

LEVEL 4 ASSESSMENT SPECIFICATION

Student name:	Parry Phillips	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:	11/01/23	Return date of provisional marks & written feedback:	25/01/23
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.

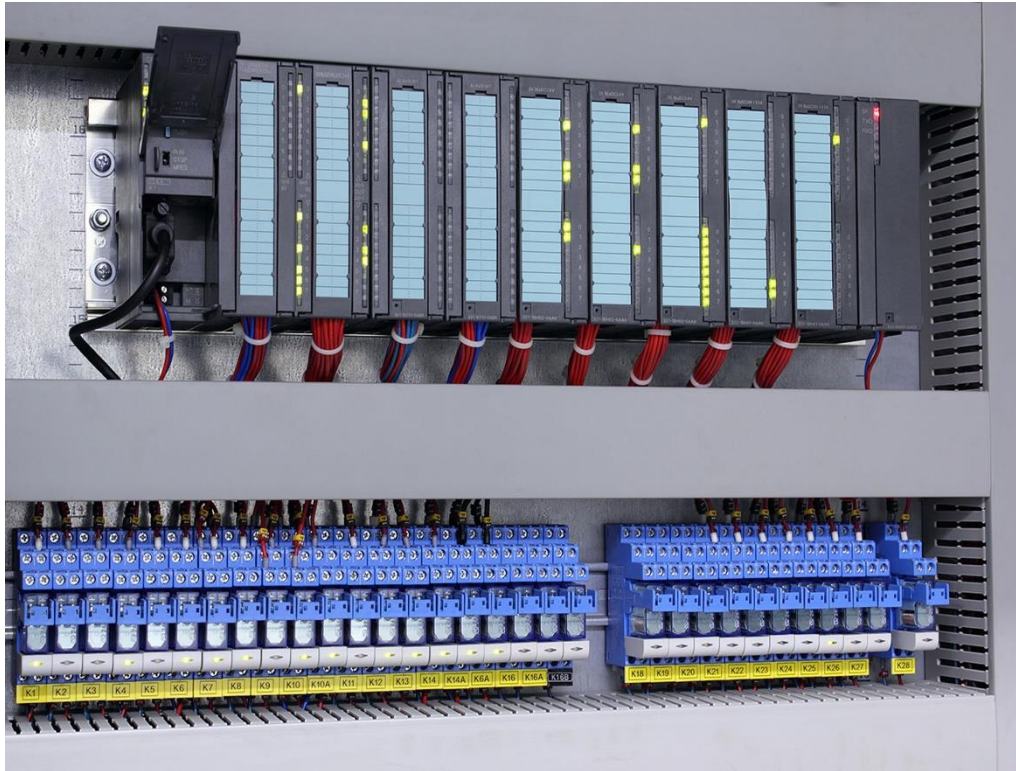
STUDENT FEEDBACK FORM

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	5.3
Poor engagement with essential reading, very few text books listed have mainly included web sites. No evidence of wider reading and reliance on inappropriate sources. Inconsistent and weak use of referencing and the reference list is very poor in its layout.		
2. Knowledge and Understanding Skills	30	16.2
Task 1 achieved 67%. Task 2 achieved 61%, Task 3 achieved 58%. Task 4 achieved 30%. Knowledge of the basic underlying concepts and principles is accurate with a good understanding in most areas. For some of the calculation work have not shown all formulas and have not shown an example of the calculations for task 4.		
3. Cognitive and Intellectual Skills	10	3.7
Task 1 achieved 42%. Task 4 achieved 32%. Minimum attempt at evaluation for Task 1 and Task 4. There are a number of additional factors to be considered when explaining the results.		
4. Practical Application Skills	35	28.4
Task 1 achieved 82%. Task 4 achieved 80%. 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	4.8
Mostly coherent, organised and accurate work, in a suitable structure and is for the most part clearly expressed.		

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)		58%
	Up to 1 week late (40% Max)		
	Over 1 week late (0%)		

Electrical Principles



Author: Parry Phillips

Lecturer: Jason Pointer

Assignment Title: Electrical Principles

Contents

References: 3

Not much of a contents page.

References:

Gussow, M. (2009). *Schaum's Outline of Basic Electricity*, 2.

(Mack & Shoemaker, 2006)

(College, 2022)

(TECHNOLOGY, 2015)

(NFCC, n.d.)

(Woodford, 2008)

(Nave, 2012)

(Tutorials, 2018)

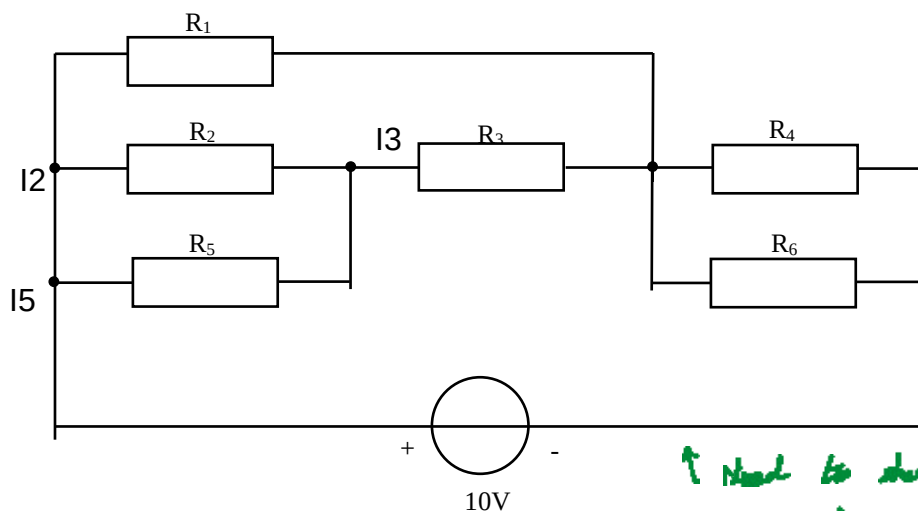
References to be stated
the end.

1. 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.

The results between the calculations and the practical results had minimal differences. The minimal difference highlights that the calculations and practical readings were done correctly. The minimal difference in readings will be due to equipment used as the multimeter and cables are used frequently in college and haven't been replaced recently. Human error may also play part in the reading differences as the numbers were rounded to two decimal places. Kirchhoff's law first law states 'that the current flowing into a node (or a junction) must be equal to the current flowing out of it. This is a consequence of charge conservation' (Physics, n.d.). An example of this can be seen below in the series parallel diagram. $I_2 + I_5 = I_3$

4.46 + 11.6 = 16.06 (Calculation Result)

When testing the current with the multimeter a reading of 16.05mA was recorded.



Resistors in Series/Parallel

↑ Had to show all currents and voltages.

Kirchhoff's second law states. 'That for a closed loop series path the algebraic sum of all the voltages around any closed loop in a circuit is equal to zero.'

(Tutorials, 2018). When testing the voltages across the circuit they did all equal to 0 when readings were rounded to a whole number.

How does this relate to your results?

There are other factors to consider.

Workings out:

Resistance:

$$1/R_{2R5} = 1/390 + 1/150$$

formula.

$$1/R_{2R5} = 3/325$$

$$R_{2R5} = 108.33\Omega$$

$$R_{2R5} + R_3 = R_{2R3R5}$$

$$108.33 + 330 = 438.33\Omega$$

$$1/R_{2R3R5} + 1/R_1 = 1/R_{1R2R3R5}$$

$$1/438.33 + 1/5.6 \times 10^{-3} = 2.46 \times 10^{-3}$$

$$R_{1R2R3R5} = 406.511$$

$$1/R_4 + 1/R_6 = 1/R_{4R6}$$

$$1/270 + 1/470 = 37/6345$$

$$R_{4R6} = 171.49$$

$$R_T = R_{4R6} + R_{1R2R3R5}$$

$$R_T = 171.49 + 406.51$$

$$R_T = 578\Omega$$

Supply Current:

$$I = V/R_T$$

$$I = 10/578$$

$$I = 17.3\text{mA}$$

$$V_4 = I \times R_{4R6}$$

$$V_4 = 17.3 \times 10^{-3} \times 171.49$$

$$V_4 = 2.97\text{V}$$

$$I_4 = V_4/R_4, I_6 = V_4/R_6$$

$$I_4 = 2.97/270, I_6 = 2.97/470$$

$$I_4 = 11\text{mA}, I_6 = 6.32\text{mA}$$

$$V_1 = V_T - V_4$$

$$V_1 = 7.03\text{V}$$

$$I_1 = V_1/R_1$$

$$I_1 = 7.03/5.6 \times 10^{-3}$$

$$I_1 = 1.26\text{mA}$$

$$I_3 = I - I_1$$

$$I_3 = 16.04\text{mA}$$

$$V_3 = I_3 \times R_3$$

$$V_3 = 16.04 \times 10^{-3} \times 330 \quad \checkmark$$

$$V_3 = 5.2932V \quad \checkmark$$

$$V_1 - V_3 = V_2 \quad \checkmark$$

$$V_2 = 7.03 - 5.2932 \quad \checkmark$$

$$V_2 = 1.74V \quad \checkmark$$

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

$$I_2 = 1.74/390 \quad \checkmark$$

$$I_2 = 4.46mA \quad \checkmark$$

$$I_5 = V_2/R_5 \quad \checkmark$$

$$I_5 = 1.74/150 \quad \checkmark$$

$$I_5 = 11.6mA \quad \checkmark$$

Power: $\checkmark$

$$P = V \times I \quad \checkmark$$

$$P_1 = 7.03 \times 1.26 \times 10^{-3}$$

$$P_1 = 8.85mW \quad \checkmark$$

$$P_2 = 1.74 \times 4.46 \times 10^{-3}$$

$$P_2 = 7.76mW \quad \checkmark$$

$$P_3 = 5.29 \times 16.04 \times 10^{-3}$$

$$P_3 = 84.85mW \quad \checkmark$$

$$P_4 = 2.97 \times 11 \times 10^{-3} \quad \checkmark$$

$$P_4 = 32.67mW$$

$$P_5 = 1.74 \times 11.6 \times 10^{-3} \quad \checkmark$$

$$P_5 = 20.18mW \quad \checkmark$$

$$P_6 = 2.97 \times 6.32 \times 10^{-3}$$

$$P_6 = 18.77mW \quad \checkmark$$

The calculations were all correct.

Calculations Results:

$R_T = 578\Omega$	$I_T = 17.3 \text{ mA}$	$V = 10V$
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R1=5.6k Ω	I1=1.26mA	V1=7.03V
R2=390 Ω	I2=4.46mA	V2=1.74V
R3=330 Ω	I3=16.04mA	V3=5.29V
R4=270 Ω	I4=11mA	V4=2.97V
R5=150 Ω	I5=11.6mA	V5=1.74V
R6=470 Ω	I6=6.32mA	V6=2.97V



Practical Results:

RT=570 Ω ✓	IT=17.25 mA ✓	V=9.97V
R1=5.6k Ω	I1=1.26mA	V1=6.99V
R2=390 Ω	I2=4.44mA	V2=1.75V
R3=330 Ω	I3=16.05mA	V3=5.20V
R4=270 Ω	I4=10.88mA	V4=2.97V
R5=150 Ω	I5=11.48mA	V5=1.74V
R6=470 Ω	I6=6.37mA ✓	V6=2.97V ✓

Task 2 – Capacitors

1. A capacitor is an electronic device that stores electrical charge and is used in a number of electronic applications. Explain the construction of the capacitor, include methods that could be used to alter the value of the capacitor.

A capacitor is a device that stores electrical energy by storing electric charges on two surfaces in proximity insulated from each other which is known as the dielectric. One plate will have a positive charge while the other plate will have an equal but opposite charge, negative in this case. The capacitor has two terminals where the electricity can charge the capacitor, or the electricity can discharge from the capacitor. To alter the capacitance effectively altering the value of the capacitor. The size of the plates and distance between the two plates will alter the capacitance of the capacitor. Finally, the dielectric can be made with different insulators resulting in difference in the release of the charge (Woodford, 2008). ✓

Would like more detail.

2.

Calculations Results:

CT=24.81μF	WT = 4957.345 μJ ✓	V=20V
Q1 = 253.78μC	W1=1789.29 μJ	V1=7.03V
Q2 = 59μC	W2=174.05 μJ	V2=1.74V
Q3 = 194.7 μC	W3 = 574.365 μJ	V3=5.29V
Q4 = 242.44 μC	W4 = 1333.42 μJ	V4=2.97V
Q5 = 242.44 μC ✓	W5 = 1086.22 μJ ✓	V5=1.74V ↑

These values are not correct, don't match your calculations

Workings out:

Circuit Capacitance:

$$C_2 C_3 = 10 + 33 \quad / \quad \text{formula?}$$

$$C_2 C_3 = 43 \mu\text{F}$$

$$1/C_1 + 1/C_2 C_3 = 1/C_{123} /$$

$$1/18 + 1/43 = 61/774$$

$$C_{123} = 12.689 \mu\text{F} \quad /$$

$$1/C_4 C_5 = 1/C_4 + 1/C_5 \quad /$$

$$1/C_4 C_5 = 1/22 + 1/27 \quad /$$

$$1/C_4 C_5 = 49/594$$

$$C_4 C_5 = 12.122 \mu\text{F} \quad /$$

$$C_T = C_{123} + C_4 C_5 \quad /$$

$$C_T = 12.689 + 12.122$$

$$C_T = 24.81 \mu\text{F} \quad \checkmark$$

Total Charge:

$$Q_T = C_T \times V \quad \checkmark$$

$$Q_T = 24.81 \times 20$$

$$Q_T = 496.22 \mu\text{C} \quad \checkmark$$

The charge in each capacitor / The energy stored in each capacitor:

$$Q_4 = Q_5 \quad \checkmark$$

$$C_4 C_5 \times V = Q_4 Q_5 \quad /$$

$$12.122 \times 20 = 242.44$$

$$Q_4 Q_5 = 242.44 \mu\text{C} \quad /$$

$$Q_T - Q_4 Q_5 = 496.22 - 242.44 \quad \checkmark$$

$$Q_1 = 253.78 \mu\text{C} \quad /$$

$$V_1 = Q_1 / C_1 \quad \checkmark$$

$$V_1 = 253.78 / 18$$

$$V_1 = 14.099 \text{V} \quad \checkmark$$

$$V_3 = V - V_1 \quad \checkmark$$

$$V_3 = 20 - 14.099$$

$$V_3 = 5.9 \text{V} \quad \checkmark$$

$$V_3 = V_2 \quad \checkmark$$

$$V_2 = 5.9V$$

$$Q_2 = C_2 \times V_2$$

$$Q_2 = 10 \times 5.9$$

$$Q_2 = 59\mu C$$

$$Q_3 = C_3 \times V_3$$

$$Q_3 = 33 \times 5.9$$

$$Q_3 = 194.7 \mu C$$

$$Q_4 = 242.44 \mu C$$

$$Q_5 = 242.44 \mu C$$

$$V_4 = Q_4/C_4$$

$$V_4 = 242.22/22$$

$$V_4 = 11.01V$$

$$V_5 = Q_5/C_5$$

$$V_5 = 242.22/27$$

$$V_5 = 8.97V$$

Total energy stored in the circuit:

$$W = 1/2 C \times V^2$$

$$W_1 = 1/2 \times 18 \times 14.1^2$$

$$W_1 = 1789.29 \mu J = 1.79 mJ$$

$$W_2 = 1/2 \times 10 \times 5.9^2$$

$$W_2 = 174.05 \mu J$$

$$W_3 = 1/2 \times 33 \times 5.9^2$$

$$W_3 = 574.365 \mu J$$

$$W_4 = 1/2 \times 22 \times 11.01^2$$

$$W_4 = 1333.42 \mu J$$

$$W_5 = 1/2 \times 27 \times 8.97^2$$

$$W_5 = 1086.22 \mu J$$

$$W_T = W_1 + W_2 + W_3 + W_4 + W_5$$

$$W_T = 4957.345 \mu J$$

Good work.

Task 3 – Magnetism

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

Permanent magnets are magnets that have an internal atomic structure creates a magnetic field within without the need of electricity. The most common forms of magnetic materials are iron, nickel and cobalt including alloys of these metals. Ferromagnetic materials with retentivity and coercivity is what creates a permanent magnet. A unique pattern forms around the permanent magnet in what is known as the magnetic field. The strength and size of the magnet determine how large the magnetic field is. All magnets have a pole which are denoted as a north and south pole opposite sides of the magnet. The magnetic field lines leave through the north pole end and loop around to the south end (Bergstresser, 2017) ✓

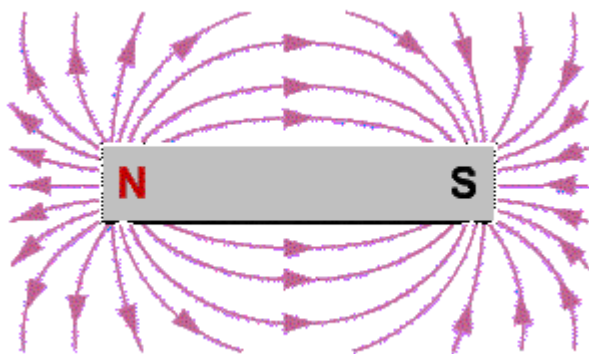


Figure 1. Magnet poles and magnetic field lines. ✓

<http://www.learningtarget.com/magpulse/Magnets.htm>

The curved lines on the diagram are the magnetic field lines which highlight the strength, direction, and shape of the magnetic field. The smaller the distance between the lines the stronger the magnetic field is at that point. If another magnet was introduced and the south pole of the introduced magnet was placed against the north pole of the initial magnet the two pole ends would be attracted to each other. However, if the same pole ends are placed together the magnetic poles would repel. Bar magnets produce their own magnetic field, if two bar magnetics are placed in proximity of each other the magnetic fields will combine and form a new coherent field (College, 2022).

2. Solve the following problems:

- a) The maximum working flux density of a lifting electromagnet is 1.6T and the effective area of a pole face is circular in cross-section. If the total magnetic flux produced is 550mWb determine the radius of the pole face.

$$B = 1.6T \quad \Phi = 550\text{mWb} \quad A = \pi r^2$$

$$B = \Phi/A$$

$$1.6A = 550 \times 10^{-3}$$

$$A = 550 \times 10^{-3} / 1.6$$

$$A = 0.34375\text{m}^2$$

$$A = \pi r^2$$

$$0.34375 / \pi = r^2$$

$$r = \sqrt{\frac{0.34375}{\pi}}$$

$$r = 0.33\text{m}$$

- b) An iron toroid having a mean radius of 0.1m and cross-sectional area of 3.49cm^2 is wound with a 1200 turn coil. The coil current re-

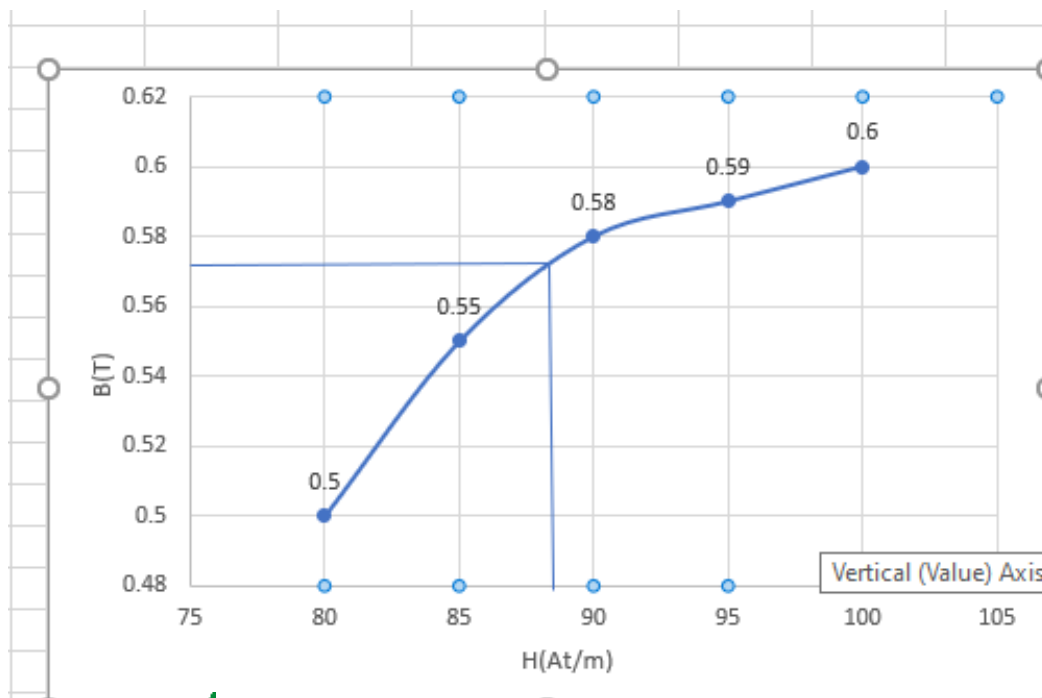
sults in a flux of 0.2mWb in the toroid. Using the following data, determine (i) the coil current and (ii) the relative permeability of the toroid under these conditions.

H(At/m)	80	85	90	95	100
B(T)	0.5	0.55	0.58	0.59	0.6

$$B = \Phi / A$$

$$B = 0.2 \times 10^{-3} / 3.49 \times 10^{-4}$$

$$B = 0.573 \text{ T}$$



$$H = 88 \text{ A/m}$$

$$H = \frac{N \times I}{L}$$

$$L = 2\pi r$$

$$L = 2\pi \times 0.1$$

$$L = 0.628 \text{ m}$$

$$I = (L \times H) / N$$

$$I = (0.628 \times 88) / 1200$$

$$I = 0.046 \text{ A}$$

$$\mu_0 \times \mu_r = \frac{B}{H}$$

$$\mu_r = \frac{B}{\mu_0 \times H}$$

$$\mu_r = \frac{0.573}{4\pi \times 10^{-7}}$$

$$\mu_r = 5181.58$$

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

Electromagnetic induction uses the relationship between electricity and magnetism whereby an electric current is passed through a conductive wire, the wire will be coiled round a metal core producing a magnetic field around it due to the moving charges creating a magnetic field.

Hence, the name electromagnet as the device will only be magnetic when electric current is passed through the magnet. The number of windings around the core and if a ferromagnetic material is used will increase the strength of the magnetic field (Nave, 2012).

A bit brief, no diagram.

4. A transformer is a device that uses some of the principles associated with magnetism. Explain the operation and construction of a transformer, include diagrams and equations to show how voltage, current and turn ratios are related. Discuss how transformers are an essential part of the National Grid System.

A transformer uses principles of electromagnetism to change the A.C. voltage to a higher or lower voltage. It works on the principle that energy can be transferred by magnetic induction from a primary coil to a secondary coil which is set by means of a varying magnetic flux. The magnetic flux is produced by an A.C voltage (Gussow, 2009) When another conductor (secondary coil) is introduced within the initial magnetic field the fields will interact and common up together which is known as mutual induction. The formula to calculate the voltage on each coil is, Voltage secondary coil (V_s) = Voltage primary coil (V_p), No. of windings

secondary coil (N_s), No. windings secondary coil. The formula can be rearranged to find various data on the transformer. The formula is $V_p = (N_p / N_s) \times V_s$. (Mack & Shoemaker, 2006). For example, if the primary voltage is 100V. The primary winding has 16 turns and the secondary winding has 8 turns. The calculation to work out the secondary voltage is $100 / (16/8) = V_s$. which equals 50v. The formula and image can help understand the relation between the number of windings and the voltage. The number of windings on either primary or secondary corelates to the voltage output of the transformer. A step-up transformer will have a greater number of windings on the secondary coil whereas a step-down transformer will have more windings on the primary coil. However, the power out must equal the power in hence why the current does the opposite to an increase or decrease in the voltage from the transformer. 'According to the power formula, it says that Current is inversely proportional to the voltage if power remains the same' (TECHNOLOGY, 2015).

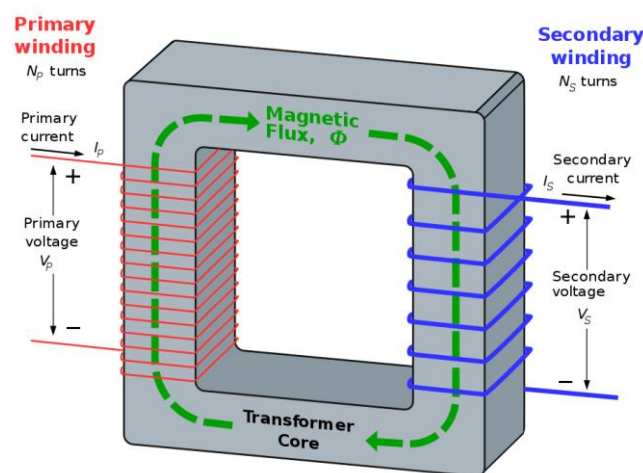


Figure 2. Basic Transformer https://en.wikipedia.org/wiki/Transformer#/media/File:Transformer3d_col3.svg

Transformers are critical to efficient distribution of electricity. The power which is generated from renewable and non-renewable sources in the UK is connected to the national transmission network. When an electricity is passed through a wire some of the energy is lost through heat. The higher the current passed through the wire the more heat / energy is lost through the wire. To reduce the loss of energy and to be efficient

with the electricity that is supplied from the power stations, a step-up transformer is used to increase the voltage significantly enough to minimise the loss of energy as the 'Current is inversely proportional to the voltage if power remains the same'. Electricity is sent through the national grid at 400kV, 275kV and 132kV. However, these high voltages are too dangerous for everyday house and business needs hence why a step-down transformer is used to decrease the voltage to a safe level. The mains supply to a house is 230v (NFCC, n.d.)



5.) Solve the following problems:

- a) An iron ring of cross-sectional area 8.4cm^2 and mean diameter 25cm, contains an air gap 3mm wide. It is required to produce a flux of 1.4mWb in the air gap. Calculate the mmf required, given that the relative permeability of the iron is 1200 under these operating conditions.

$$A = 8.4 \times 10^{-4}$$

$$D = 0.25\text{m}$$

$$AG = 3 \times 10^{-3}$$

$$S_i = L_{\text{iron}} / (\mu_0 \times \mu_r \times A)$$

$$S_i = 0.25 \times \pi / (4\pi \times 10^{-7}) \times 1200 \times 8.4 \times 10^{-4}$$

$$S_i = 620039.6825 \text{ A/Wb}$$

$$S_a = L_a / (\mu_0 \times \mu_r \times A)$$

$$S_a = 3 \times 10^{-3} / (4\pi \times 10^{-7}) \times 1 \times 8.4 \times 10^{-4}$$

$$S_a = 2842052.56 \text{ A/Wb}$$

$$\text{Total, } S_i + S_a = 3462092.243$$

$$S = \text{mmf} / \Phi$$

$$\text{mmf} = S \times \Phi$$

$$3.462092 \times 10^6 \times 1.4 \times 10^{-3} = \text{mmf}$$

$$\text{mmf} = 4846.929 \text{ At}$$

- 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 80 turns and rotates at 1200rev/min. (i) Calculate the maximum generated e.m.f. (ii) If the coil generates 100V, at what speed will the coil rotate?

(i) $E = 2 \times B \times L \times V \times N$ ✓
 $V = \omega r = nr/60 \times 8 \times 10^{-2} \times 2\pi$ ✓
 $V = \omega r = nr/60 \times 8 \times 10^{-2} \times 2\pi$ ✓
 $V = 1200/60 \times 6 \times 10^{-2}/2 \times 2\pi$ ✓
 $V = 3.77 \text{ m/s}$ ✓
 $E = 2 \times 1.2 \times 10 \times 10^{-2} \times 3.77 \times 80$
 $E = 72.384\text{V}$ ✓

(ii) $V = 100$
 $V = E / 2 \times B \times L \times N$ ✓
 $100 / 2 \times 1.2 \times 10 \times 10^{-2} \times 80 = V$
 $V = 5.208\text{m/s}$ ✓
 $\omega = v/r = 5.208 / (6 \times 10^{-2}) / 2$
 $\omega = 173.6 \text{ rad/s}$ ✓
 $\text{speed} = \omega \times 60 / 2 \pi = 173.6 \times 60 / 2 \pi$
 $\text{speed} = 1657.864 \text{ rpm}$ ✓

well done.

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

You have not cover the first part of the task.

Frequency (f) (kHz)	CH1 (V) pk to pk Volt- age	CH2 (V) pk to pk Volt- age	Time Differ- ence (be- tween peaks) (μ s)	Phase Angle ($^{\circ}$)
1	1.62	1.22	58	20.88
2	1.9	1.2	56	40.32
3	2.2	1.14	47	50.76
4	2	0.92	39.6	57.024
5	1.68	0.96	32.8	59.04
6	2.44	0.84	30	64.8
7	3.04	0.84	25.2	63.504
8	3.14	0.78	23.2	66.816
9	3.24 ✓	0.72 ✓	20.8 ✓	67.392 ✓

Calculated Values

L= 2.23 mH

R = 26.7 Ω

RL= 6.28 Ω

write

Frequency (f - kHz)	X_L (Ω)	R_T	Z (Ω)	Current (A)	Phase Angle ($^{\circ}$)
1	14.011 503	32.980	35.833	0.112	23.02

2	28.023 006	32.980	43.278	0.092	40.35
3	42.034 51	32.980	53.428	0.075	51.88
4	56.046 013	32.980	65.030	0.062	59.53
5	70.057 516	32.980	77.432	0.052	64.79
6	84.069 019	32.980	90.307	0.044	68.58
7	98.080 523	32.980	103.477	0.039	71.41
8	112.09 203	32.980	116.843	0.034	73.60
9	126.10 353 ✓	32.980 ✓	130.345 ✓	0.031 ✓	75.34 ✓

The results between the calculations and the practical results had minimal differences. The minimal difference highlights that the calculations and practical readings were done correctly. The minimal difference in the calculations and practical will have been affected by the ability to accurately position the oscilloscope gauges on the change in the x-axis on the sin wave as the oscilloscope could only zoom so far on the sin wave so human error could have been a factor, a peak-to-peak reading was needed. To input the correct the voltage on the oscilloscope was difficult even with the fine-tuning settings so the results will have been affected by a +- minute difference. ✓

Have not include an example of calculations