

LEVEL 4 ASSESSMENT SPECIFICATION

Student name:	Chris Bendall	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	1.5
Little evidence of reading and/or reliance on inappropriate sources. There are no direct references in the report and a lack of books referenced at the end.		
2. Knowledge and Understanding Skills	25	16.9
Task 1 achieved 67%. Task 2 achieved 67%, Task 3 achieved 65%. Task 4 achieved 72%. Competent knowledge of the basic underlying concepts and principles. Showed excellent understanding the calculated requirements. Some the research work need to be more detailed but this is probably due to the limited use of source materials.		
3. Cognitive and Intellectual Skills	15	7.3
Task 1 achieved 50%. Task 4 achieved 48%. Good evaluation of the underlying concepts and principles but were a little bit limited in the evaluation of Task 4.		
4. Practical Application Skills	35	24.9
Task 1 achieved 60%. Task 4 achieved 82%. A good application of practical work for Task 1 and 4, very good use of the test equipment to obtain all of the required results. The Multisim results were not included in Task 1.		
5. Transferable Skills for Life and Professional Practice	10	5.2
Mostly coherent, organised and accurate work, in a suitable structure and is for the most part clearly expressed. Try to produce all of the work on computer, equations can be produced using Equation Editor in Word.		

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)		56%
	Up to 1 week late (40% Max)		
	Over 1 week late (0%)		



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

Electrical Principles - PCEE4001

Abstract

Capacitors are an electronic device that has the ability to store energy within a circuit. This has many different uses and applications in electronics. They are made up of two metal plates and an insulating layer in between them.

This is not an abstract.

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* Introduction

* You should start the introduction on new page.

The aim of this Electronics based assignment is to gain a deep understanding of the fundamentals of electrical principles through both theoretical, practical and mathematical applications. This will serve to provide a solid underpinning base of knowledge to go forward and build on.

The assignment will cover the following areas of Electrical Principles – DC circuits, Capacitors in DC circuits, magnetism and AC circuits. ✓

Task 1- DC Circuits

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

① constructed the circuit using components specified and bread board. The circuit was arranged as shown in the diagram. Before applying power to the circuit to test its functionality, ① measured the total resistance of the circuit using a multi-meter set to 'Ohms'.

Do not refer to yourself within a report.

This measured at 351Ω . This is in the ball park of my expected with a slight discrepancy.

Poorly written.

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

Which resistor, are you measuring?

Make the columns wider.

	Resistance		Voltage (V)			Current (mA)		
	Given value	Measur ed	Measur ed	Calculat ed	Simulat ed	Measur ed	Calculat ed	Simulat ed
R1		265	2.1			5.5		
R2		561	3.14			5.6		
R3		325	4.9			15.2		
R4		273	6.8			15.2		
R5		325	3.85			11.8		
R6		665	6.7			11.9		
RT		351 ✓	11.8 ✓			32 ✓		

Electrical Principles

Once the circuit had a 12V supply connected, I proceeded to take all measurements as instructed. Again a multi-meter was used set to Volts for voltage and Amps for current. ✓

3. Calculate the

- total resistance, R_T
- supply current, I
- current in each resistor
- The PD value across each resistor.

All formulas and workings must be shown.

DC Circuits.

$R_T = \frac{1}{\frac{1}{270} + \frac{1}{330}} = 236.12 \Omega$ ✓
 $236.12 + 270 = 506.12$ ✓
 $\frac{1}{330} + \frac{1}{680} = X$ ✓
 $330 + 680 = 1010$ ✓
 $\frac{1}{1010} + \frac{1}{506.12}$ ✓
 $R_T = 337.16 \Omega$ ✓

$V_1 = I_1 \times R_1 = 0.00675 \times 270 = 1.8V$ ✓
 $V_2 = I_2 \times R_2 = 0.00675 \times 560 = 3.18V$ ✓
 $V_3 = I_3 \times R_3 = 0.0169 \times 330 = 5.58V$ ✓
 $V_4 = I_4 \times R_4 = 0.0237 \times 270 = 6.4V$ ✓
 $V_5 = I_5 \times R_5 = 0.01188 \times 330 = 3.92V$ ✓
 $V_6 = I_6 \times R_6 = 0.01188 \times 680 = 8.08V$ ✓

Current constant in series.

Need to state formula.

$I_1 = I_2 = 5.6V / (270 + 560) = 0.00675 = 6.75mA$ ✓
 $I_3 = 5.6V / 330\Omega = 0.0169A = 16.9mA$ ✓
 $I_4 = (I_1) + I_3 = 23.71mA$ ✓
 $I_5 = I_6 = 12V / (330 + 680) = 0.01188 = 11.8mA$ ✓
 $I_T = I_4 + I_5/6 = 11.8mA + 23.71mA = 35.6mA$ ✓

4. Use Multisim to also produce a set of test results for the voltages and currents.

	Resistance		Voltage (V)			Current (mA)		
	Given value	Measured	Measured	Calculated	Simulated	Measured	Calculated	Simulated
R1	270	265	2.1	1.8	?	5.5	6.7	?
R2	560	561	3.14	3.78		5.6	6.75	
R3	330	325	4.9	5.58		15.2	16.9	
R4	270	273	6.8	6.4		15.2	22.1	
R5	330	325	3.85	3.92		11.8	11.8	
R6	680	665	6.7	8.08		11.9	11.8	
RT	337.16	351	11.8	12		32	35.6	

You have not included the simulated results.

5. Comment on the practical, calculation and simulation results, discussing any variations when comparing these results and make reference to relative theories such as Kirchhoff's laws.

From my values, I notice that the calculated and simulated values are identical/very similar. This is because the simulation programme will also use calculations to obtain the values. The two methods are very much two of the same although the fact they are so close does go towards proving my calculations to be correct.

The difference we see is in the actual measured values. There are many variables that could alter these either way, firstly, the actual resistance across the resistor. It is unlikely a resistor will ever measure exactly what it is supposed to. There are given tolerances which can typically range between 1% and 10%. As you can see from the results, every one of my resistors measured differently and this fundamental figure immediately throws off the calculations, having a knock on effect with the current and the voltage. Other things that could affect the readings are the accuracy of the test instrument used, continuity or resistance within the leads, room temperature or the quality of the connection between the test probes and the circuit itself. Bread boards are fairly small so getting any kind of solid connection can prove tricky at times.

Kirchoffs law relates directly to this kind of simple DC circuit. It states: "the sum of the voltage sources around any closed path is equal to the sum of the potential drops around that path". This again reconfirms how the offset values of the resistor have a direct impact on the voltage at various points of the circuit and in turn, the current.

*You should related this directly to your values.
Also have not considered the current law.*

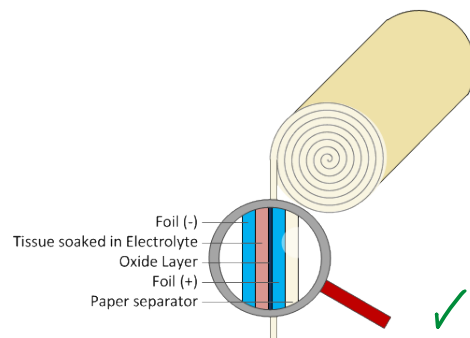
Task 2 - Capacitors

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.

Capacitors are an electronic device that has the ability to store energy within a circuit. This has many different uses and applications in electronics. They are made up of two metal plates and an insulating layer in between them. This insulating layer is known as the dielectric. In physics terms- the energy within a capacitor is stored in the form of an excess of electrons on one plate and a deficiency on the other. There are many types of capacitor, a lot of them having subtle differences in their construction and properties yet the concept remains the same. ✓

Aluminium electrolytic capacitors are a fairly common type- made from two aluminium foils either side of a paper spacer soaked in electrolyte. One of the two aluminium foils is covered with an oxide layer, and that foil acts as the anode, while the uncoated one acts as a cathode. During normal operation, the anode must be at a positive voltage in relation to the cathode, which is why the cathode is most commonly marked with a minus sign along the body of the capacitor. The anode, electrolyte-soaked paper and cathode are stacked. The stack is rolled, placed into a cylindrical enclosure and connected to the circuit using pins. ✓

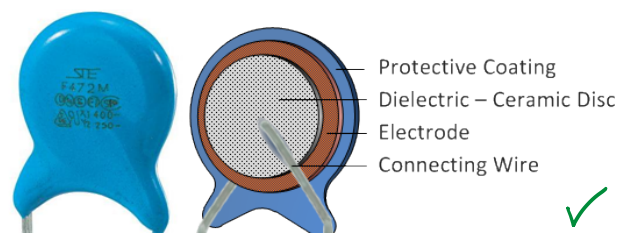


Construction of an electrolytic capacitor

When comparing to most other types of capacitor, electrolytic generally have a larger capacitance.

This can be between $1\mu\text{F}$ and 47mF . The 'super-capacitor' of which capacitance values can reach thousands of farads. This is a type of electrolytic capacitor, in order to achieve the high capacitance values the plate area and thickness of electrolyte must be increased. This means it will inevitably be bulky in size and therefore less practical in smaller applications. ✓

There is more than one type of ceramic capacitor available, but by definition, a ceramic capacitor is a capacitor that uses a ceramic material as the dielectric. Common types are ceramic disc capacitors and MLCC's. Ceramic disc capacitors are made by coating a ceramic disc with silver contacts on both sides, as seen in the diagram. In order to process these with larger capacitance values, they may be made up of multiple layers. MLCC's (Multi-layer ceramic capacitors) are made by accurately mixing finely ground granules of para-electric and Ferro-electric materials and alternatively layering the mix with metal contacts. Once this is complete, the device is subjected to high temperatures and the whole mixture is sintered. This results in a ceramic material of desired properties. In basic terms; we now have a capacitor that consists of many smaller capacitors (as many as 500) connected in



Construction of a ceramic disc capacitor

parallel, increasing the capacitance (if connected in series we would not achieve the same effect). ✓

Ceramic capacitors are all in all the most widely used in the electronic world. A few examples are:

- Ceramic capacitors are majorly used in the resonant circuit in transmitter stations.
- Class 2 high-power capacitors are used in high voltage laser power supplies, power circuit breakers, induction furnaces etc.
- Surface mount capacitors are often used in printed circuit boards and high-density applications.
- Ceramic capacitors can also be used as a general-purpose capacitor, because of their non-polarity and are available in a large variety of capacitances, voltage ratings, and sizes.
- Ceramic disc capacitors are used across brush DC motors to minimize RF noise.
- MLCC used in printed circuit boards (PCB) are rated for voltages from only a few volts up to several hundreds of volts, depending on the application. ✓

Other types include Mica, paper and plastic film. There are also types of variable capacitor. This variable property can be achieved by either electrical or mechanical means. Commonly a variable capacitor will consist of pairs of parallel conductive plates in one device. One of each pair is a fixed plate- a stator plate and the other is a moveable plate- a rotor. Air is used as the capacitor's dielectric so when a rotor plate is taken off this area increases therefore changes the capacitance. ✓



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

Using the values stated in Table 2, determine:

- A. The equivalent circuit capacitance
- B. The total charge
- C. The charge in each capacitor
- D. The energy stored in each capacitor
- E. The total energy stored in the circuit.

Table 2 – values for Task 2

Student Number	C ₁ (μF)	C ₂ (μF)	C ₃ (μF)	C ₄ (μF)	V _s (V)
1	12	27	33	4.7	12
2	15	27	39	3.3	15
3	18	27	43	2.2	20
4	22	27	47	2.2	25
5	27	22	43	1.5	30
6	10	22	39	3.3	25

Task 2 - capacitors.

$C = Q/V$ capacitance
 $Q = CV$ charge
 $Q = It$
 $D = Q/A$ Flux density
 $W = \frac{1}{2} CV^2$ Power.

$V = Q/C$
 $V_1 = 0.00012 / 0.000012 = 10V$
 $V_{23} = 0.00012 / 0.00006 = 2V$
 $V_4 = 0.0000564 / 0.000047 = 12V$

a) Equivalent circuit capacitance.

$$\left(\frac{1}{C_1} + \frac{1}{C_2 + C_3} \right) + C_4 = C_T$$

$$C_2 + C_3 = 33 + 27 = 60 \mu F$$

$$\frac{1}{12} + \frac{1}{60} = \frac{1}{C_T} = 10 \mu F = C_{123}$$

$$\therefore 10 + 4.7 = 14.7 \mu F$$

b) The total charge.

$$Q_T = C_T \times V = 14.7 \times 10^{-6} \times 12 = 0.0001764 = 176.4 \mu C$$

c) The charge in each capacitor. $Q = CV$

$C_1 - C_{123} \times V = 0.00001 \times 12 = 0.00012 = 120 \mu C$
 $C_2 - \text{As above}$
 $C_3 - \text{As above}$
 $C_4 - 0.0000047 \times 12 = 56.4 \times 10^{-6} = 56.4 \mu C$

} No

The energy stored in each capacitor.

d) $W_1 = \frac{1}{2} C_1 \times V_1^2 = 0.5 \times 0.000012^2 \times 10^2 = 600 \times 10^{-6} = 600 \mu J$ ✓

$W_2 = \frac{1}{2} C_2 \times V_2^2 = 0.5 \times 0.000027^2 \times 2^2 = 54 \times 10^{-6} = 54 \mu J$ ✓

$W_3 = \frac{1}{2} C_3 \times V_3^2 = 0.5 \times 0.000033^2 \times 2^2 = 66 \times 10^{-6} = 66 \mu J$ ✓

$W_4 = \frac{1}{2} C_4 \times V_4^2 = 0.5 \times 0.000047^2 \times 12^2 = 338.4 \times 10^{-6} = 338.4 \mu J$ ✓

e) The total energy stored in the circuit.

$W_1 + W_2 + W_3 + W_4 = W_T$ ✓

$\therefore 600 \times 10^{-6} + 54 \times 10^{-6} + 66 \times 10^{-6} + 338.4 \times 10^{-6}$ ✓

$= 1058 \times 10^{-6} = 1.058 mJ$ ✓

could also be expressed as:

$\frac{1}{2} C_T \times V_T^2 = 0.5 \times 14.7 \times 10^{-6} \times 12^2 = 1.0584 mJ$ ✓ good.

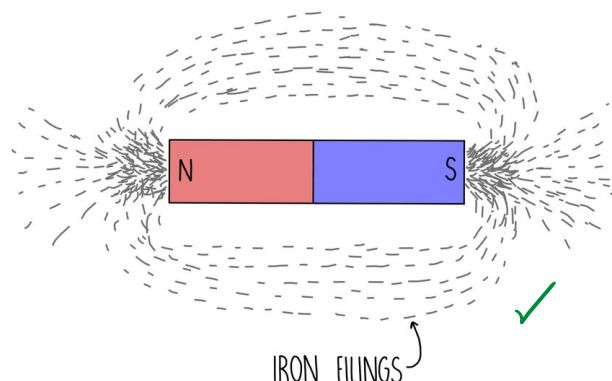
If you are to include hand written working make sure the copy is straight.

Task 3- Magnetism

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

Permanent magnetism naturally occurs in certain materials in which a magnetic field is generated by the internal structure. This would be called a permanent magnet. The field cannot be seen but if we sprinkle some iron filings around a permanent magnet they actually fall in line with the field giving us a great visual representation. As can be demonstrated on the picture to the right.

These magnetic lines we can see radiate from the north-pole to the south-pole. These lines will never cross and if you offered opposite poles of separate magnets, they would attract whereas offering the same pole of another magnet would actually repel. ✓



2. 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 $130\mu\text{Wb}$, calculate the flux density.

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.

2.a) Length = 220mm Height = 120mm $\phi = 130\mu\text{Wb}$

Find flux density. $B = \phi / A$ ✓

$A = L \times H$ $0.22 \times 0.12 = 0.0264\text{m}^2$

$\therefore B = 130 \times 10^{-6} / 0.0264 = 0.005\text{T} = 5\text{mT}$ ✓

2.b. $B = 1.9\text{T}$ $\phi = 611\text{mWb}$

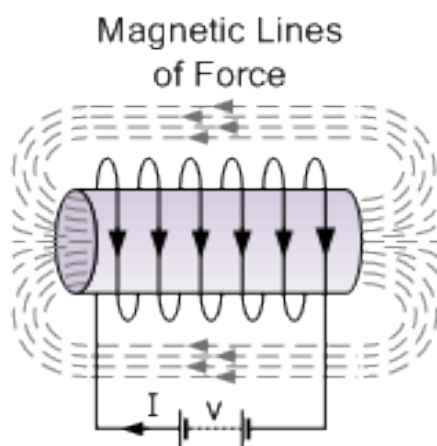
Determine radius of pole face. $r = \sqrt{A / \pi}$ ✓

$A = \phi / B$ $0.611 / 1.9 = 0.322\text{m}^2$ ✓

$\therefore r = \sqrt{0.322 / \pi} = 0.32\text{m}$ ✓ $r = 320\text{mm}$ ✓

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

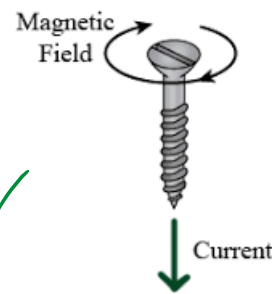
An electromagnet differs from a permanent magnet in the fact it is temporary and the force created can be manipulated. The magnetic field is created by a DC current flowing through a conductor. When the current is raised, the field grows stronger and, inversely, when the



current is cut altogether the magnetic field dissipates to nothing. In many ways the concepts of magnetism and electricity are closely related and often work hand in hand. If the conductor (a wire for example) is then wound into a coil around a core (using a ferrous material like iron or steel), the magnetic field is greatly intensified producing a static magnetic field around itself - giving a distinct North and South pole. ✓

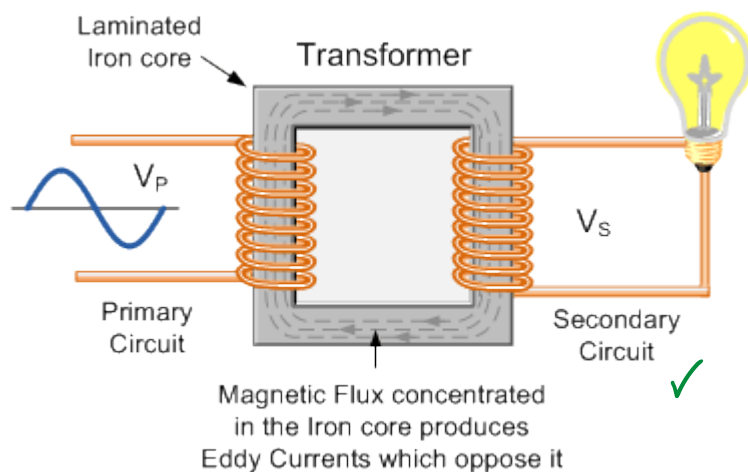
You have not discussed the construction.

The magnetic field created is dependent on the direction of the current flow- this allows us to alter the poles if need be. This is where we can refer to faradays laws of electromagnetic induction. If you are to look down the length of a conductor with the current is flowing away from you, the magnetic field around the conductor will be in a clockwise direction. The way I remember this is the screw head analogy- pictured.



2. 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 utilises the working principles of electromagnetism and induction to either raise or lower voltage- transform it. They are made up of two coils- each wrapped around an iron core. We refer to as windings, primary on the input and secondary on the output. The iron core is not a solid piece of iron but made up of many laminations. These keep something called eddy currents to a minimum. Eddy currents can reduce the efficiency of energy transfer within the transformer. This is by increasing the resistance (via the laminations) to reduce the current and therefore keep power lost to heat to a minimum. On the refinery I work at, the transformers are often oil filled and fitted with plates for heat dissipation, both methods of reducing losses. An important point is only AC voltage can be transformed- a big positive for AC current in the age old dispute of AC vs DC.



An AC current is applied to the primary coil which creates alternating magnetic flux through the Iron core in is wrapped around. The strength of the magnetic flux is directly proportional to the input applied. An EMF is then induced into the secondary windings via the iron core. We get our step up/step down amount by the amount of loops within the coils- this is given as a ration. For example, a 2:1 transformer will have twice as many coils on the primary side of the transformer and output half the voltage.

3. 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.

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

Chris Bendall.

3. a) $N = 700$ $I = 1.6A$ $L = 2.5H$ $dt = 20ms$

$$L = N\phi / I \quad \therefore \phi = L \times I / N \quad \checkmark$$

$$2.5 \times 1.6 / 700 = 0.005714 = 5.7mwb \quad \checkmark$$

$$e = Nd\phi / dt = -700 \times 0.005714 / 0.02$$

$$= -199.99V \quad \checkmark$$

3. b) i) $N = 70$ $B = 1.2T$ $L = 0.1m$ $v = 1200rpm$

$$v(m/s) = (1200 \times 2\pi / 60) \times (0.06 / 2)$$

Generated EMF = $2 \times NBLv \sin \phi \quad \checkmark$

Maximum EMF = $90^\circ \quad \phi \quad \checkmark$

$$= 3.77m/s \quad \checkmark$$

$$\therefore E = 2 \times 70 \times 1.2 \times 0.1 \times 3.77 \times (\sin 90) = 63.34V \quad \checkmark$$

ii) $E = 80$ $\sin 90^\circ = 1$

$$v(m/s) = E / 2NBL = 80 / 2 \times 70 \times 1.2 \times 0.1 \quad \checkmark$$

$$= 4.76m/s \quad \checkmark$$

$$\therefore rpm = (v \times 60 / 2\pi) \times (2 / 0.06) \quad \checkmark$$

$$= 4.761 \times 60 \times 2 / 2 \times \pi \times 0.06$$

$$= 1515.47 r/m \quad \checkmark$$

Good

Task 4 – AC Circuits

Table 3 – values for Task 4

Student Number	Oscilloscope Settings		Grid Spacing	
	Volts/Div	Time-base (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

1. Using the oscilloscope measurements for a sine wave stated in table 3 perform the following calculations
 - a) Peak voltage
17V ✓
 - b) Frequency
12.5Hz ✓
 - c) Average voltage
10.83V ✓
 - d) Root mean square (rms) voltage.
12.02V ✓

Task 4.

1. a) $V_P = \frac{1}{2} V_m$ (peak to peak).
 $V_m = 5 \times 6.8 = 34V$
 $V_P = 34 / 2 = 17V$ ✓

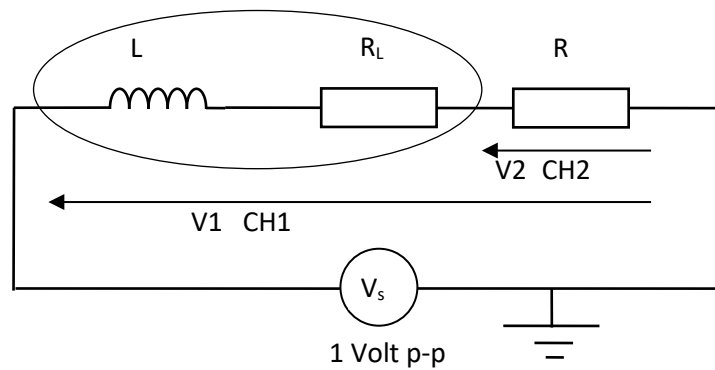
b) Frequency. $F = 1/T$. $T = 1 \text{ cycle (ms)}$.
 $T = 20 \times 4 = 80ms$.
 $1/0.08 = 12.5Hz$ ✓

c) Average Voltage. $V_{av} = 0.637 \times V_P$
 $V_{av} = 0.637 \times 17 = 10.83V$ ✓

d) Root means square (rms) voltage. $V_{rms} = V_P / \sqrt{2}$
 $V_{rms} = 17 / \sqrt{2} = 12.02V$ ✓

See below for full workings.

2. Below is an RL circuit:



$$L = 1\text{mH}, R = 18\Omega, R_L = 2.43\Omega \text{ (Measure this value)}$$

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

$$L = 0.8\text{mH} \quad R = 18.02\Omega \quad R_L = 2.43\Omega \quad \checkmark$$

4. 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)	Calculated values		
				Time for 1 cycle (T) =1/f	Fraction of cycle (T2-T1)/T	Phase Angle (°) (fraction x 360)
1	1	0.67	37.8	0.001	0.0378	13.608
2	1	0.80	37.8	0.0005	0.0756	27.216
3	1	0.84	34.3	0.000333	0.1029	37.044
4	1	0.89	31.4	0.00025	0.1256	45.216
5	1	0.92	28.6	0.0002	0.143	51.48
6	1	0.95	26.9	0.000167	0.1614	58.104
7	1	0.96	24.4	0.000143	0.1708	61.488
8	1	0.98	23.1	0.000125	0.1848	66.528
9	1 ✓	0.96 ✓	19.9 ✓	0.000111	0.1791	64.476 ✓

5. Produce a table of calculations as shown below:

Frequency (f - kHz)	$X_L (\Omega)$ ($2\pi fL$)	R_T ($R + R_L$)	$Z (\Omega)$	Current (A)	Phase Angle ($^\circ$)
1	5.03	20.45	21.06	0.047	13.81
2	10.05	20.45	22.79	0.044	26.18
3	15.08	20.45	25.41	0.039	36.40
4	20.11	20.45	28.68	0.035	44.51
5	25.13	20.45	32.40	0.031	50.87
6	30.16	20.45	36.44	0.027	55.86
7	35.19	20.45	40.70	0.025	59.83
8	40.21	20.45	45.11	0.022	63.04
9	45.24 ✓	20.45 ✓	49.65 ✓	0.020 ✓	65.67 ✓

5. Reactance (X_L) = $2\pi fL$ Total resistance = (R_T) $R + R_L$ Impedance (Z) = $\sqrt{R_T^2 + X_L^2}$ Current (I) = V/Z Phase angle (θ) = $\tan^{-1}(X_L/R_T)$. ✓	
Chosen frequency = 5 kHz	
a) $X_L = 2\pi fL$ ✓	$= 2 \times \pi \times 5000 \times 0.0008 = 25.13 \Omega$ ✓
b) $R_T = R + R_L$ ✓	$= 18.02 + 2.43 = 20.45 \Omega$ ✓
c) Impedance = $\sqrt{R_T^2 + X_L^2}$ ✓	$= \sqrt{20.45^2 + 25.13^2} = 32.40 \Omega$ ✓
d) Current = V/Z ✓	$= 1/32.40 = 0.031 A$ ✓
e) Phase angle = $\theta = \tan^{-1}(X_L/R_T)$ ✓	$= \tan^{-1}(25.13/20.45) = 50.86^\circ$ ✓

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

When considering differences in practical and calculated results, there are a few things that could have an effect and cause a discrepancy. Firstly, when taking a reading you are putting trust in the test instrument. If we are extracting a reading from a waveform for example on an oscilloscope- we are gauging it roughly. The cursor may be slightly misplaced and the reading may be fluctuating in real time. Although the result will be good enough for reference we may see a slight difference in comparison to the calculated. Other things such as room temperature, external factors, correct lighting and age of the test instrument could have an impact. We may even see slight differences in calculated readings. This could be due to rounding too soon or differently. Rounded numbers early on in an equation would have a knock on effect as it goes on.

Final word count (Excluding questions) = 2175

Throughout this report your calculation has been excellent but are a number of elements that you could improve.

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*You have used limited resources, have not used any text books.
There is no direct referencing within your assignment.*