

LEVEL 4 ASSESSMENT SPECIFICATION

Student name:	Sian Nunnery	Student ID number:	
Programme:	HNC Electrical/Electronic Engineering & Instrumentation Engineering		
Module:	Electrical Principles		
Module code:	PCEE4001	Contribution to Overall Module Assessment (%):	100%
Lecturer:	Jason Pointer	Internal Verifier:	Lance Rutherford
Assignment Title:	Electrical Principles	Word count (or equivalent):	2000
Submission deadline:	15/01/21	Return date of provisional marks & written feedback:	29/01/21
Submission method:	All written assessments, where practical and possible, must be submitted via Turnitin unless otherwise instructed by the Lecturer. (Please DO NOT put this assessment specification into Turnitin or it will match many similarities with other students' submissions.) Alternative submission method (if applicable): Late submission of the assessment will result in a late penalty mark. Penalties for late submission: Up to one week late, maximum mark of 40%. Over one week late, 0%. Only the Extenuating Circumstances Panel may approve a change to submission dates.		
Academic honesty / referencing:	Academic honesty is required. In the main body of your submission you must give credit to authors on whose research and ideas your work is based. Append to your submission a reference list that indicates the books, articles, etc. that you have used, cited or quoted in order to complete this assessment.		

Module Learning Outcomes (from module syllabus)

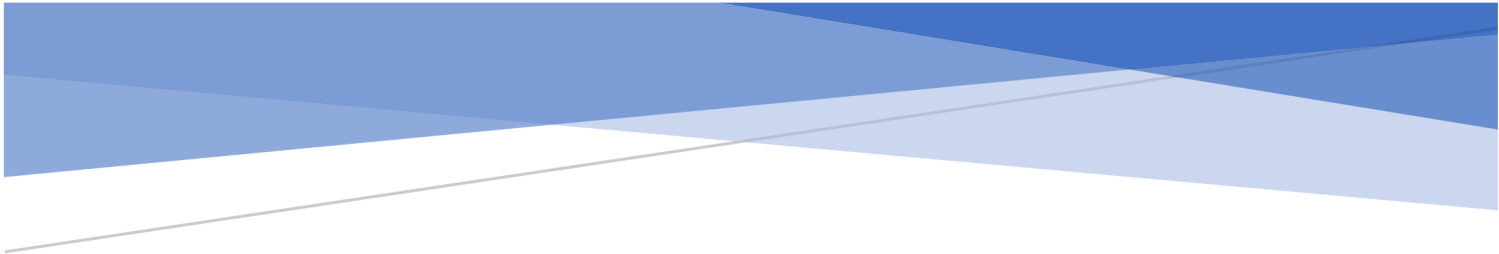
1. Produce routine solutions to typical electrical problems.
2. Relate and apply basic electrical theory to collected data.

STUDENT FEEDBACK FORM

This section details the *extent* to which the assessment criteria are demonstrated by you, which in turn determines your mark. The marks available for each category of skill 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.

Generic Assessment Criteria	Marks available	Marks awarded
1. Engagement with Literature Skills	15	9
Engagement with a wide range of literature sources, including sources retrieved independently. Generally sound referencing, with very few inaccuracies or inconsistencies.		
2. Knowledge and Understanding Skills	25	14.9
Task 1 achieved 67%. Task 2 achieved 40%, Task 3 achieved 57%. Task 4 achieved 75%. Knowledge of the basic underlying concepts and principles is accurate with a good understanding in most areas. Your work for Task 1 was very good and showed a good understanding but in the other tasks have made some mistakes in the calculation work and in some parts have discussed concepts that were not relative to the task.		
3. Cognitive and Intellectual Skills	15	8
Task 1 achieved 50%. Task 4 achieved 57%. Good evaluation of the underlying concepts and principles but were a little bit limited in the evaluation of Task 1.		
4. Practical Application Skills	35	28
Task 1 achieved 79%. Task 4 achieved 81%. An excellent application of practical work for Task 1 and 4, very good use of the test equipment to obtain all of the required results.		
5. Transferable Skills for Life and Professional Practice	10	7
Work is coherent, very fluent and is presented professionally. Excellent layout making the assignment easy to read.		

Assessment 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)		67%
	Up to 1 week late (40% Max)		
	Over 1 week late (0%)		



HNC ELECTRICAL/ELECTRONIC ENGINEERING, POWER SYSTEMS ENGINEERING & INSTRUMENTATION ENGINEERING

Electrical principles

Student: Sian Nunnery
Lecturer: Jason Pointer

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Introduction

Within this assignment will look at the key principles of electronic principles, through the means of theoretical and practical applications. This assignment will cover electrical principles, DC circuits, capacitors in DC circuits, magnetism, and AC circuit. This will be achieved in the form of research, practical, calculation and simulation software, which will support any data or information given. ✓

Task 1 – DC Circuits

Q1. Total Resistance

Construct the circuit and measure the total resistance (R_T) before connecting the power supply.

The results found from the total resistance before connecting the power supply were as follows;

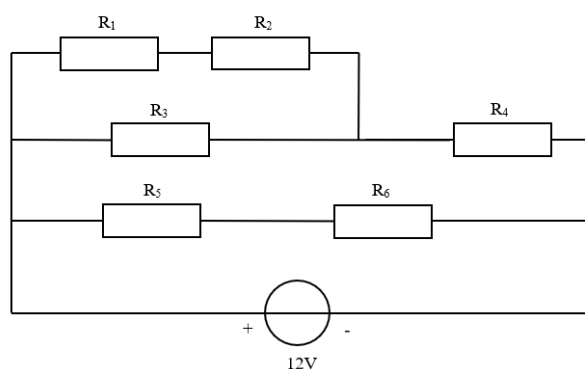
$$R_T = 384 \, \Omega$$

Q2. Circuit Results

The following result were recorded by using a multi-meter, from the constructed circuit, using the stated resistor sizes assigned for this task by the tutor.

R_T	384 Ω	
I	Ω	
	Voltage (V)	Current (mA)
R1	1.49	4.53
R2	2.56	4.53
R3	4.05	12.03
R4	7.86	16.86
R5	2.51	13.86
R6	9.4	13.86

Q2. Calculation



$$R_1 = 330\Omega \quad R_2 = 560\Omega \quad R_3 = 330\Omega \quad R_4 = 470\Omega \quad R_5 = 180\Omega \\ R_6 = 680\Omega$$

$$R_{12} = R_1 + R_2 \quad \checkmark$$

$$R_{12} = 330 + 560$$

$$R_{12} = 890 \, \Omega \quad \checkmark$$

$$R_{123} = \frac{R_{12} \times R_3}{R_{12} + R_3} \quad \checkmark$$

$$R_{123} = \frac{890 \times 330}{890 + 330}$$

$$R_{123} = 240.74 \, \Omega \quad \checkmark$$

$$R_{1234} = R_{123} + R_4$$

$$R_{1234} = 270.74 + 470$$

$$R_{1234} = 710.74 \, \Omega$$

$$R_{56} = R_5 + R_6 \quad \checkmark$$

$$R_{56} = 180 + 680$$

$$R_{56} = 860 \, \Omega \quad \checkmark$$

$$R_T = \frac{R_{1234} \times R_{56}}{R_{1234} + R_{56}} \quad \checkmark$$

$$R_T = \frac{710.74 \times 860}{710.74 + 860}$$

$$R_T = 389.14 \, \Omega \quad \checkmark$$

$$I = \frac{V}{R_T} \quad \checkmark$$

$$I = \frac{12}{389.14}$$

$$I = 30.84 \, \text{mA} \quad \checkmark$$

$$I_5 = I_6 = \frac{V}{R_{56}} = \frac{12}{860} = 13.95 \, \text{mA} \quad \checkmark$$

$$V_5 = I_5 \times R_5 \quad \checkmark$$

$$V_5 = 13.95 \times 180$$

$$V_5 = 2.51 \, \text{V} \quad \checkmark$$

$$V_6 = I_6 \times R_6 \checkmark$$

$$V_6 = 13.95 \times 680$$

$$V_6 = 9.49V \checkmark$$

$$I_4 = \frac{V}{R_{1234}} = \frac{12}{710.74} = 16.88mA \checkmark$$

$$V_4 = I_4 \times R_4 \checkmark$$

$$V_4 = 16.88 \times 470$$

$$V_4 = 7.93V \checkmark$$

$$V_3 = V - V_4 \checkmark$$

$$V_3 = 12 - 7.93$$

$$V_3 = 4.07V \checkmark$$

$$I_3 = \frac{V_3}{R_{12}} = \frac{4.07}{330} = 12.33mA \checkmark$$

$$I_1 = I_2 = \frac{V_3}{R_{12}} = \frac{4.07}{890} = 4.57mA \checkmark$$

$$V_1 = I_1 \times R_1 \checkmark$$

$$V_1 = 4.57 \times 330$$

$$V_1 = 1.51V \checkmark$$

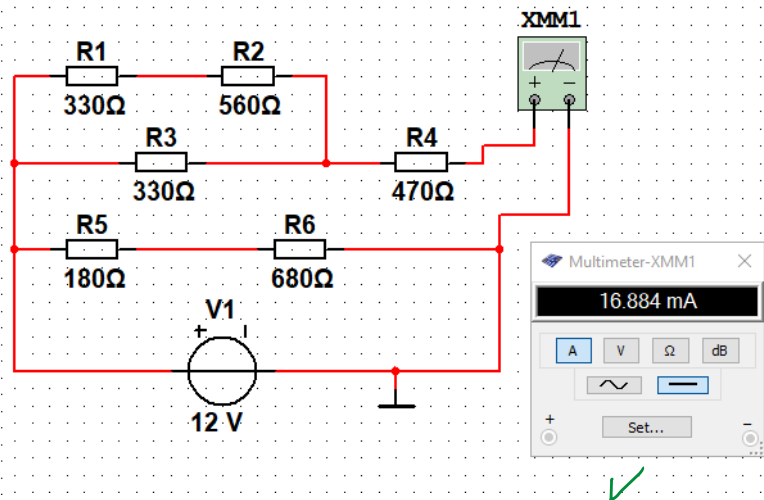
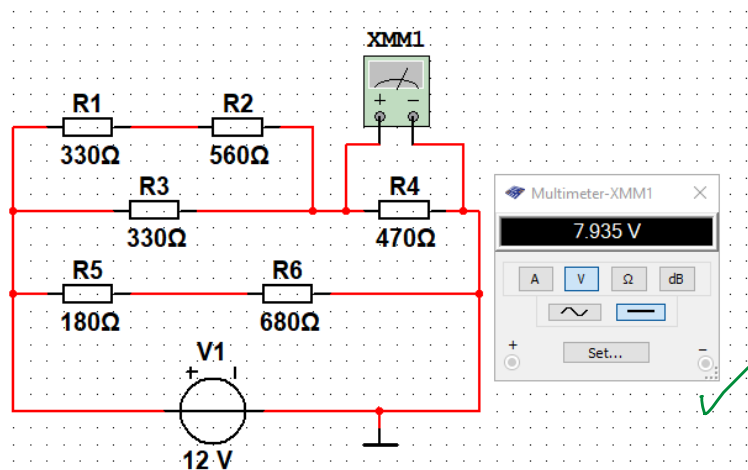
$$V_2 = I_2 \times R_2 \checkmark$$

$$V_2 = 4.57 \times 560$$

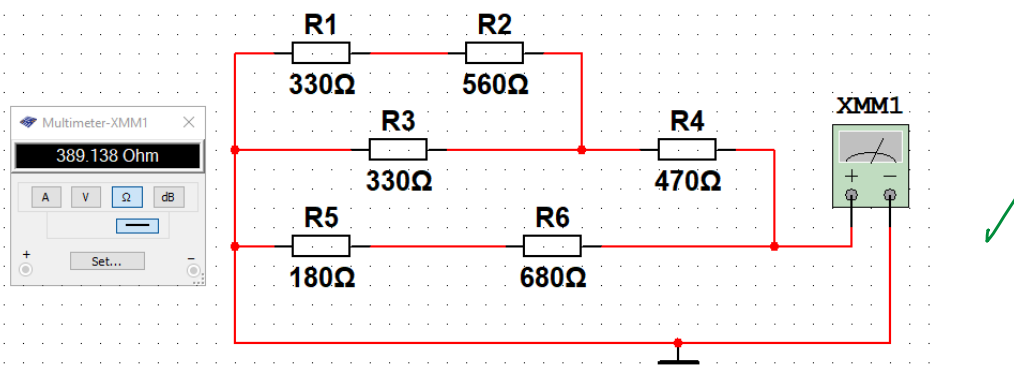
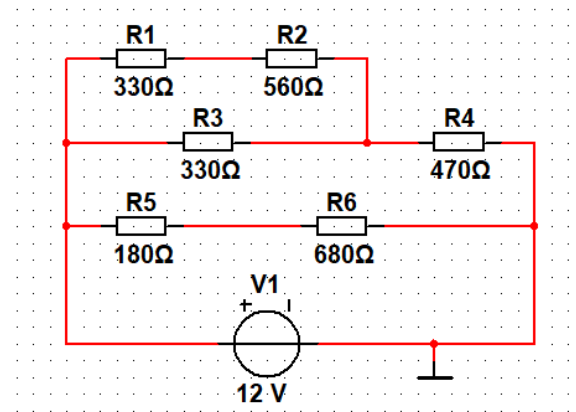
$$V_2 = 2.56V \checkmark$$

Very well done , excellent presentation .

Q4. Multisim Results



	Multisim
RT	389.14Ω
V1	1.51V
I1	4.57mA
V2	2.56V
I2	4.57mA
V3	4.07V
I3	12.32mA
V4	7.94V
I4	16.88mA
V5	2.51V
I5	13.95mA
V6	9.49V
I6	13.95mA



Q5. Comparing Results

The following table are the overall results either calculated, simulated, or taken via a multi-meter from a constructed circuit. By putting them in the format allows to make a clear comparison between each set of results.

	Measured	Multisim	Calculated
RT	384 Ω	389.14 Ω	389.14 Ω
I	30.83mA	30.84mA	30.84mA
V1	1.49V	1.51V	1.51V
I1	4.53mA	4.57mA	4.57mA
V2	2.56V	2.56V	2.56V
I2	4.53mA	4.57mA	4.57mA
V3	4.05V	4.07V	4.07V
I3	12.03mA	12.32mA	12.33mA
V4	7.86V	7.94V	7.93V
I4	16.86mA	16.88mA	16.88mA
V5	2.51V	2.51V	2.51V
I5	13.86mA	13.95mA	13.95mA
V6	9.4V	9.49V	9.49V
I6	13.88mA	13.95mA	13.95mA

✓ Good.

From these results you can see that there were not many variances, and there are only minor. The multisim results in comparison to the calculated results is only a difference of 0.01, these variations might be down to the rounding of the calculated results which may give the slight difference between these two sets of results. The reasoning of these two results being close is that multisim is a simulation software and gives you a theoretical result, similarly to the calculated results, these are both theoretical. ✓

There are further variations with the measured results from the practical aspect of this task of physical construction of the circuit. There are a few aspects to consider that might be the cause, the multi-meter may not be calibrated or might be low in battery which can have an effect on the readings that it gives. ✓ Another factor could be the resistors might not have

been slotted properly into the breadboard not having a permanent fixing. But overall, these variations are minor from the overall outcome of the results. ✓ *There are other factors to consider.* Kirchhoff's Current (1st) Law "states that current flowing into a node (or a junction) must be equal to current flowing out of it. This is a consequence of charge conservation." (Isaac Physics, n.d.) → *Need to state how the theory relates to your results.*

Task 2 – Capacitors

Q1. Explain the construction and function of a capacitor, listing some of the different types that are available and typical values. Include methods that could be used to alter the value of the capacitor.

Capacitors are made up of two plates, these two plates do not touch. The plates are separated by a small distance with an insulating material known as a dielectric. The plates are usually made up of either aluminium, brass, or copper. The space between the two plates is filled with a non-conductive material or an electric insulator or dielectric. The two plates within a capacitor are good conductors, these easily pass electrical current through them, these can also hold the electric charge. Storing an electric charge is the main use of a capacitor when a voltage is applied. Capacitors have the capacity to store a set quantity of static electricity. Hence why there are variety of capacitors to use, they also can be with different units such as microfarads, nano-farads and picofarads. The symbol used to show a capacitor in a circuit is shown in figure 3. ✓



Capacitor ✓

Figure 3

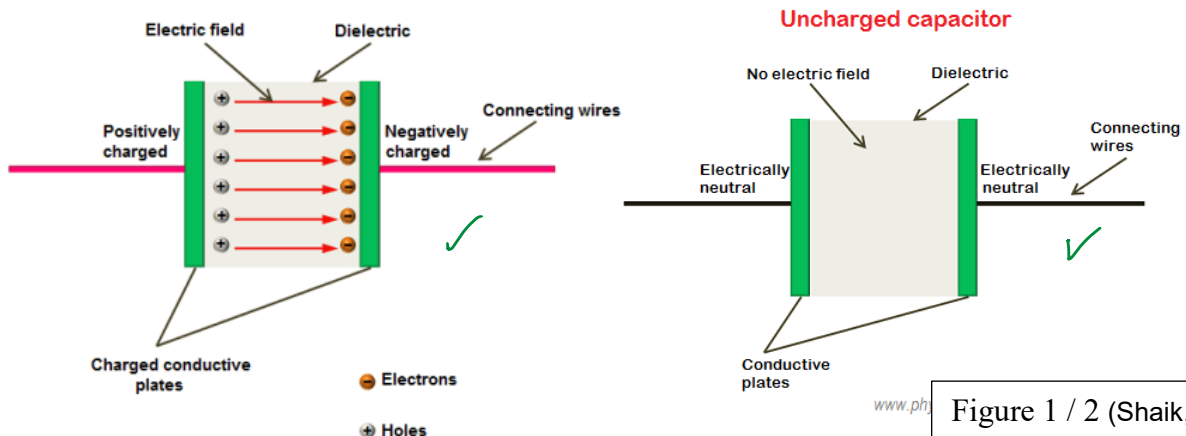


Figure 1 / 2 (Shaik, n.d.)

Where,

Q is the charge stored in a capacitor

C is the capacitance of a capacitor

V is the voltage applied to a capacitor

$$Q = CV \quad C = \frac{Q}{V} \quad V = \frac{Q}{C}$$

These equations do not change the value of the capacitance $\Rightarrow C = \frac{\epsilon_0 \epsilon_r A}{d}$

By using these equations, you are able to alter the value of the capacitance.

Could have talked about some of different types and their values.

Q2.

a) The equivalent circuit capacitance

should include a copy of the circuit,

$$C_{23} = C_2 + C_3 = 22 + 43 = 65 \mu\text{F}$$

$$C_{123} = \frac{C_1 C_{23}}{C_1 + C_{23}} = \frac{27 \times 65}{27 + 65} = \frac{1755}{92} = 19.076 \mu\text{F}$$

$$C_T = C_{123} + C_4 = 19.076 + 1.5 = 20.576 \mu\text{F}$$

b) The total charge

$$Q_T = C_T \times V$$

$$Q_T = (20.576 \times 10^{-6}) \times 30$$

$$Q_T = 617.28 \times 10^{-6} \text{C} = 617.28 \mu\text{C}$$

c) The charge in each capacitor

$$Q_4 = C_4 \times V = (1.5 \times 10^{-6}) \times 30 = 45 \mu\text{C}$$

$$Q_{123} = C_{123} \times V$$

$$Q_{123} = 19.076 \times 10^{-6} \times 30 = 572.28 \mu\text{C}$$

$$\text{So } Q_1 = Q_{123} \text{ as it is in series } Q_1 = 572.28 \mu\text{C}$$

$$\text{So } V_1 = \frac{Q_1}{C_1} = \frac{572.28}{27} = 21.19 \text{ V}$$

$$V_{23} = \frac{Q_1}{C_{23}} = \frac{572.28}{65} = 8.80 \text{ V}$$

$$Q_2 = C_2 \times V_{23} = 22 \times 8.80 = 193.6 \mu\text{C}$$

Correct method wrong number

$$Q_3 = C_3 \times V_{23} = 43 \times \underline{12.46} = 535.78 \mu\text{C} \quad \times$$

d) The total energy stored in the circuit

$$W = \frac{1}{2} CV^2$$

$$W_1 = \frac{1}{2} C_1 V_1^2 = \frac{1}{2} \times (27 \times 10^{-6}) \times \underline{30}^2 = 12150 \times 10^{-6} \text{J} \quad \times$$

$$W_2 = \frac{1}{2} C_2 V_{23}^2 = \frac{1}{2} \times (22 \times 10^{-6}) \times \underline{12.46}^2 = 1707.7676 \times 10^{-6} \text{J} \quad \times$$

$$W_3 = \frac{1}{2} C_3 V_{23}^2 = \frac{1}{2} \times (43 \times 10^{-6}) \times \underline{12.46}^2 = 3337.9094 \times 10^{-6} \text{J} \quad \times$$

$$W_4 = \frac{1}{2} C_4 V^2 = \frac{1}{2} \times (1.5 \times 10^{-6}) \times 30^2 = 675 \times 10^{-6} \text{J} \quad \checkmark$$

e) The total energy stored in the circuit

$$W_T = \frac{1}{2} C_T V^2 \checkmark = \frac{1}{2} \times (20.576 \times 10^{-6}) \times 30^2 = 9259.2 \times 10^{-6} \text{J} \quad \checkmark$$

$= 9.259 \text{ mJ}$

Task 3 – Magnetism

Q1. Explain the principles of permanent magnets including the distribution of magnetic fields.

A permanent magnet is made up of materials (such as nickel or iron) where a magnetic field is produced, this is because of the internal structure of the magnet. A magnet is made up of atoms where the electrons and nucleus act similarly to the magnet itself. A permanent magnet has an absence of current or inducing field keeps its magnetic properties, similarly a permanent magnet produces its own magnetic field, therefore can not be turned off. As Robertson, C (2008, p.111) states "Ferromagnetic materials, all of which exhibit very strong magnetic effects." One of the advantages of a permanent magnet is exhibiting a strong magnetic field, permanent magnets also have the ability to maintain a strong magnetic field over a long period of time with no persistent energy. ✓

His work in electrical and electronic pinciples John Bird explains that "The distribution of a magnet field can be investigated by using some iron filings. A bar magnet is placed on a flat surface covered by, say cardboard, upon which is sprinkled some iron filings. If a number of magnets of different strengths are used, it is found that the stronger the field the closer are the lines of magnetic flux and vice versa. Thus, a magnetic field has the property of exerting a force, the strength of the magnetic field decreases as we move away from the magnet." ✓

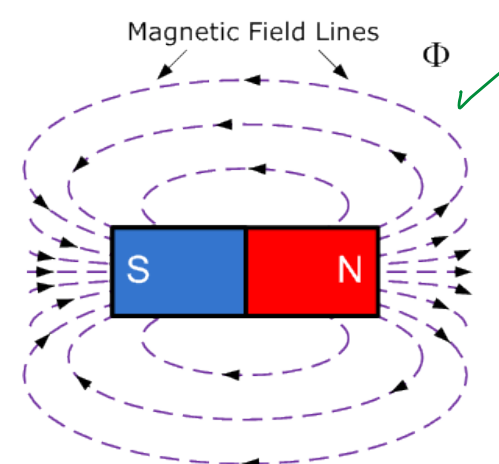
(2007, p.72) From this statement it is evident that the lines of a magnetic flux do not

physically exist, and that they were imagined by Michael Faraday to allow visualisation of the magnetic field distribution.

Magnets have a north and south pole, when two of the same poles are put together, they repel but opposite poles attract each other. Figure 4 illustrates that the space that surround the magnet and the line that radiate from north to south pole do not cross. The line of flux which appears from the N-pole of the magnet pass back the surrounding space to the S-pole. ✓

How do the fields react with each other?

Figure 4 (Electromagnetism. n.d.)



Q2. Solve the following problems:

a) A magnetic pole face has a rectangular section having dimensions 220mm by 120mm. If the total flux emerging from the pole is 130μWb, calculate the flux density.

$$a = 220 \times 120 = 26400\text{mm}^2$$

$$a = 26400\text{mm} = 26.4\text{m}^2$$

$$B = \frac{\Phi}{a} = \frac{130 \times 10^{-6}}{26.4} = 4.92 \times 10^{-6} \text{ T}$$

b) The maximum working flux density of a lifting electromagnet is 1.9T and the effective area of a pole face is circular in cross-section. If the total magnetic flux produced is 611mWb determine the radius of the pole face.

$$B = 1.9\text{T}$$

$$\Phi = 611\text{mWb} = 611 \times 10^{-3}$$

$$a = \frac{\Phi}{B} = \frac{611 \times 10^{-3}}{1.9} = 0.32\text{m}^2$$

$$r = \sqrt{\frac{a}{\pi}} = \sqrt{\frac{0.32}{\pi}} = 0.32\text{m}$$

Q3. Explain the principle operation and construction of an electromagnet including the distribution of magnetic fields.

The operation and construction of an electromagnet works where a coil of wire (copper) is wound around a magnetically soft material such as an iron core, this acts as a conductor, then a current is applied and passes through the wire creates a magnetic field. The magnetic field only exists when there is a current applied to it, if the current is switched off then the magnetic field does not exist.

As Bird, J (2008) points out 'The magnetic flux produced has the same properties as the flux produced by a permanent magnet', the strength of an electromagnet can be changed by the amount of electric current flowing through it, this is the same for a permanent magnet.

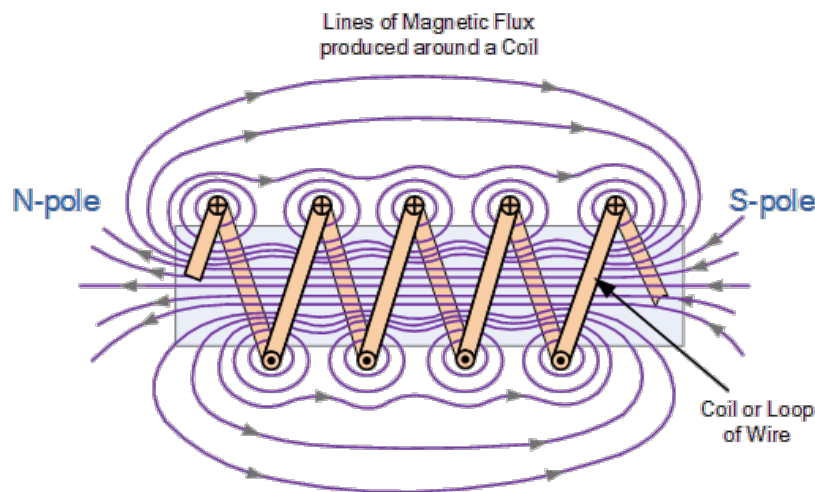


Figure 5 shows an electromagnet including the lines of magnetic flux produced around the coil.

Figure 5 (The Electromagnet, n.d.)

When a conductor such as Iron carries a current, it produces a magnetic field. The direction of the magnetic field is dependant of the current direction, in other words is perpendicular to the wire. If the direction of the current is reversed, this means the lines of flux direction is also reversed. Magnetic flux extends the entire length of a conductor. Flux means the action of flow. The flux pattern extends outwards with concentric circles.

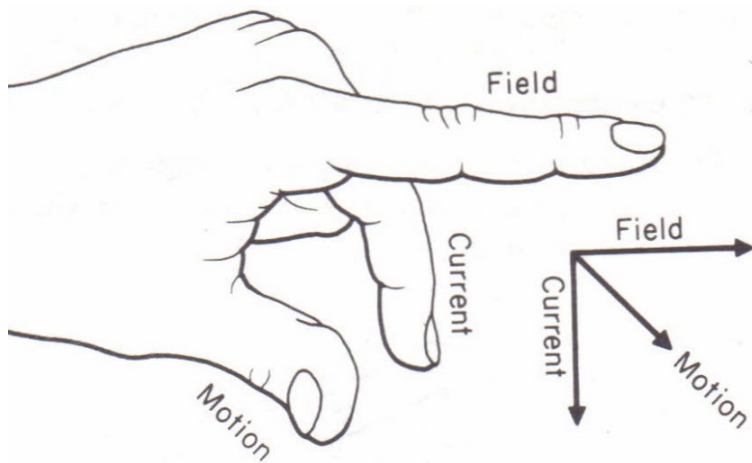
Magnetic fields can be represented by magnetic field line, the properties of this are:

- “ - The field is tangent to the magnetic field line
- Field strength is proportional to the line density.
- Field lines cannot cross.
- Field lines are continuous loops ”

(Magnetic Fields and Magnetic Field Lines | Physics, n.d.)

One of the rules the represent electromagnetism is Flemings left hand rule, also known as the motor rule, this can be used to determine the direction of force exerted by a conductor. In his work in electromagnetism John Bird states “Let the thumb, first finger and second finger of the left hand be extended such that they are all right angles to each other, if the first finger points in the direction of the magnetic field, the second finger points in the direction of the current, then the thumb will point in the direction of the motion of the conductor.”

This is used to show the motion of a conductor in a magnetic field.



To summarise figure 6 demonstrates this rule.

First finger – Field

SeCond finger – Current

ThuMb - Motion

Figure 6 (The Electromagnet, n.d.)

When a conductor is moved across a magnetic field, cutting through the lines of flux the emf is produced in the conductor. The conductor forms part of a closed circuit then the emf will cause the current to flow round the circuit, this is 'electromagnetic induction. Faradays law of electromagnetic inductions explains the electric circuit and magnetic field. Faradays law has two crucial parts which are;

1. The value of electromotive force (emf) induced in a circuit o conductor is directly proportional to the rate if change of magnetic flux linking with it.
2. The polarity of such an emf, induced by an increasing flux, is opposite to that induced by a decreasing flux.

You are stating a concept that do not affect electromagnetics

Q4. A transformer is a device that uses some of the principles associated with electromagnetism. Explain the operation and construction of transformer, include methods to reduce power loss within the transformer.

A transformer is where is take an input current and then steps the current down. For example, this is used where electricity from the main grid is stepped down via a transformer in a substation to a safer value for a house, e.g. 230 ✓ *What about voltage?*

Transformer are made up of two coils; a primary and secondary, which are wound on an iron core. This iron core is made up of laminations (usually about 0.3mm thickness).

Reduced power losses within the transformer is caused by either I^2R loses, Eddy current loss, hysteresis loss or a transformer loss. I^2R loses is where the copper windings cause a heat loss when the current is flowing. Eddy current loses is caused by the alternating current

that are induced magnetically in the core, this is reduced by laminating. Hysteresis loss is an energy loss due to the changing magnetism in the core. ✓

To reduce loss of power, you need to remove the heat generated in the transformer. On small scale transformers that have small rating natural air cooling is enough. However, on larger scales where the transformer has a higher rating, they need to have a cooling system in place. To cool transformers down you can immerse the transformer in oil within a tank, the oil will assist in helping to remove the heat by natural convection or by forced circulation via an external pump. Other methods to cool transformers are via fans, this helps circulate air around the transformer to assist in cooling the transformer down. ✓

*Need more detail explaining the operation.
Also include a diagram*

Q5. Solve the following problems:

a) A 700-turn coil of inductance 2.5H carries a current of 1.6A. Calculate the flux linking the coil and the e.m.f. induced in the coil when the current collapses to zero in 20ms.

$N=700$ turns $L=2.5\text{H}$ $I=1.6\text{A}$ $dt=20\text{ms}$

$$\Phi = \frac{L \times I}{N} = \frac{2.5 \times 1.6}{700} = 5.71\text{mWb} \quad \checkmark$$

$$e = \frac{Nd\Phi}{dt} = \frac{700 \times 5.71 \times 10^{-3}}{20 \times 10^{-3}} = 199.85\text{V} \quad \checkmark$$

b) A rectangular coil of sides 10cm and 6cm is rotated in a magnetic field of flux density 1.2T, the longer side of the coil actually cutting this flux. The coil is made up of 70 turns and rotates at 1200rev/min.

(i) Calculate the maximum generated e.m.f.

$N=70$ turns $B=1.2\text{T}$ $L=10\text{cm}=0.1\text{m}$

$V=1200\text{rev/min}$

$$V = \omega r = \left(\frac{1200 \times 2\pi}{60} \right) \times \left(\frac{0.06}{2} \right) = 3.77\text{m/s} \quad \checkmark$$

$$E = 2NB\ell V \sin\theta \quad \checkmark$$

$$E = 2 \times 70 \times 1.2 \times 0.1 \times 3.77 \times \sin 90 \quad \checkmark$$

$$E = 63.336\text{V} \quad \checkmark$$

(ii) If the coil generates 80V, at what speed will the coil rotate?

E = 80V

$$V = \frac{E}{2NBl} = \frac{80}{2 \times 70 \times 1.2 \times 0.1} = 4.76 \text{ m/s}$$

$$V = \frac{V \times 60}{2\pi} = \frac{4.76 \times 60}{2\pi} \times \frac{2}{0.06} = 1515.16 \text{ rev/min}$$

Task 4 – AC Circuits

Q1. Using the oscilloscope measurements for a sine wave stated in table 3 perform the following calculations

a) Peak voltage

$$V_p = \frac{5 \times 4.8}{2} = 12 \text{ V}$$

b) Frequency

$$F = \frac{1}{T} = \frac{1}{24 \times 10^{-3}} = 41.6 \text{ Hz}$$

$$T = 5 \times 4.8 = 24$$

c) Average voltage

$$V_{av} = 0.637 \times V_p = 0.637 \times 12 = 7.644 \text{ V}$$

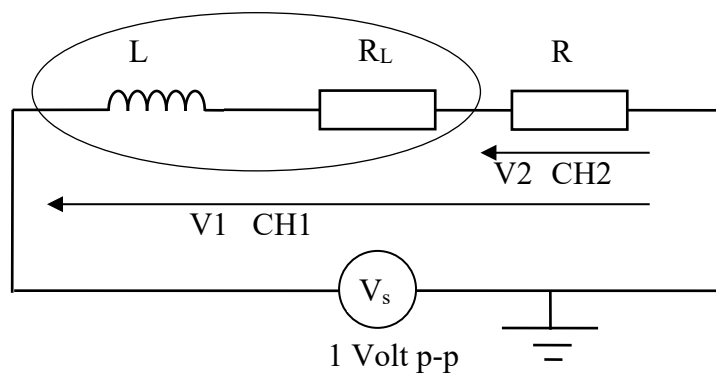
d) Root mean square (rms) voltage.

$$V_{rms} = \frac{V_p}{\sqrt{2}} = \frac{12}{\sqrt{2}} = 8.485 \text{ V}$$

Table 3 – values for Task 4

Student Number	Oscilloscope Settings		Grid Spacing	
	Volts/Div	Timebase (ms/Div)	Vertical (peak to peak)	Horizontal (1 cycle)
1	5	20	6.8	4
2	2	20	7.2	4.4
3	2	10	7.8	4.4
4	5	10	5.4	4.6
5	5	5	4.8	4.8
6	2	5	6.6	4
7	2	20	5.2	5.2

Q2. Below is a RL circuit:



$L = 1\text{mH}$, $R = 18\Omega$, $R_L = ?\Omega$ (measure this value)

Q3. Measure and record the value of each of the component.

$L = 0.98\text{mH}$ $R = 18.97\Omega$ $R_L = 2.63\Omega$ ✓

Q4. Produce a table of measurements as shown below:

$L = 0.98\text{mH}$ $R = 18.97\Omega$ $R_L = 2.63\Omega$

Frequency (f) (kHz)	CH1 (V) pk to pk Voltage	CH2 (V) pk to pk Voltage	Time Difference (between peaks) (T2-T1)	Calculated values		
				Time for 1 cycle (T) =1/f	Fraction of cycle (T2-T1)/T	Phase Angle (°) (fraction x 360)
1	1	0.67	37.0	1.000	0.037	13.32
2	1	0.77	36.3	0.500	0.0726	26.136
3	1	0.82	33.2	0.333	0.0996	35.856
4	1	0.86	30.2	0.250	0.1208	43.488
5	1	0.90	27.9	0.200	0.1395	50.22
6	1	0.94	26.3	0.167	0.1578	56.808
7	1	0.95	23.9	0.143	0.1673	60.228
8	1	0.97	22.7	0.125	0.1816	65.376
9	1	0.95	19.5	0.111	0.1755	63.18

Q5. Produce a table of calculations as shown below:

$L = 0.98\text{mH}$ $R = 18.97\Omega$ $R_L = 2.63\Omega$

Frequency (f - kHz)	Reactance $X_L (\Omega)$ ($2\pi fL$)	Total Resistance R_T ($R + R_L$)	Impedance $Z (\Omega)$	Current (mA)	Phase Angle ($^\circ$)
1	6.16	21.6	22.46	44.52	15.91
2	12.32	21.6	24.86	40.22	29.69
3	18.47	21.6	28.42	35.18	40.54
4	24.63	21.6	32.76	30.53	48.75
5	30.79	21.6	37.61	26.59	54.95
6	36.95	21.6	42.80	23.37	59.69
7	43.10	21.6	48.21	20.74	63.38
8	49.26	21.6	53.79	18.59	66.32
9	55.42 ✓	21.6 ✓	59.48 ✓	16.81 ✓	68.71 ✓

Show clearly **one full example of your method** for calculating for $X_L (\Omega)$, $Z (\Omega)$, Current (A) and Phase Angle ($^\circ$) for a chosen frequency.

Frequency – 1

$$\text{Reactance} = X_L = 2\pi fL = 2 \times \pi \times 1 \times 0.98 = 6.16\Omega \quad \checkmark$$

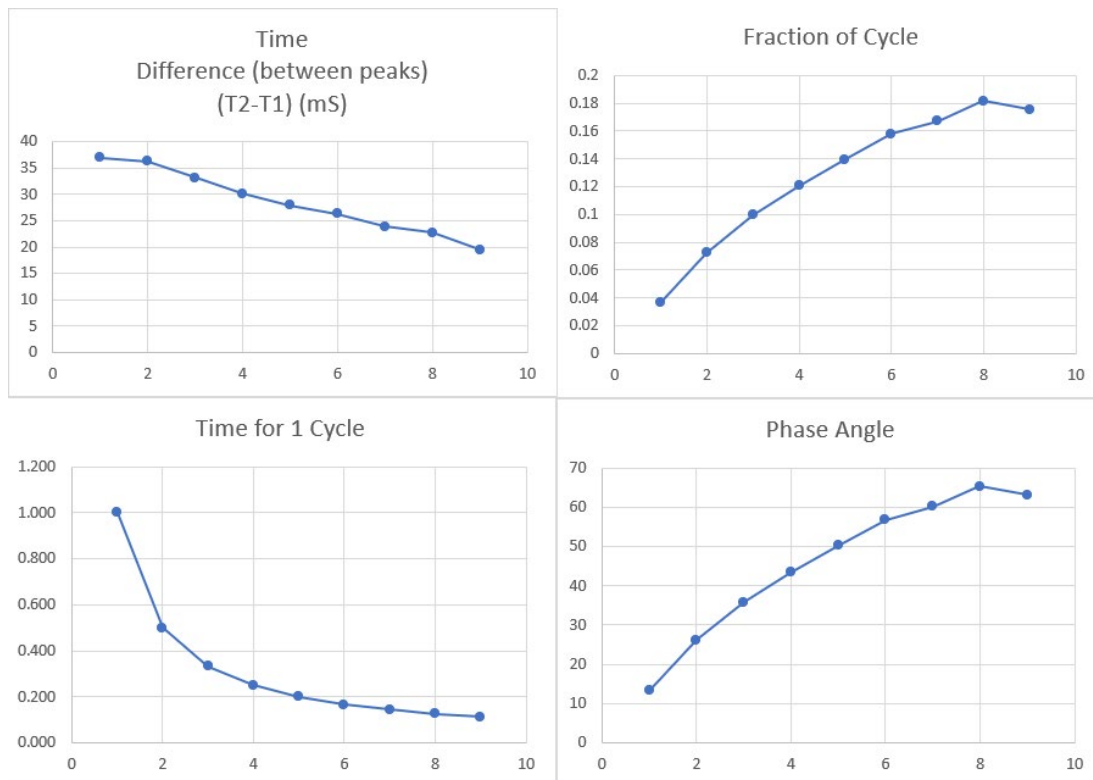
$$\text{Total Resistance} = R_T = R + R_L = 18.97 + 2.63 = 21.6\Omega \quad \checkmark$$

$$\text{Impedance} = Z = \sqrt{R_T^2 + X_L^2} = \sqrt{21.6^2 + 6.16^2} = 22.46\Omega \quad \checkmark$$

$$\text{Current} = I = \frac{V}{Z} = \frac{1000}{22.46} = 44.52\text{mA} \quad \checkmark$$

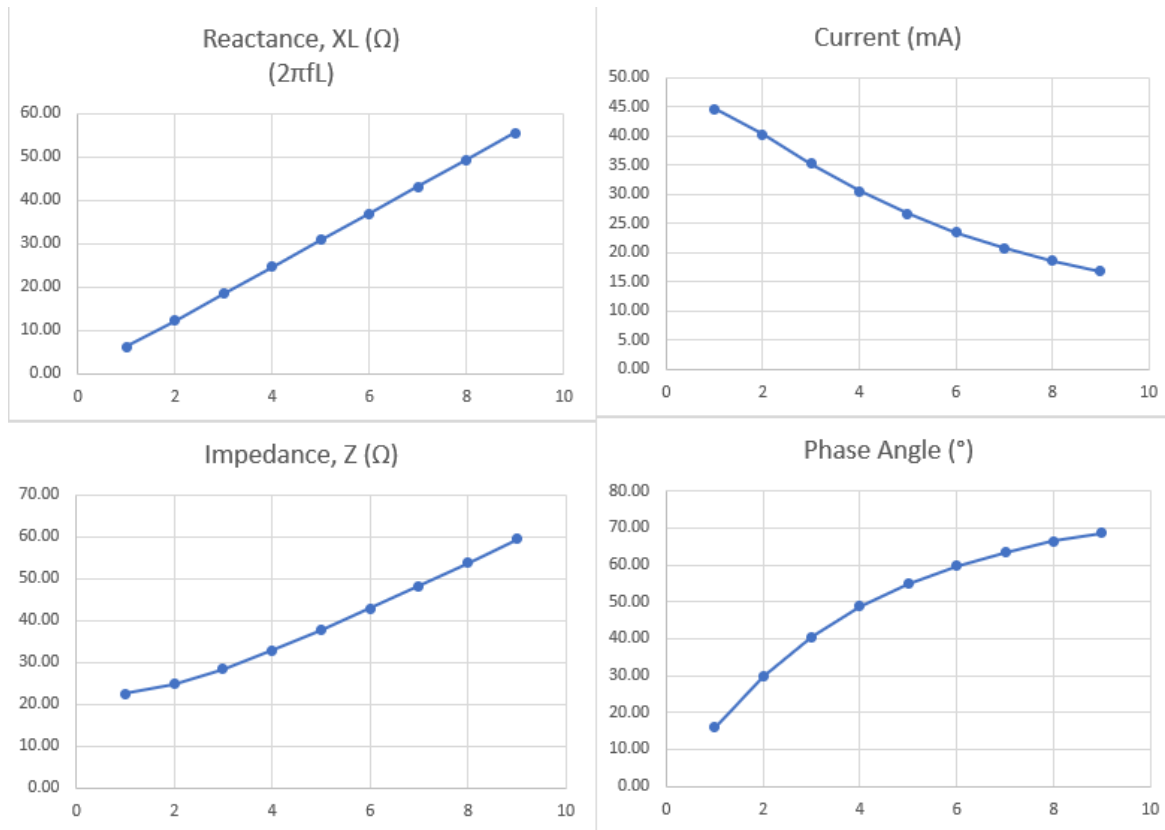
$$\text{Phase Angle} = \theta = \tan^{-1} \frac{6.16}{21.6} = 15.91^\circ \quad \checkmark$$

Q6. Comment on the practical and calculation results, discussing any variations when comparing these results.



From the calculated results it is visible that when the frequency increases the reactance, impedance, and phase angle increases, whereas the current decreases.

As the frequency increases the time different between peaks and the time for one cycle decreases, whereas the phase angle increases as well as the fraction of cycle. ✓



In an AC Circuit, when there is an increase in frequency there is a decrease in current this is due to that reactance is inversely proportional to current. As frequency increases, reactance also increases as these are proportional to each other, which then decreases the current through the load, this is due to the resistance in reactance and impedance. The inductance and reactance are proportional to each other. Also, the impedance is inversely proportional to the current. Reactance is directly proportional to the frequency and impedance. Therefore, from this we can see this reflection in the practical and this is visible through the means of graphs displayed, this shows a change in reactance as the frequency increases. Through the practical results there are some values that are higher or lower than what would be predicted, this is due to human error, this could be when setting up the equipment, such as when setting the values for the amplifier, the time base variable. This could also be due to when adjusting the X or Y shift, these are used when taking measurements for peak-peak voltage, amplitude (Y-axis) or time-period (X-axis), this error is due to human error, as there will always be an error in judgement when setting and adjusting these readings. ✓

A good attempt, in some of the tasks you made a few calculation errors.
There is also a need to make sure you relate the theory to the correct concepts.

References

Electromagnetism. n.d. [online] Available at: <<https://www.electronics-tutorials.ws/electromagnetism/magnetism.html>> [Accessed 29 December 2020].

Electrical Apprentice. n.d. *The Basic Principles Of Electromagnetism*. [online] Available at: <<https://electricalapprentice.co.uk/the-basic-principles-of-electromagnetism/>> [Accessed 29 December 2020].

Courses.lumenlearning.com. n.d. *Magnetic Fields And Magnetic Field Lines | Physics*. [online] Available at: <<https://courses.lumenlearning.com/physics/chapter/22-3-magnetic-fields-and-magnetic-field-lines/>> [Accessed 30 December 2020].

Bird, J., 2007. *Electrical and Electronic Principles and Technology*. 3rd ed. The Netherlands: Elsevier Ltd.

Robertson, C., 2008. *Fundamental Electrical And Electronic Principles*. 3rd ed. Slovenia: Elsevier Ltd.

Electronics Tutorials. n.d. *The Electromagnet*. [online] Available at: <<https://www.electronics-tutorials.ws/electromagnetism/electromagnets.html>> [Accessed 30 December 2020].

Isaac Physics. n.d. *Isaac Physics*. [online] Available at: <https://isaacphysics.org/concepts/cp_kirchhoffs_laws> [Accessed 6 November 2020].

Shaik, A., n.d. *Capacitor - Construction And Working*. [online] Physics-and-radio-electronics.com. Available at: <<https://www.physics-and-radio-electronics.com/electronic-devices-and-circuits/passive-components/capacitors/capacitorconstructionandworking.html#:~:text=The%20construction%20of%20capacitor%20is%20very%20simple.%20A,a%20capacitor%20is%20separated%20by%20a%20small%20distance>> [Accessed 20 November 2020].

Bibliography

ELECTRICAL TECHNOLOGY. n.d. *In Inductive Circuit, Why Current Increases When Frequency Decreases?*. [online] Available at:

<<https://www.electricaltechnology.org/2019/09/inductive-circuit-current-increases-frequency-decreases.html>>.

Electromagnetism. n.d. [online] Available at: <<https://www.electronicstutorials.ws/electromagnetism/magnetism.html>> [Accessed 29 December 2020].

Bird, J., 2007. *Electrical and Electronic Principles and Technology*. 3rd ed. The Netherlands: Elsevier Ltd.

Robertson, C., 2008. *Fundamental Electrical And Electronic Principles*. 3rd ed. Slovenia: Elsevier Ltd.

Shaik, A., n.d. *Capacitor - Construction And Working*. [online] Physics-and-radio-electronics.com. Available at: <<https://www.physics-and-radio-electronics.com/electronic-devices-and-circuits/passive-components/capacitors/capacitorconstructionandworking.html#:~:text=The%20construction%20of%20capacitor%20is%20very%20simple.%20A,a%20capacitor%20is%20separated%20by%20a%20small%20distance>> [Accessed 20 November 2020].

Electrical Apprentice. n.d. *The Basic Principles Of Electromagnetism*. [online] Available at: <<https://electricalapprentice.co.uk/the-basic-principles-of-electromagnetism/>> [Accessed 29 December 2020].

Dictionary, M., n.d. *Permanent Magnet - Maglab*. [online] Nationalmaglab.org. Available at: <<https://nationalmaglab.org/about/maglab-dictionary/permanent-magnet#:~:text=Permanent%20magnets%20are%20materials%20where,structure%20of%20the%20material%20itself.&text=But%20in%20certain%20materials%2C%20called,normal%20iron%2C%20cobalt%2C%20nickel.>> [Accessed 29 December 2020].

Courses.lumenlearning.com. n.d. *Magnetic Fields And Magnetic Field Lines* | *Physics*.
[online] Available at: <<https://courses.lumenlearning.com/physics/chapter/22-3-magnetic-fields-and-magnetic-field-lines/>> [Accessed 30 December 2020]. ✓