could be due to the tolerances of the gold resistors + or - 5%.

Step 3

MAKE:



Step 4

MEASURE using a multimeter the supply current.
RECORD your observation:

Supply Current = 1.987mA ✓

Supply voltage = 10 V ✓

CALCULATE the circuit resistance using Ohm's Law.
RECORD your result:

$$R = \frac{V}{I} = \frac{10V}{1.987mA} = 5032 \Omega \quad \checkmark$$

Calculated resistance = 5032 Ω

DISCONNECT the multimeter and the power supply.

MEASURE the circuit resistance.
RECORD your measurement:

Measured resistance = 4910 Ω ✓

FIND the PRODUCT of the 2 resistances and divide it by their SUM.
RECORD this operation:

$$\frac{R1 * R2}{R1 + R2}$$

Product = 10 K Ω $\times$ 10 K Ω

Sum = 10 K Ω + 10 K Ω Result = 5 K Ω ✓

COMPARE the value calculated, the measured value and the value found by the PRODUCT/SUM Rule.

RECORD your comparisons:

Ohm's Law value of resistance = 5032 Ω

Measured value of resistance = 4910 Ω

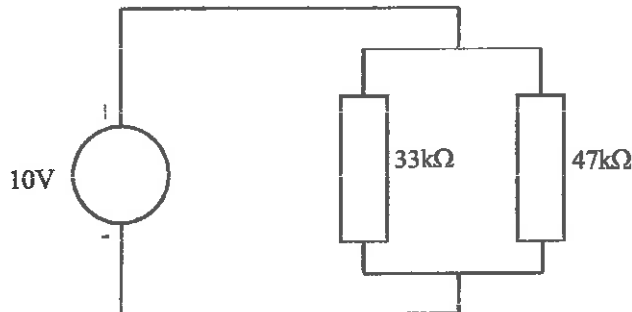
Product/Sum value of resistance = 5000 Ω

COMMENT on any discrepancy:

The product/ sum value is a perfect value and doesn't consider any tolerances. Whereas the measured value could have discrepancies in the resistor values or a multi-meter calibration issue. The ohms law figure has a measured value for current, which again could have multi-meter calibration issues.

Step 5

MAKE:



Step 6

MEASURE the supply current using a multimeter.

RECORD your observation:

Supply Current = 522 μA

Supply Voltage = 10V

CALCULATE the circuit resistance.

RECORD your result:

$$R = \frac{V}{I} = \frac{10V}{522\mu A} = 19157\Omega$$

Calculated resistance = 19.157K Ω

DISCONNECT the multimeter and power supply.

MEASURE the circuit resistance.

RECORD your measurement:

Measured resistance = 19 K Ω

FIND the PRODUCT of the 2 resistances and divide it by their SUM.
RECORD this operation:

$$\text{Product} = 33\text{K}\Omega \times 47\text{K}\Omega$$

$$\text{Sum} = 33\text{K}\Omega + 47\text{K}\Omega$$

$$\text{Result} = 19.387\text{K}\Omega$$

COMPARE the value calculated the measured value and the value found by the PRODUCT/SUM Rule.

RECORD your comparisons:

$$\text{Ohm's Law value of resistance} = 19.157\text{K}\Omega$$

$$\text{Measured value of resistance} = 19\text{K}\Omega$$

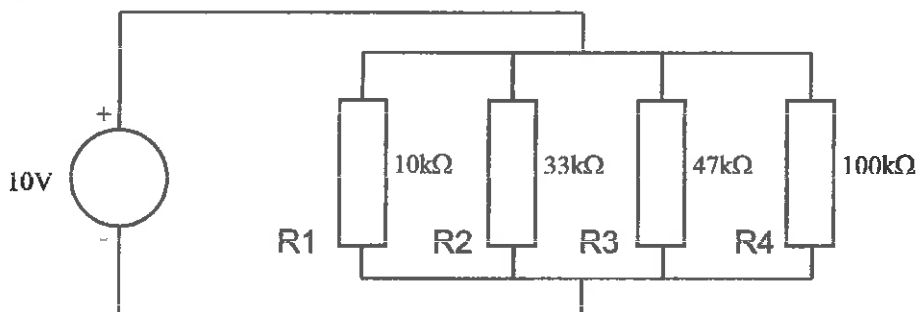
$$\text{Product/Sum value of resistance} = 19.387\text{K}\Omega$$

COMMENT on any discrepancy:

The product/ sum value is a perfect value and doesn't consider any tolerances. Whereas the measured value could have discrepancies in the resistor values or a multi-meter calibration issue. The ohms law figure has a measured value for current, which again could have multi-meter calibration issues.

Step 7

MAKE:



Step 8

MEASURE the supply current using a multimeter.
RECORD your observation:

$$\text{Supply Current} = 1.607\text{mA}$$

$$\text{Supply Voltage} = 10\text{V}$$

CALCULATE the circuit resistance.
RECORD your result:

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4}$$

$$\frac{1}{R_T} = \frac{1}{10\text{K}\Omega} + \frac{1}{33\text{K}\Omega} + \frac{1}{47\text{K}\Omega} + \frac{1}{100\text{K}\Omega}$$

$$R_T = 6188.9 \Omega$$

Calculated resistance = 6.189 K Ω

DISCONNECT the multimeter and power supply.

MEASURE the circuit resistance.

RECORD your measurement:

Measured resistance = 6.11K Ω ✓

FIND the PRODUCT of one pair of the 4 resistances and divide it by the SUM of the same pair.
RECORD this operation:

First pair:

Product = 10K Ω $\times$ 33K Ω

Sum = 10K Ω + 33 K Ω Result = 7.674 K Ω ✓

FIND the PRODUCT of the other pair of the 4 resistances and divide it by the SUM of the same pair.

RECORD this operation:

Second pair:

Product = 47 K Ω $\times$ 100 K Ω

Sum = 47 K Ω + 100 K Ω Result = 31.973 K Ω ✓

REPEAT the PRODUCT/SUM rule on the results for the 2 pairs.

RECORD this operation:

Product of 2 results = 7.674 K Ω $\times$ 31.973 K Ω

Sum of 2 results = 7.674 K Ω + 31.973 K Ω Final Result = 6.189 K Ω ✓

COMPARE the value calculated using Ohm's Law with the measured value and the value found by the PRODUCT/SUM Rule.

RECORD your comparisons:

Ohm's Law value of resistance = 6.189 K Ω

Measured value of resistance = 6.11 K Ω

Product/Sum value of resistance = 6.189 K Ω ✓

COMMENT on any discrepancy:

Ohms law and product/ sum value are the same. The measured value has a small discrepancy, which could be down to resistance tolerance.

Lab 1d-Thevenin's Theorem

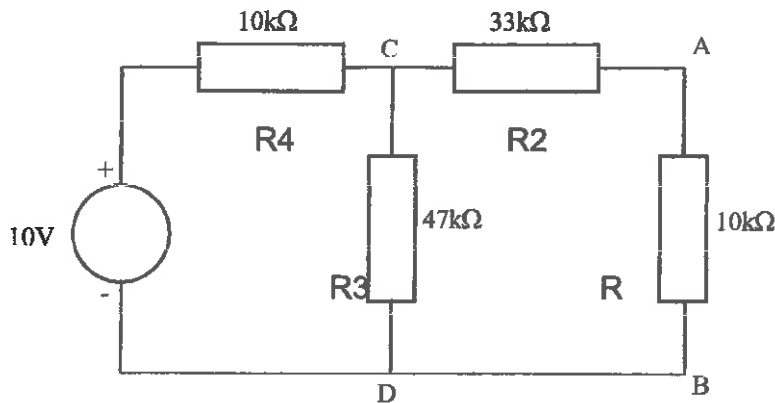
Objective

On completion of this work the student will be able:

1. Determine the Thevenin Equivalent voltage for a branch of a network, both practically and theoretically.
2. Determine the Thevenin Equivalent resistance that exists across an open circuited branch of a network, both practically and theoretically.

Step 1

MAKE:



$$V_{th} = \frac{10V * 47K\Omega}{10K\Omega + 47K\Omega} = 8.246V$$

$$R_{th} = \frac{10K\Omega * 47K\Omega}{10K\Omega + 47K\Omega} + 33K\Omega = 41.245K\Omega$$

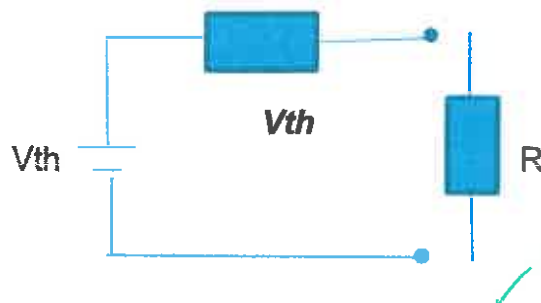
Step 2

STATE the steps that would be applied to the circuit when using Thevenin's theorem.

1. Remove the load
2. Short circuit the supply
3. Calculate R_{th} the Thevenin equivalent resistance
4. Calculate V_{th} The Thevenin equivalent voltage
5. Redraw equivalent circuit

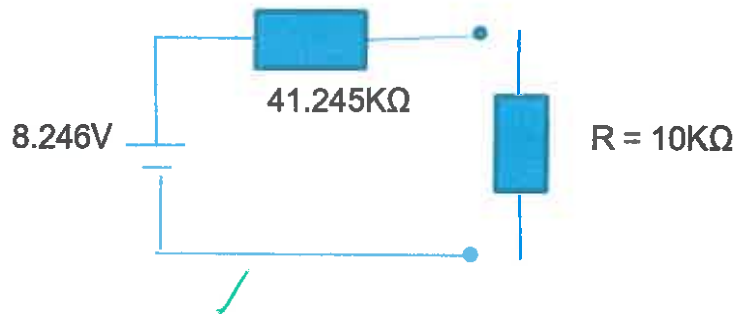
$$R_{th} = \frac{R4 * R3}{R4 + R3} + R2$$

$$V_{th} = \frac{V * R3}{R3 + R4}$$



Step 3

DRAW the Thevenin equivalent circuit.



Step 4

MAKE the Thevenin equivalent circuit that you have drawn, in addition to the original circuit:

Step 5

FIT the resistor removed from AB across the terminals of your Thevenin Equivalent circuit.

MEASURE the actual current through the resistor using a multimeter.

Current = 193.7 $\mu\Omega$ ✓

MOVE the resistor from its position in the equivalent circuit to its position in the original circuit.
MEASURE the actual current through the resistor using a multimeter.

Current = 159.8 $\mu\Omega$ ✓

Conclusions?

The original circuit had more resistors therefore the circuit would have a varied range of resistance due to each resistor having $\pm 5\%$ tolerance. Also, when making the equivalent circuit the resistance had to be less because of the resources available. A 40.8K Ω resistor was used instead of 41.2k Ω . ✓

/SDP

GUIDANCE FOR STUDENTS IN THE COMPLETION OF TASKS

1. **Research-informed Literature:** You must provide evidence of individual research of component and circuit theory, selecting credible sources and application of appropriate referencing conventions.
2. **Knowledge and Understanding of Subject:** Must show an understanding of concepts and underlying principles associated with ac circuits.
3. **Analysis:** Provide analysis of the practical activities.
4. **Practical Application and Deployment:** Show the ability to perform practical work and be able to verify circuit operation against calculated and theoretical results.
5. **Skills for Professional Practice:** Your work should be well organised and presented in a professional manner.

FdSc & HN COMMON ASSESSMENT AND MARKING CRITERIA

Assessment Criteria	OUTRIGHT FAIL	UNSATISFACTORY	SATISFACTORY	GOOD	VERY GOOD	EXCELLENT	EXCEPTIONAL
	REFER (equivalent to 0-29%)	REFER (equivalent to 30-39% ^a)	PASS (equivalent to 40-49%)	PASS (equivalent to 50-59%)	MERIT (equivalent to 60-69%)	DISTINCTION (equivalent to 70-79%)	DISTINCTION (equivalent to 80-100%)
1. Research-informed Literature Extent of research and/or own reading, selection of credible sources, application of appropriate referencing conventions	Little or no evidence of reading. Views and findings unsupported and non-authoritative. Referencing conventions largely ignored.	Poor evidence of reading and/or of reliance on inappropriate sources, and/or indiscriminate use of sources. Referencing conventions used inconsistently.	References to a limited range of mostly relevant sources. Some omissions and minor errors. Referencing conventions evident though not always applied consistently.	Inclusion of a range of research-informed literature, including sources retrieved independently. Referencing conventions mostly consistently applied.	Inclusion of a wide range of research-informed literature, including sources retrieved independently. Selection of relevant and credible sources. Very good use of referencing conventions, consistently applied.	A comprehensive range of research-informed literature embedded in the work. Excellent selection of relevant and credible sources. High-level referencing skills, consistently applied.	Outstanding knowledge of research-informed literature embedded in the work. Outstanding selection of relevant and credible sources. High-level referencing skills consistently and professionally applied.
2. Knowledge and Understanding of Subject Extent of knowledge and understanding of concepts and underlying principles associated with the discipline.	Major gaps in knowledge and understanding of material at this level. Substantial inaccuracies.	Gaps in knowledge, with only superficial understanding. Some significant inaccuracies.	Evidence of basic knowledge and understanding of the relevant concepts and underlying principles.	Knowledge is accurate with a good understanding of the field of study.	Knowledge is extensive. Exhibits understanding of the breadth and depth of established views.	Excellent knowledge and understanding of the main concepts and key theories. Clear awareness of challenges to established views and the limitations of the knowledge base.	Highly detailed knowledge and understanding of the main theories/concepts, and a critical awareness of the ambiguities and limitations of knowledge.
3. Analysis Analysis, evaluation and synthesis; logic, argument and judgement; analytical reflection; organisation of ideas and evidence	Unsubstantiated generalisations, made without use of any credible evidence. Lack of logic, leading to unsupported/missing conclusions. Lack of any attempt to analyse, synthesise or evaluate.	Some evidence of analytical intellectual skills, but for the most part descriptive. Ideas/findings sometimes illogical and contradictory. Generalised statements made with scant evidence. Conclusions lack relevance.	Evidence of some logical, analytical thinking and some attempts to synthesise, albeit with some weaknesses. Some evidence to support findings/views, but evidence not consistently interpreted. Some relevant conclusions and recommendations, where relevant.	Evidence of some logical, analytical thinking and synthesis. Can analyse new and/or abstract data and situations without guidance. An emerging awareness of different stances and ability to use evidence to support the argument. Valid conclusions and recommendations, where relevant.	Sound, logical, analytical thinking; synthesis and evaluation. Ability to devise and sustain persuasive arguments, and to review the reliability, validity & significance of evidence. Ability to communicate ideas and evidence accurately and convincingly. Sound, convincing conclusions / recommendations.	Thoroughly logical work, supported by evaluated evidence. High quality analysis, developed independently or through effective collaboration. Ability to investigate contradictory information and identify reasons for contradictions. Strong, persuasive, conclusions, justifiable recommendations.	Exceptional work; judiciously selected and evaluated evidence. Very high quality analysis, developed independently or through effective collaboration. Ability to investigate contradictory information and identify reasons for contradictions. Highly persuasive conclusions.
4. Practical Application and Deployment Effective deployment of appropriate methods, materials, tools and techniques; extent of skill demonstrated in the application of concepts to a variety of processes and/or contexts; formulation of innovative and creative solutions to solve problems.	Limited or no use of methods, materials, tools and/or techniques. Little or no appreciation of the context of the application.	Rudimentary application of methods, materials, tools and/or techniques but without consideration and competence. Flawed appreciation of the context of the application.	An adequate awareness and mostly appropriate application of well-established methods, materials, tools and/or techniques. Basic appreciation of the context of the application.	A good and appropriate application of standard methods, materials, tools and/or techniques. Good appreciation of the context of the application, with some use of examples, where relevant.	A very good application of a range of methods, materials, tools and/or techniques. Very good consideration of the context of the application, with perceptive use of examples, where relevant. Evidence of some innovation and creativity.	An advanced application of a range of methods, materials, tools and/or techniques. The context of the application is well considered, with extensive use of relevant examples. Application and deployment extend beyond established conventions. Innovation and creativity evident throughout.	Outstanding levels of application and deployment skills. Assimilation and development of cutting edge processes and techniques.
5. Skills for Professional Practice Demonstrates attributes expected in professional practice including: individual initiative and collaborative working; deployment of appropriate media to communicate (including written and oral); clarity and effectiveness in presentation and organisation.	Communication media is inappropriate or misapplied. Little or no evidence of autonomy in the completion of tasks. Work is poorly structured and/or largely incoherent.	Media is poorly designed and/or not suitable for the audience. Poor independent or collaborative initiative. Work lacks structure, organisation, and/or coherence.	Can communicate in a suitable format but with some room for improvement. Can work as part of a team, but with limited involvement in group activities. Work lacks coherence in places and could be better structured.	Can communicate effectively in a suitable format, but may have minor errors. Can work effectively as part of a team, with clear contribution to group activities. Mostly coherent work and is in a suitable structure.	Can communicate well, confidently and consistently in a suitable format. Can work very well as part of a team, with very good contribution to group activities. Work is coherent and fluent and is well structured and organised.	Can communicate professionally and, confidently in a suitable format. Can work professionally within a team, showing leadership skills as appropriate, managing conflict and meeting obligations. Work is coherent, very fluent and is presented professionally.	Can communicate with an exceptionally high level of professionalism. Can work exceptionally well and professionally within a team, showing advanced leadership skills. Work is exceptionally coherent, very fluent and is presented professionally.

MARKING CRITERIA AND STUDENT FEEDBACK

This section details the assessment criteria. The *extent* to which these are demonstrated by you determines your mark. The marks available for each criterion are shown. Lecturers will use the space provided to comment on the achievement of the task(s), including those areas in which you have performed well and areas that would benefit from development/improvement.

Common Assessment Criteria Applied	Marks available	Marks awarded
1. Research-informed Literature Extent of research and/or own reading, selection of credible sources, application of appropriate referencing conventions.	10	
wide range of research and informed literature.		6.9
2. Knowledge and Understanding of Subject Extent of knowledge and understanding of concepts and underlying principles associated with the discipline.	20	
Highly detailed knowledge and understanding shown.		17.1
3. Analysis Analysis, evaluation and synthesis; logic, argument and judgement; analytical reflection, organisation of ideas and evidence.	20	
Sound logical analytical thinking		13.6
4. Practical Application and Deployment Deployment of methods, materials, tools and techniques; application of concepts; formulation of innovative and creative solutions to solve problems.	40	
The context of the application is well considered.		31.6
5. Skills for Professional Practice Attributes in professional practice: individual and collaborative working; deployment of appropriate media; presentation and organisation.	10	
Can communicate confidently.		6

Assignment Mark (Assessment marks are subject to ratification at the Exam Board. These comments and marks are to give feedback on module work and are for guidance only until they are confirmed.)

Late Submission Penalties (tick if appropriate)

Up to one week late (capped at 40%)	
First Attempt?	☒

75.2 %

✓
STP



Taflen Cyflwyno Aseiniad Assignment Hand in Sheet

MANYLION Y MYFYRIWR STUDENT'S DETAILS			
ENW: NAME:		<i>RHIF P Y MYFYRIWR: STUDENT P NUMBER:</i>	P
CWRS: COURSE:	Foundation Year/HNC/HND/FdSc/BEng/BSc/MEng/MComp/MSc * <i>dileer fel y bo'n berthnasol / delete as appropriate</i>	<i>LEFEL Y CWRS: LEVEL OF COURSE:</i>	4
MODIWL: MODULE:	ELECTRICAL TECHNOLOGY PSDE4021		
TEITL YR ASEINIAD: ASSIGNMENT TITLE:	DC Circuit Lab		
DARLITHIWR/WYR: LECTURER/S:	Steve Roberts	<i>DYDDIAD: DATE:</i>	
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ENW / NAME:		<i>RHIF P Y MYFYRIWR: STUDENT P NUMBER:</i>	P
CWRS / COURSE:	Foundation Year/HNC/HND/FdSc/BEng/BSc/MEng/MComp/MSc * <i>dileer fel y bo'n berthnasol / delete as appropriate</i>	<i>LEFEL Y CWRS / LEVEL OF COURSE:</i>	4
MODIWL / MODULE:	Electrical Technology PSDE4021		
TEITL YR ASEINIAD/ ASSIGNMENT TITLE:	DC Circuit Lab		
DARLITHIWR/WYR: LECTURER/S:	Steve Roberts	<i>DYDDIAD / DATE:</i>	
Staff Llyfrgell YN UNIG / Library Staff ONLY Derbyniwyd gan / Accepted by: _____ Dyddiad Cyflwyno: Date Submitted: _____ Amser / Time: _____			

Task 4 (b)

An Atom is a small particle of an element. The Atom and all its positive charge is concentrated in the nucleus, while negatively charged electrons revolve around the nucleus in an orbit. The nucleus is made up of protons and neutrons. A neutron carries no charge, whereas a proton carries positive charge. There are the same amount of positive protons as orbiting electrons, this is illustrated in Fig.1.

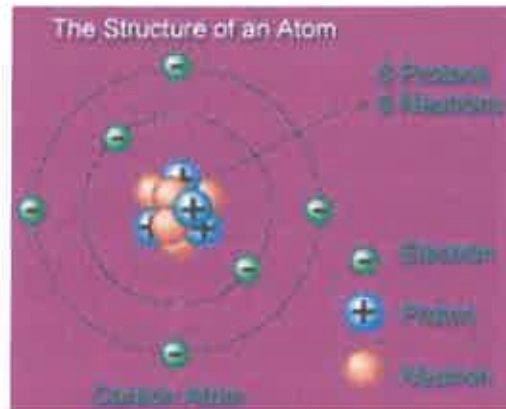


Fig.1 structure of an atom

Due to the opposite charge, there is an attraction between the electron and the nucleus. The closer the electron is to the nucleus the stronger the bound, therefore the further away in the orbit the weaker the bound, which can result in a detachment from the nucleus. ✓

In metals, atoms are tightly packed together and the electrons in the outer orbits can experience sufficient force of attraction from the neighbouring nucleus. By adding a small amount of energy from an electric source the electrons start oscillating and become detached from the nucleus, these are called free electrons. These free electrons can be made to move in a particular direction by applying an energy source. Such metals are categorised as conductors. ✓

A material with atoms that are electrically stable and with the outer orbit complete, is called an insulator. In such materials the gap between the atoms are very large, and as a result the energy required by the electron to cross over is impracticable. Insulators do not conduct electricity easily but are able to store electricity better than conductors.

/JTP

Task 4 (c)

In an insulator there are so few free electrons that hardly any current can flow. Almost all the electrons are tightly bound within their particular atom (Fig 2.)



Fig 2. Good Insulator



Fig 3. Insulator at high temperature

Heating an insulating material vibrates the atoms, and if heated sufficiently, the atoms vibrate enough to actually shake some of their captive electrons free, creating free electrons to become carriers of current (Fig 3.).

Therefore at high temperatures the resistance of an insulator can reduce. When resistance FALLS with an increase in temperature, the material is said to have a negative temperature coefficient.

The resistance at a particular temperature can be determined by using the following temperature coefficient formula:

$$R = R_{ref} (1 + \alpha(T - T_{ref}))$$

R = conductor resistance at temperature T

R_{ref} = Conductor resistance at reference temperature T_{ref} , usually 20°C , but sometimes 0°C

α = Temperature coefficient of resistance for the conductor material

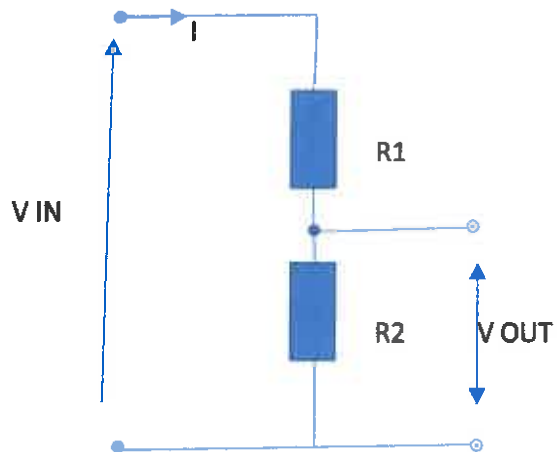
T = conductor temperature in $^{\circ}\text{C}$

T_{ref} = Reference temperature that α is specified at for the conductor material

Materials chosen as insulators will have a very low negative temperature coefficient over their working range of temperature.

SDP

Task 4 (d)

Voltage Divider rule from first principles

The total resistance is:

$$R_T = R_1 + R_2$$

Supply current is then calculated:

$$1. \quad I = \frac{V_{in}}{R_T} = \frac{V_{in}}{R_1 + R_2}$$

Also

$$2. \quad I = \frac{V_{out}}{R_2}$$

Combine equations 1. And 2.

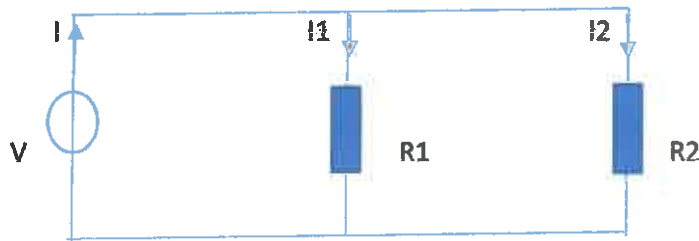
$$\frac{V_{out}}{R_2} = \frac{V_{in}}{R_1 + R_2}$$

Therefore,

$$V_{out} = \frac{V_{in} \cdot R_2}{R_1 + R_2}$$



/SDP

Current divider rule from first principles

Total resistance (R_T):

$$R_T = \frac{R_1 + R_2}{R_1 + R_2}$$

Therefore, equation 1. $V = \frac{I \cdot R_1 + R_2}{R_1 + R_2}$

For R_1 :

Equation 2. $V = I_1 \cdot R_1$

For R_2 :

Equation 3. $V = I_2 \cdot R_2$

Combine equations 1. And 2. For I_1 :

$$I_1 \cdot \cancel{R_1} = \frac{I \cdot \cancel{R_1} + R_2}{R_1 + R_2}$$

Therefore, $I_1 = \frac{I \cdot R_2}{R_1 + R_2}$ ✓

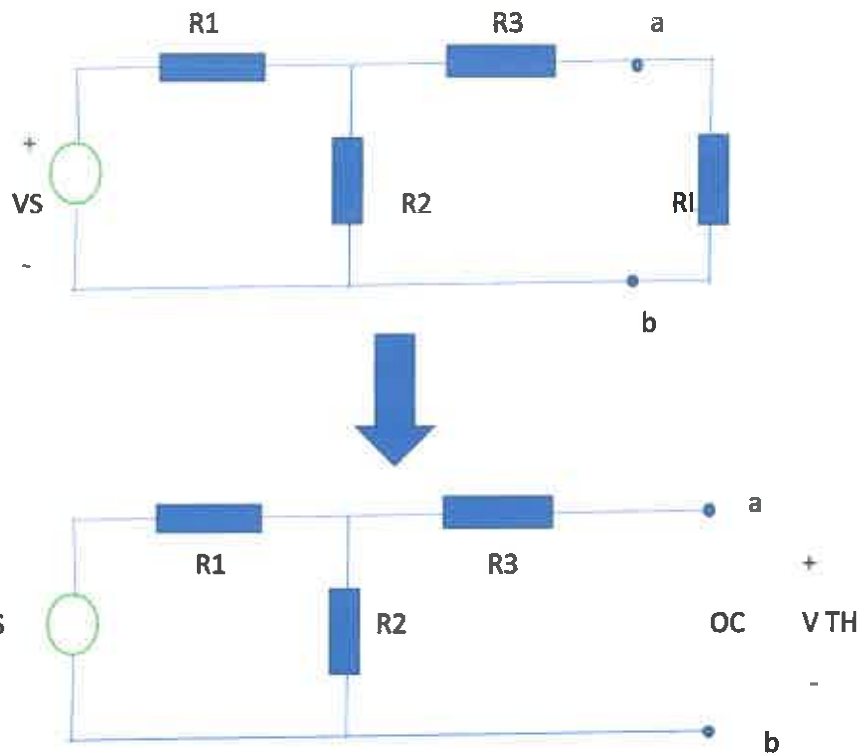
Combine equation 1. And 3. For I_2

$$I_2 \cdot \cancel{R_2} = \frac{I \cdot R_1 + \cancel{R_2}}{R_1 + R_2}$$

Therefore, $I_2 = \frac{I \cdot R_1}{R_1 + R_2}$ ✓

/SDP

Task 4 (e)



Find Thevenin equivalent voltage with an open circuit (oc) between a and b:

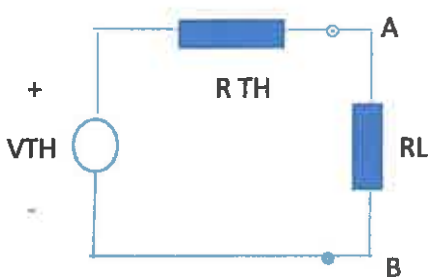
$$V_{TH} = V_{R2} = \frac{R2}{R1+R2} V_S$$

With R_L removed, the supply voltage is then short circuited (sc) and R_{TH} can be determined between a and b:

$$R_{TH} = R3 + R1 \parallel R2$$

Therefore,
$$R_{TH} = R3 + \frac{R1R2}{R1+R2}$$

Redraw the Thevenin equivalent circuit.



/SDP

The current through and the voltage across R_L can be determined:

$$I_{RL} = \frac{V_{TH}}{R_{TH} + R}$$

$$V_{RL} = IR = \frac{V_{TH} * R}{R_{TH} + R}$$

References and Bibliography

Books

- Electrical and Electronic Principles and Technology, Third edition, John Bird, Published by Elsevier Ltd 2007
- Fundamental Electrical and Electronic Principles, 3rd Edition, Christopher Robertson

Website

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