

LEVEL 4 ASSESSMENT SPECIFICATION

Student name:	Charlie Malloy	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:	Nigel Richards
Assignment Title:	Electrical Principles	Word count (or equivalent):	2000
Submission deadline:	15/01/25	Return date of provisional marks & written feedback:	29/01/25
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: Work which is submitted up to 1 week late will be capped at 40% for the first attempt and will be awarded a mark of 0% for re-assessment. Late submission penalties may be lifted only if there is an approved extenuating circumstances claim. Work submitted more than 1 week late will be considered as a non-submission and will not be marked. The work may be considered as a submission for reassessment if offered by an Examining Board or if there is an approved extenuating circumstances claim.		
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	10	5
Poor engagement with essential reading, no textbooks listed have only included web sites. No evidence of wider reading and reliance on inappropriate sources. Inconsistent and weak use of referencing, no direct quotes.		
2. Knowledge and Understanding Skills	40	26.1
Task 1 achieved 65%. Task 2 achieved 78%, Task 3 achieved 57%. Task 4 achieved 61%. Generally competent knowledge of the basic underlying concepts and principles of the work required for subjects covered in each task. Showed a very good understanding of the calculated requirements and design work.		
3. Cognitive and Intellectual Skills	10	4.5
Task 1 achieved 53%. Task 4 achieved 38%. Limited attempt at evaluation of the underlying concepts and principles for Task 1 and 4, tending towards description.		
4. Practical Application Skills	30	25.1
Task 1 achieved 84%. Task 4 achieved 83%. 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)		68%
	Up to 1 week late (40% Max)		
	Over 1 week late (0%)		

TASK DESCRIPTION

Introduction

The aim of this assignment is to develop an understanding of the fundamentals of electrical principles through theoretical and practical applications. The assignment will cover the following areas of Electrical Principles – DC circuits, Capacitors in DC circuits, magnetism and AC circuits. This will be achieved through a range of practical, calculation and research work.

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Task 1 – DC Circuits

Figure 1 below shows a combinational arrangement of a DC circuit.

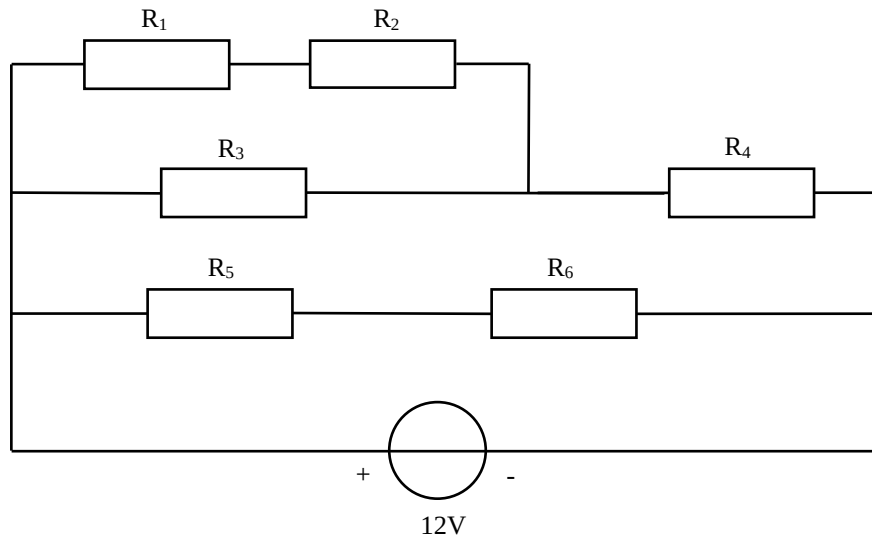


Figure 1 – Resistors in Series/Parallel

To complete the activities for this task you will be given a student number which relates to the resistor values for the combinational circuit. Table 1 shows the student numbers and resistor values.

Table 1 – values for Task 1

Student Number	R_1 (Ω)	R_2 (Ω)	R_3 (Ω)	R_4 (Ω)	R_5 ($k\Omega$)	R_6 (Ω)
1	680	330	330	560	1	270
2	560	180	220	470	1.2	390
3	680	220	330	470	1.5	220
4	560	330	220	680	1.8	270
5	680	180	330	560	1	330
6	560	270	220	680	1.2	180
7	680	220	330	560	1.5	220
8	680	180	220	470	1.8	330
9	680	180	270	560	1	270
10	560	220	390	680	1.2	330
11	680	330	270	560	1.5	180
12	560	180	390	470	1.8	390

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

$$485\Omega$$

- Connect a 12V supply and measure the p.d. value across each resistor, the supply current and the current in each resistor.

$$V_1 = 2.68V$$

$$V_2 = 0.70V$$

$$V_3 = 3.38V$$

$$V_4 = 8.99V$$

$$V_5 = 10.46V$$

$$V_6 = 1.91V$$

$$I = 25.5mA$$

$$I_1 = I_2 = 3.93mA$$

$$I_3 = 15.35mA$$

$$I_4 = 18.55mA$$

$$I_5 = I_6 = 5.64mA$$

Must be written
in past tense

- Calculate the

- total resistance, R_T

$$R_T = \frac{\left(\frac{R_1 + R_2}{R_3}\right) + R_4}{R_5 + R_6}$$

$$R_{12} = R_1 + R_2 = 680 + 180 = 860\Omega$$

$$R_{123} = \frac{R_1 \times R_2}{R_1 + R_2} = \frac{860 \times 220}{860 + 220} = 175.19\Omega$$

$$R_{1234} = R_{123} + R_4 = 175.19 + 470 = 645.19\Omega$$

$$R_{56} = R_5 + R_6 = 1800 + 330 = 2130\Omega$$

$$R_T = \frac{R_{1234} \times R_{56}}{R_{1234} + R_{56}} = \frac{645.19 \times 2130}{645.19 + 2130} = 495.19\Omega$$

- supply current, I

$$I = \frac{V}{R_T} = \frac{12}{495.19} = 0.024A = 24.23mA$$

- current in each resistor

$$I_5 = I_6 = \frac{V}{R_{56}} = \frac{12}{2130} = 5.63mA$$

$$I_4 = I - I_5 = 24.23 - 5.63 = 18.60mA$$

$$I_3 = \frac{V_3}{R_3} = \frac{3.26}{220} = 14.81mA$$

$$I_1 = I_2 = I - I_3 - I_5 = 24.23 - 14.81 - 5.63 = 3.79mA$$

- the p.d. value across each resistor

$$V_5 = I_5 \times R_5 = (5.63 \times 10^{-3}) \times 1800 = 10.14V$$

$$V_6 = I_6 \times R_6 = (5.63 \times 10^{-3}) \times 330 = 1.86V$$

$$V_4 = I_4 \times R_4 = (18.60 \times 10^{-3}) \times 470 = 8.74V$$

$$V = V_3 + V_4 \quad V_3 = V - V_4 = 12 - 8.74 = 3.26V$$

$$V_1 = I_1 \times R_1 = 3.79 \times 680 = 2.58V$$

$$V_2 = I_2 \times R_2 = 3.79 \times 180 = 0.68V$$

- and power dissipation in each resistor.

0
0
0

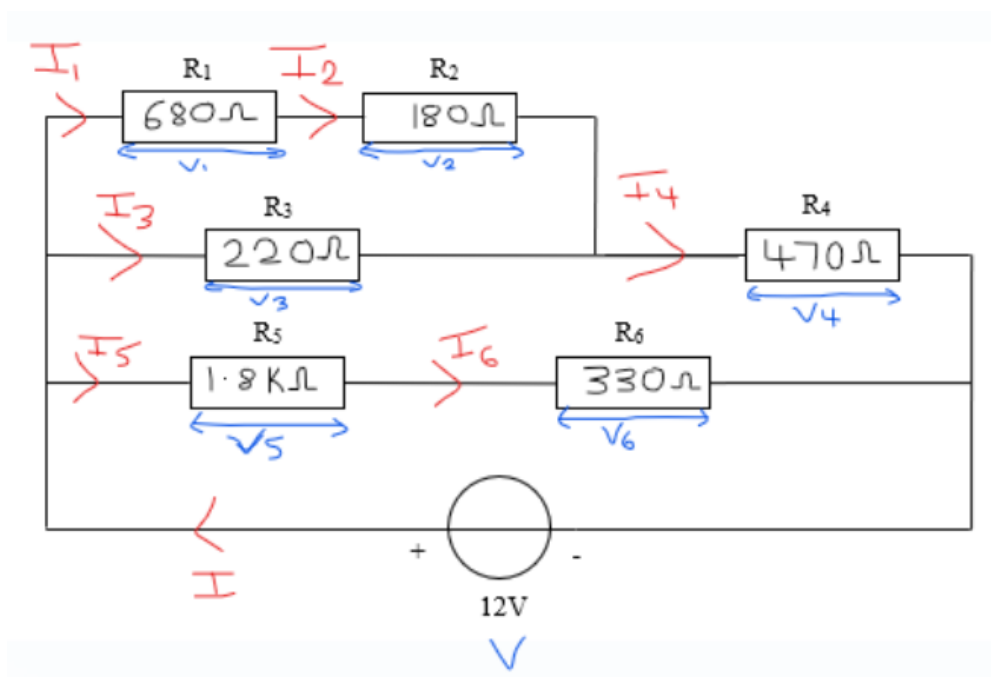
$$\begin{aligned}
 P_1 &= I_1 \times V_1 = 3.79 \times 2.58 = 9.78W \\
 P_2 &= I_2 \times V_2 = 3.79 \times 0.68 = 2.58W \\
 P_3 &= I_3 \times V_3 = 3.26 \times 14.81 = 48.28W \\
 P_4 &= I_4 \times V_4 = 18.60 \times 8.74 = 162.56W \\
 P_5 &= I_5 \times V_5 = 5.63 \times 10.13 = 57.03W \\
 P_6 &= I_6 \times V_6 = 5.63 \times 1.86 = 10.47W
 \end{aligned}$$

$\times 10^{-3}$

All formulas and workings must be shown.

4. Comment on the practical and calculation results, discussing any variations when comparing these results, referring to relative theories such as Kirchhoff's laws and how they relate to the results.

When comparing the practical and calculation results, we see that there are differences, the reasons for this will be explained later on. Using examples found in the questions above, we see that the supply current is different, in the practical it was 25.5mA but in the calculations it was 24.23mA, so we can take from this that the difference isn't major, with it only being 1.27mA however this difference can affect the answers in other calculations. Further to this, another example of the variance can be found in the total resistance, where in the practical it was 485Ω but in the calculations it was 495.19Ω, again not a huge difference but again showing that there can be errors when carrying out practical measurements. ✓



The calculation results show that they are more accurate compared to the practical results, this can come down to several reasons which will be discussed further. The first and most obvious explaining of why there are variations in the answers is because of human error, mistakes can easily occur during measurement activities due to perhaps the placement of the meter probes on the breadboard. This is in comparison to calculation results, which are completed and worked out by a computer, which in return limits the number of errors in the answers. As well as this, "rounding" plays a big part in the difference in answers, for example, in the practical we were rounding to the nearest 2 decimal places, whereas for the calculations this does not occur. Further to this, another reason commonly involves the accuracy of the equipment, for example if the multi-meter is close to its calibration expiry date the accuracy may not be as precise.

There are other factors that could be considered.

Kirchhoff's Laws

Kirchhoff's Current Law, states that the "total current or charge entering a junction or node is exactly equal to the charge leaving the node as it has no other place to go except to leave, as no charge is lost within the node". An example of this can be found in the current, where $I_4 + I_6 = I$, to compare this to the current law, the current that is going in is also coming out which is what this law is in simple terms. (Law, n.d.)

Kirchhoff's Voltage Law, states that "in any closed loop network, the total voltage around the loop is equal to the sum of all the voltage drops within the same loop" Finding an example of this can be found in the voltage, where $V_5 + V_6 = V$, which shows this law where the voltage in the loop is equal to the sum of the voltage or the total voltage. (Law, n.d.)

DC Circuits

A simple description of what a dc circuit is the closed path where the direct current is flowing, which means that the current only flows in one direction which contains components such as resistors. The three types of DC circuits include series, which is where the resistors are connected end to end. Another example is parallel circuits where the resistors are all joined to a common point. The last example is where in some cases the circuits can contain both series and parallel DC circuits

Ohms Law

"Ohm's law states that the voltage across a conductor is directly proportional to the current flowing through it, provided all physical conditions and temperatures remain constant."

The formula for this is $V = I \times R$ (Law, 24)

Task 2 – Capacitors

A capacitor is an electronic device that stores electrical charge and is used in a number of electronic applications.

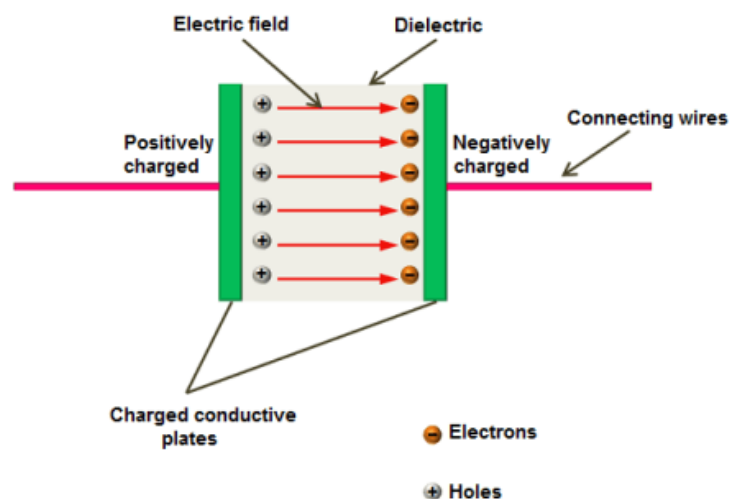
1. Explain the construction and function of a capacitor, listing some of the different types that are available and typical values. Include methods that could be used to alter the value of the capacitor.

Construction of a capacitor

The construction of a capacitor includes two electrically conductive plates placed near each other, but they never actually come into contact with one another. These conductive plates are commonly made of materials like aluminium, brass, or copper, which are just a few of the materials that can be used. The conductive plates of a capacitor are separated by a small gap, this gap between the plates is filled with a non-conductive material/electric insulator/dielectric region. This non-conductive material is called dielectric. A dielectric material is the poor conductor of electricity, they cannot pass electric current through them. In capacitors, the dielectric material stops the flow of charge carriers (especially electrons) between the conductive plates.

Function of a capacitor

A capacitor has the ability to store a quantity of static electricity. The function of a capacitor involves a circuit component that temporarily stores electrical energy through distributing charged particles on (generally two) plates to create a potential difference.

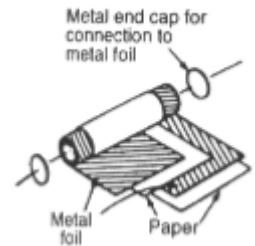


Different types that are available and typical values

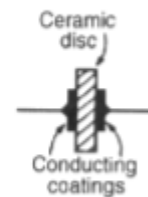
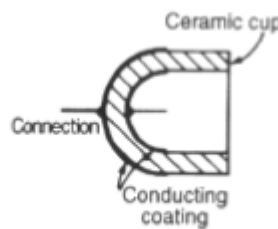
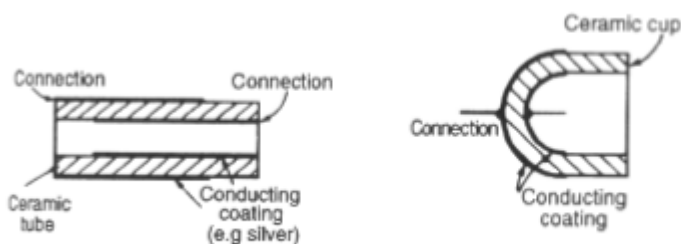
Variable air capacitors - These usually consist of two sets of metal plates, one fixed, the other is variable. As the moving plates are rotated through half a revolution, the meshing, and therefore the capacitance, varies from a minimum to a maximum value. Variable air capacitors are used in radio and electronic circuits where very low losses are required, or where a variable capacitance is needed. The maximum value of such capacitors is between 500pF and 1000pF.



Paper capacitor - A typical paper capacitor can be seen in the image below, where the length of the roll corresponds to the capacitance required. The whole thing is usually covered with oil or wax to exclude moisture and then placed in a plastic or aluminium container for protection. Paper capacitors are made in various working voltages up to about 150kV and are used where loss is not very important. The maximum value of this type of capacitor is between 500pF and 10mF.



Ceramic capacitors - Certain ceramic materials have a very high permittivity and this enables capacitors of high capacitance to be made which are of small physical size with a high working voltage rating. Ceramic capacitors are available in the range 1pF to 0.1mF and may be used in high frequency electronic circuits subject to a wide range of temperatures.



Factors that could be used to alter the value of the capacitor.

Plate area – Having a greater plate area would result in greater capacitance and less plate area gives less capacitance, the larger plate area results in more fluid flux which is the charge on the plates for a given field force (the voltage across the plates).

Plate spacing – Having a wider gap between the plates can change the values, where having a wider gap result in there being less capacitance, and the closer they are together means there is a larger capacitance. This is a factor of greater field force which affects the field flux.

Dielectric material - Greater permittivity of the dielectric gives greater capacitance; less permittivity of the dielectric gives less capacitance. Some materials offer less opposition to field flux for a given amount of field force, materials with a greater permittivity allow for more field flux. *Well done.*

2. Figure 2 shows a circuit containing capacitors in series/parallel to a d.c. voltage source.

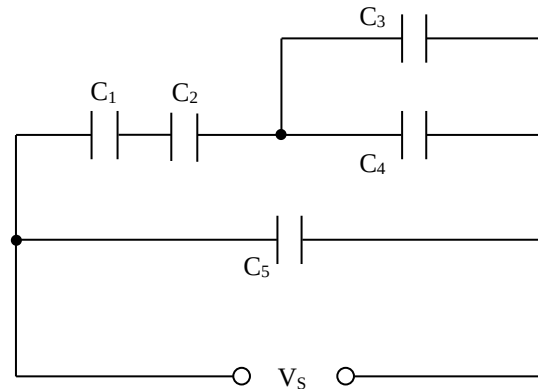


Figure - 2

Using the values stated in Table 2 on the next page, determine:

- a) the equivalent circuit capacitance

$$C_{12} = \frac{C_1 \times C_2}{C_1 + C_2} = \frac{220 \times 330}{220 + 330} = 132\mu F$$

$$C_{34} = C_3 + C_4 = 39 + 15 = 54\mu F$$

$$C_{1234} = \frac{C_{12} \times C_{34}}{C_{12} + C_{34}} = \frac{132 \times 54}{132 + 54} = 38.32\mu F$$

$$C_T = C_{1234} + C_5 = 38.32 + 22 = 60.32\mu F$$

- b) the total charge

$$Q_T = C_T \times V = 60.32 \times 15 = 904.84\mu C$$

- c) the charge in each capacitor

$$Q_5 = C_5 \times V = 22 \times 15 = 330\mu C$$

$$Q_{1234} = Q_T - Q_5 = 904.84 - 330 = 574.84\mu C$$

$$Q_1 = Q_2 = Q_{1234} = 574.84\mu C$$

$$V_1 = \frac{Q_1}{C_1} = \frac{574.84}{220} = 2.61V$$

$$V_2 = \frac{Q_2}{C_2} = \frac{574.84}{330} = 1.74V$$

$$V_3 = V_4 = V - (V_1 + V_2) = 15 - (2.61 + 1.74) = 10.65V$$

$$Q_3 = C_3 \times V_3 = 39 \times 10.65 = 415.35\mu C$$

$$Q_4 = C_4 \times V_4 = 15 \times 10.65 = 159.75\mu C$$

d) the energy stored in each capacitor

$$W_1 = \frac{1}{2} \times C_1 \times (V_1)^2 = \frac{1}{2} \times 220 \times 2.61^2 = 749.33\mu J$$

$$W_2 = \frac{1}{2} \times C_2 \times (V_2)^2 = \frac{1}{2} \times 330 \times 1.74^2 = 499.55\mu J$$

$$W_3 = \frac{1}{2} \times C_3 \times (V_3)^2 = \frac{1}{2} \times 39 \times 10.65^2 = 2211.74\mu J$$

$$W_4 = \frac{1}{2} \times C_4 \times (V_4)^2 = \frac{1}{2} \times 15 \times 10.65^2 = 850.67\mu J$$

$$W_5 = \frac{1}{2} \times C_5 \times (V_5)^2 = \frac{1}{2} \times 22 \times 15^2 = 2475\mu J$$

e) the total energy stored in the circuit.

$$W_T = \frac{1}{2} \times C_T \times V^2 = \frac{1}{2} \times 60.32 \times 15^2 = 6786\mu J$$

Excellent work, well done.

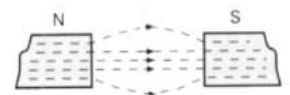
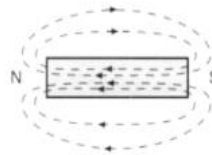
Table 2 – values for Task 2

Student Number	C ₁ (μF)	C ₂ (μF)	C ₃ (μF)	C ₄ (μF)	C ₅ (μF)	V _s (V)
1	150	470	33	12	15	12
2	150	330	39	15	18	15
3	150	220	43	18	33	20
4	150	220	47	22	27	25
5	220	150	43	27	33	25
6	220	330	39	10	15	25
7	220	470	33	12	18	20
8	220	330	39	15	22	15
9	180	220	33	10	27	20
10	180	270	39	12	33	25
11	180	270	33	6.8	22	18
12	180	150	39	10	27	15

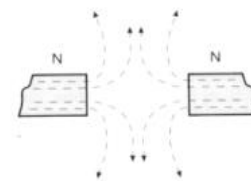
Task 3 – Magnetism

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

Magnetic fields are produced by permanent magnets or by current flowing through a conductor, magnetic fields have many characteristics which include that they always form a complete closed loop. They behave as if they are elastic, when distorted they try to return to their natural shape and spacing, in the space surrounding a magnet, the lines of force radiate from the north (N) pole to the south (S) pole. The lines of force never cross, like poles repel and unlike poles attract each other.



Attraction between unlike poles

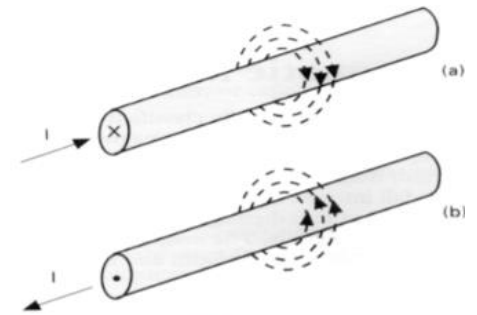


Repulsion between like poles

The direction of the magnetic field around the conductor is clockwise for X and anticlockwise for .

The strength of the field is directly proportional to the value of the current. When a conductor is wound into a coil the lines distort to form complete loop around the whole coils.

This is not related to permanent magnetics



X for current flowing away from you
• for current flowing towards you.

2. Solve the following problems:

- a) A magnetic pole face has a rectangular section having dimensions 250mm by 140mm. If the total flux emerging from the pole is 150μWb, calculate the flux density.

$$H = 250\text{mm or } 0.25\text{m} \quad L = 140\text{mm or } 0.14\text{m} \quad \Phi = 120\mu\text{Wb}$$

$$A = H \times L = 0.25 \times 0.14 = 0.035\text{m}^2$$

$$B = \frac{\Phi}{A} = \frac{120 \times 10^{-6}}{0.035} = 3.43 \times 10^{-3} = 3.43\text{mT}$$

Correct method wrong value.

- b) The maximum working flux density of a lifting electromagnet is 2T and the effective area of a pole face is circular in cross-section. If the total magnetic flux produced is 630mWb determine the radius of the pole face.

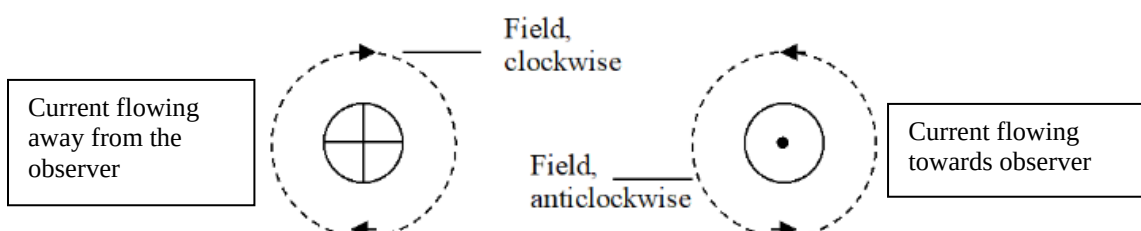
$$B = 2\text{T} \quad \Phi = 630\text{mWb}$$

$$A = \frac{\Phi}{B} = \frac{630 \times 10^{-3}}{2} = 315 \times 10^{-3}\text{m}^2$$

$$r^2 = \frac{A}{\pi} \quad r = \sqrt{\frac{A}{\pi}} = \sqrt{\frac{315 \times 10^{-3}}{\pi}} = 0.317\text{m or } 317\text{mm}$$

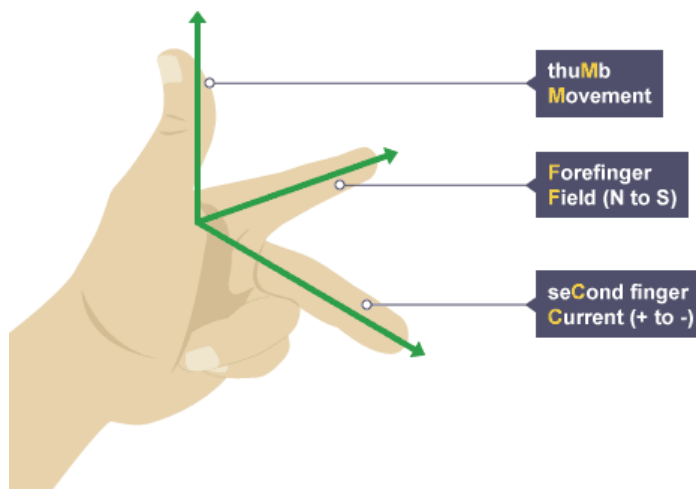
3. Explain the principle operation and construction of an electromagnet including the distribution of magnetic fields.

When a conductor carries a current, a magnetic field is produced around that conductor, this field is in the form of concentric circles along the whole length of the conductor. The direction of the field depends on the direction of the current, which is clockwise for a current flowing away from the observer and anticlockwise for a current flowing towards the observer, in order to show these directions, certain signs are used, as shown below.

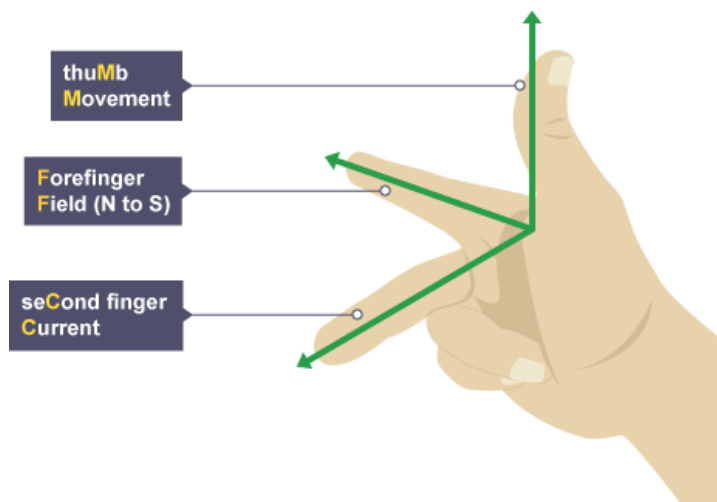


“For any given combination of current and magnetic field strength, the force is greatest when the direction of the current is 90° to the direction of the magnetic field.” The direction of the force can be found using Fleming's left-hand rule. ✓

(Bitesize, n.d.)



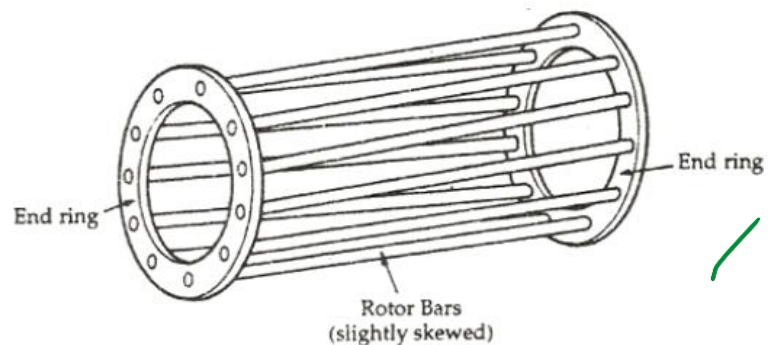
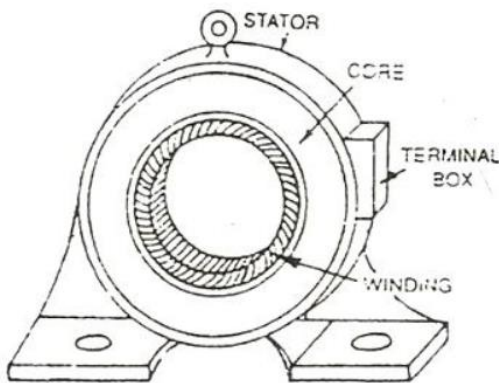
“If a conductor is moved through a stationary magnetic field, a current is induced. This is the principle behind an electric generator.” This can be remembered with Fleming's Right Hand Rule for electron flow. (Bitesize, n.d.)



4. An induction motor is a device that uses some of the principles associated with electromagnetism. Explain the operation and construction of a induction motor, make reference to how to reduce power loss within the motor.

An induction motor works by turning electrical energy into mechanical energy, it does when an electrical current flows through the wire, where it generates an electromagnetic field. Creating a coil of wire would create a stronger electromagnetic field, this is because it creates a north and south pole to attract and repel. The magnetic field in an AC circuit expands and collapses and the polarity alternates each time. ✓

An induction motor is constructed and operates off of two main parts, these are called the stator and the rotor. The stator is always stationary and contains parts such as the stator core which carries the alternating magnetic field and the windings which are connected in the terminal box of the motor. The other main part is the rotor, which is the part that rotates, it consists of a laminated cylindrical core, the slots that can be seen in the diagram below are semi-closed and each slot contains an uninsulated bar conducted which is normally made out of aluminium or copper. On the end the conductors are short-circuited by a heavy ring of copper or aluminium.



5. Solve the following problems:

- a) A 800 turn coil of inductance 3H carries a current of 1.5A. Calculate the flux linking the coil and the e.m.f. induced in the coil when the current collapses to zero in 25ms.

$$L = 3H \quad I = 1.5A \quad N = 800 \text{ turns}$$

$$\frac{L \times I}{N} = \frac{3 \times 1.5}{800} = 5.63 \text{ mWb}$$

$$E = \frac{-Nd\Phi}{dt} = \frac{-800 \times 5.63}{25} = -180.16V$$

- b) A rectangular coil of sides 12cm and 7cm is rotated in a magnetic field of flux density 1.5T, the longer side of the coil actually cutting this flux. The coil is made up of 80 turns and rotates at 1400rev/min. (i) Calculate the maximum generated e.m.f. (ii) If the coil generates 85V, at what speed will the coil rotate?

$$E = 2NBLV \times \sin\Phi$$

$$V = Wr = \left(\left(\frac{1400}{60} \right) \times 2\pi \right) \times \frac{7 \times 10^{-2}}{2} = 5.13 \frac{m}{s}$$

$$E = -2 \times 80 \times 1.5 \times (12 \times 10^{-2}) \times 5.13 \times \sin 90 = 147.7V$$

$$V = \frac{E}{2NBL} = \frac{85}{2 \times 80 \times 1.5 \times (12 \times 10^{-2})} = 2.95 \frac{m}{s}$$

$$W = \frac{V}{r} = \frac{2.95}{(7 \times 10^{-2})} = 84.29 \frac{rad}{sec}$$

$$Speed = \frac{84.29 \times 60}{2\pi} = 804.91 = 805 \frac{rev}{min}$$

Task 4 – AC Circuits

The most commonly used AC waveform in circuit theory is the sinusoidal waveform, also known as a sine wave. This type of periodic AC voltage source generates an electromotive force (EMF) that alternates its polarity at consistent intervals. The time it takes for one complete cycle of polarity reversal is called the waveform's period.

1. An AC voltage is represented by the equation:

$$V = V_m \sin(\omega t \pm \phi)$$

Using the values stated in table 3 determine the following:

- a) The root mean square voltage of the waveform

$$V_{RMS} = \frac{V_{MAX}}{\sqrt{2}} = \frac{15}{\sqrt{2}} = 10.61V$$

- b) Angular velocity

$$2\pi f = 2 \times \pi \times 45 = 282.74 \frac{rad}{sec}$$

- c) The output voltage at time, $t = 0s$

$$\text{Covert angle into radians} = 34 \times \frac{\pi}{180} = \frac{17}{90}\pi$$

$$V_0 = V_{MAX} \sin \theta$$

$$V_0 = 15 \sin\left(\frac{17}{90}\pi\right) = 8.39V$$

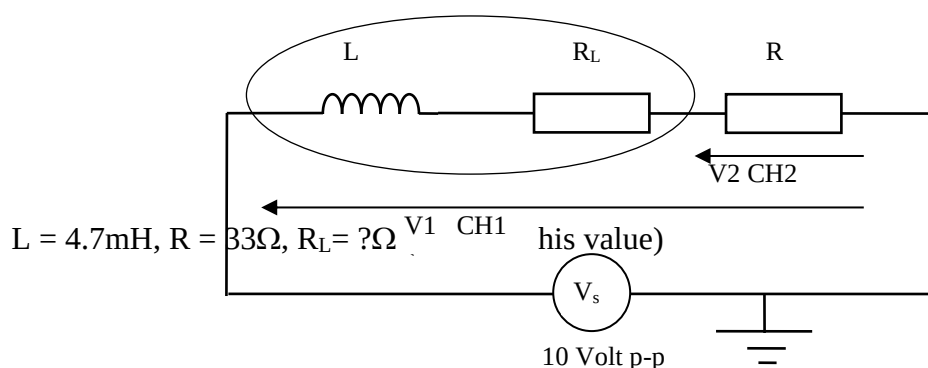
- d) The time taken to reach the first peak of maximum voltage.

$$\text{Time Taken} = 1000 \times \left(\frac{\left(\frac{1}{2} \times \pi\right) - \left(\frac{34 \times \pi}{180}\right)}{282.74} \right) = 3.46s$$

Table 3 – values for Task 4

Student Number	Maximum Voltage (V)	Frequency (Hz)	Phase Angle (°)
1	10	40	25
2	12	45	28
3	15	50	33
4	18	55	35
5	20	60	26
6	10	55	28
7	12	50	32
8	15	45	34
9	18	40	38
10	20	44	33
11	12	48	29
12	16	56	25

2. Below is a RL circuit:



Measure and record the value of each of the component.

$L = 4.52\text{mH}$ ✓ $R = 32.8\Omega$ ✓ $R_L = 12.54\Omega$ ✓

3. Produce a table of measurements as shown below:

Frequency (f) (kHz)	CH1 (V) pk to pk Voltage	CH2 (V) pk to pk Voltage	Time Difference (between peaks) (T2-T1)	Phase Angle (°)
1	5.56	2.19	85.5	30.78
2	6.59	2.83	71.93	51.79
3	7.57	2.41	56.6	61.13
4	8.2	2.01	44.81	64.53
5	8.6	1.8	40.09	72.16
6	8.87	1.6	34.2	73.87
7	9.09	1.43	29.48	74.29
8	9.27	1.27	24.76	71.31
9	9.36	1.13	23.01	74.55

4. Produce a table of calculations as shown below:

Frequency (kHz)	Reactance (Ω)	Total Resistance (Ω)	Impedance (Ω)	Current (A)	Phase Angle (°)
1	28.40	45.34	53.50	0.187	32.06
2	56.80	45.34	72.68	0.138	51.40
3	85.20	45.34	96.51	0.104	61.98
4	113.60	45.34	122.31	0.082	68.24
5	142.00	45.34	149.06	0.067	72.29
6	170.40	45.34	176.33	0.057	75.10
7	198.80	45.34	203.90	0.049	77.15
8	227.20	45.34	231.68	0.043	78.71
9	255.60	45.34	259.59	0.039	79.94

Show clearly **one full example of your method** for calculating for Reactance, Impedance, Current and Phase Angle for a chosen frequency.

$$\frac{F \times \Delta T \times 360}{1000}$$

$$X_L = 2\pi FL$$

$$R_T = R + R_L$$

$$Z = \sqrt{(R_T)^2 + (X_L)^2}$$

$$I = \frac{V}{Z} = \frac{10}{Z}$$

frequency

$$\frac{F \times \Delta T \times 360}{1000} = \frac{5 \times 40.09 \times 360}{1000} = 72.16^\circ /$$

Must state all units.

$$X_L = 2\pi FL = 2 \times \pi \times 5 \times 4.52 = 142 \Omega$$

$$R_T = R + R_L = 32.8 + 12.54 = 45.34 \Omega$$

$$Z = \sqrt{(R_T)^2 + (X_L)^2} = \sqrt{(45.34)^2 + (142)^2} = 149.06 \Omega$$

$$I = \frac{V}{Z} = \frac{10}{149.06} = 0.067A /$$

Have not shown the calculation of the phase angle.

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

When comparing the results of the measurements and the calculations we can see that there were variations throughout the process. However, when we get to frequency 8 when measuring we see the phase angle dip down to 71.31° and then back up again in frequency 9 to 74.55, this could be proof of how easy mistakes can be made when completing measurements manually, instead of using electronic calculations, as this could possibly be the reason for this error. Correspondingly to this, additional factors to the variations we can see can include human errors, for example the resolution of the screen can play a part in the differences we see in the results, because this can affect the placement of the cursor when we are selecting precise point on the graph. The first sign of errors beginning is at the first frequency where we see our measurement result was 30.78 compared to the calculation which was 32.06, a further explanation to these errors could be that the formulas or workings out may have not been entered accurately, since this would lead to the calculations being incorrect. ✓

Continuing the topic of why there are variations in the results of the practical measurements and the calculations, as well as the factors already stated, there are also further factors which include the resistance in the test leads being inaccurate or not where the figures should be. This also links into the other reasoning for errors, which is the overall condition of the test equipment, for example the supply may not have been calibrated recently so the figures may have been wrong there.

Bibliography

Birmingham, U. o., n.d. *Introduction to capacitors*. [Online]

Available at: <https://www.birmingham.ac.uk/study/undergraduate/schools-and-colleges/post-16/a-level-stem-resources/capacitors#:~:text=Unlike%20the%20battery%2C%20a%20capacitor,all%20the%20energy%20v ery%20quickly.>

[Accessed 17 01 25].

Bitesize, B., n.d. *Fleming's left-hand rule and the motor effect*. [Online]

Available at: <https://www.bbc.co.uk/bitesize>

[Accessed 17 01 25].

Bitesize, B., n.d. *Magnetic fields*. [Online]

Available at:

<https://www.bbc.co.uk/bitesize/guides/zyfyyrd/revision/4#:~:text=This%20can%20be%20remembered%20 with,represented%20by%20the%20seCond%20finger>

[Accessed 17 01 25].

ChatGPT, n.d. [Online] → *How did you use it, what did you research?*

Available at: <https://chatgpt.com/>

[Accessed 01 17 25].

circuitglobe, n.d. *Construction of Induction Motor*. [Online]

Available at: <https://circuitglobe.com/construction-of-induction-motor.html>

[Accessed 17 01 25].

electronics-tutorials, n.d. *AC Waveform and AC Circuit Theory*. [Online]

Available at: <https://www.electronics-tutorials.ws/accircuits/ac-waveform.html>

[Accessed 17 01 25].

Law, K. C., n.d. *All About Circuits*. [Online]

Available at: <https://www.allaboutcircuits.com/>

[Accessed 17 01 2025].

Law, O., 24. *geeksforgeeks*. [Online]

Available at: <https://www.geeksforgeeks.org/ohms-law/>

[Accessed 17 01 25].

Mindset, T. E., 22. *Induction Motor Basics*. [Online]

Available at: <https://www.youtube.com/watch?v=N7TZ4gm3aUg>

[Accessed 17 01 25].

physics-and-radio-electronics, n.d. *Capacitor*. [Online]

Available at: https://www.physics-and-radio-electronics.com/electronic-devices-and-circuits/passive-components/capacitors/capacitorconstructionandworking.html#google_vignette

[Accessed 17 01 25].

References

Birmingham, U. o., n.d. *Introduction to capacitors*. [Online]

Available at: <https://www.birmingham.ac.uk/study/undergraduate/schools-and-colleges/post-16/a-level-stem-resources/capacitors#:~:text=Unlike%20the%20battery%2C%20a%20capacitor,all%20the%20energy%20very%20quickly.>

[Accessed 17 01 25].

Bitesize, B., n.d. *Fleming's left-hand rule and the motor effect*. [Online]

Available at: <https://www.bbc.co.uk/bitesize>

[Accessed 17 01 25].

Bitesize, B., n.d. *Magnetic fields*. [Online]

Available at:

<https://www.bbc.co.uk/bitesize/guides/zyfyyrd/revision/4#:~:text=This%20can%20be%20remembered%20with,represented%20by%20the%20second%20finger>

[Accessed 17 01 25].

would like to see actual text books being referenced.