UEENEEG101A – Solve problems in electromagnetic devices and related circuits (Release 3)

Assessment instructions

Table 1 Assessment instructions

Assessment details	Instructions
Assessment overview	The objective of this assessment is to assess your knowledge as would be required to solve problems in electromagnetic devices and related circuits.
Assessment Event number	1 of 3
Instructions for this assessment	This is a written assessment and will be assessing you on your knowledge of the unit. It is divided into the following parts. The assessment may be delivered as a whole, or the parts delivered separately or in combinations relevant to delivery schedule. Part 1 – Magnetism Part 2 – Electromagnetism Part 3 – Magnetic Circuits Part 4 – Electromagnetic Induction Part 5 – Inductance Part 6 – Measuring Instruments Part 7 – Magnetic Devices Part 8 – DC Machine Principles Part 9 – DC Machine Construction, Testing and Maintenance Part 10 – DC Generators Part 11 – DC Motors Part 12 – DC Machine Efficiency Part 13 – Assessment feedback

Assessment details	Instructions
Submission instructions	On completion of this assessment, you are required to hand it to your trainer for marking. Ensure you have written your name at the bottom of each page of this assessment. It is important that you complete the assessment declaration when submitting the assessment.
What do I need to do to achieve a satisfactory result?	To achieve a satisfactory result for this assessment all questions must be answered correctly. If you do not achieve this on the first attempt but you do answer more than 60% of questions correctly, you will be allowed to reattempt questions or parts of this assessment after referring to your learning materials to build your understanding and correct mistakes. Your assessor will advise you of the criteria and process for reattempting parts or questions, and/or resitting the whole assessment.
What do I need to provide?	Pens, pencils, eraser, rule, highlighter, scientific calculator.
Due date and time allowed	3 hours in total. Where sections are delivered independently, the time allowed is indicated at the beginning of each section.
Assessment feedback, review or appeals	In accordance with the TAFE NSW policy Manage Assessment Appeals, all students have the right to appeal an assessment decision in relation to how the assessment was conducted and the outcome of the assessment. Appeals must be lodged within 14 working days of the formal notification of the result of the assessment. If you would like to request a review of your results or if you have any concerns about your results, contact your Teacher or Head Teacher. If they are unavailable, contact the Student Administration Officer. Contact your Head Teacher for the assessment appeals procedures at your college/campus.

Equation Summary

$$F = \frac{2 \times 10^{-7} \times I_1 \times I_2}{S}$$

$$E = N\frac{\Delta\Phi}{\Delta t}$$

$$I_a = \frac{V_T - E_g}{R_a}$$

$$F_m = IN$$

$$V = L\frac{\Delta \mathrm{I}}{\Delta t}$$

$$I_{sh} = \frac{V_{sh}}{R_{sh}}$$

$$H = \frac{IN}{l}$$

$$L = N\frac{\Delta\Phi}{\Delta \mathrm{I}}$$

$$I_a = I_L - I_{sh}$$

$$B = \frac{\Phi}{A}$$

$$L = \frac{\mu_0 \mu_r N^2 A}{l}$$

$$V_T = I_a R_a + E_g$$

$$A = \pi r^2$$

$$\tau = \frac{L}{R}$$

$$V_T = I_a(R_a + R_{se}) + E_g$$

$$A = \frac{\pi d^2}{4}$$

$$T = Fr$$

$$P = \frac{2\pi nT}{60}$$

$$\mu = \mu_0 \mu_r$$

$$T = \frac{p\Phi IZ}{2\pi a}$$

$$P_{loss} = P_{in} - P_{out}$$

$$R_m = \frac{l}{\mu_0 \mu_r A}$$

$$E_g = \frac{p\Phi nZ}{60a}$$

$$h\,\% = \frac{P_{out}}{P_{in}} \times 100$$

$$\Phi = \frac{IN}{R_m}$$

$$I_{sh} = \frac{V_{sh}}{R_{sh}}$$

$$I_a = \sqrt{\frac{P_{fixed}}{R_a}}$$

$$e = Blv\sin\theta$$

$$I_a = I_{sh} + I_L$$

$$V_{Reg}\,\% = \frac{V_{NL} - V_{FL}}{V_{FL}} \times 100$$

$$F = BIl$$

$$R_m = R_c + R_g$$

$$E_g = I_a R_a + V_T$$

$$N_{Reg}\% = \frac{N_{NL} - N_{FL}}{N_{FL}} \times 100$$

$$E_g = I_a(R_a + R_{se}) + V_T$$

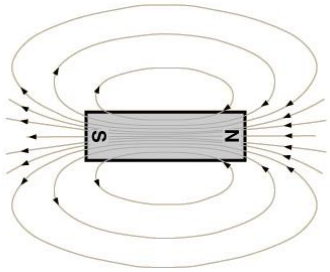
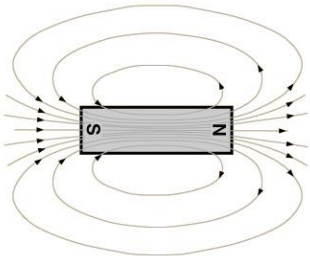
Part 1: Magnetism

(Time allowed - 10 minutes)

Instructions: For multiple choice questions, place an X in the appropriate box. For short answer questions, write the answer in the space provided. For questions that require calculations, show all working and write your answer in the space provided.

1. 1 Which of the following diagrams represent the conventional direction of flux outside a bar magnet?

Table 2 Multiple choice

Answer choices	Put X next to your answer
	
	**B**

1. 2 When the following bar magnets are brought into close proximity, what would be the effect?

Table 3 Multiple choice

Answer choices	Put X next to your answer
a) The magnets will attract one another	
b) The magnets will repel one another	B

Answer choices	Put X next to your answer
c) There will be no effect due to the lack of south poles	

1. 3 A soft iron bar when held near a horseshoe magnet as shown below will take on the properties of a magnet. What pole will be created at the end of the bar marked "A"?

Table 4 Multiple choice

Answer choices	Put X next to your answer
a) North pole	
b) South pole	x

1. 4 Materials containing **iron** typically have a **strong attraction** to magnetic fields. These are known as:

Table 5 Multiple choice

Answer choices	Put X next to your answer
a) diamagnetic materials	
b) ferromagnetic materials	x
c) paramagnetic materials	

1. 5 Some materials, like aluminium, have only a **very weak attraction** to magnetic fields. These are known as:

Table 6 Multiple choice

Answer choices	Put X next to your answer

Answer choices	Put X next to your answer
a) diamagnetic materials	
b) ferromagnetic materials	
c) paramagnetic materials	x

1. 6 Some materials, like water, are **repelled** by a magnetic field. These are known as:

Table 7 Multiple choice

Answer choices	Put X next to your answer
a) diamagnetic materials	x
b) ferromagnetic materials	
c) paramagnetic materials	

1. 7 The purpose of **magnetic screening** is to:

Table 8 Multiple choice

Answer choices	Put X next to your answer
a) increase the strength of a magnetic field	
b) shield equipment from a magnetic field	x
c) eliminate a magnetic field	
d) saturate a magnetic field	

1. 8 Which of the following materials would be best for **magnetic screening**?

Table 9 Multiple choice

Answer choices	Put X next to your answer
a) Aluminium	

Answer choices	Put X next to your answer
b) Brass	
c) Plastic	
d) Steel	x

1. 9 If a magnet is moved closer to a normally open (NO) type reed switch:

Table 10 Multiple choice

Answer choices	Put X next to your answer
a) the moveable contact in a reed switch is magnetised by a permanent magnet and is attracted to the magnet and closes the contact	x
b) the moveable contact in a reed switch is not affected by the magnetic field.	

1. 10 What would be a common application of a reed switch?

Table 11 Multiple choice

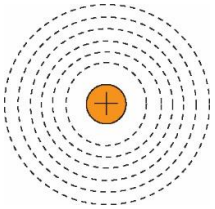
Answer choices	Put X next to your answer
c) Used for switching high current circuits	
d) Used with alarm systems sensing circuits	x
e) Used for temperature control	
f) Used for high voltage switching	

Part 2 – Electromagnetism

(Time allowed - 10 minutes)

Instructions: For multiple choice questions, place an X in the appropriate box. For short answer questions, write the answer in the space provided. For questions that require calculations, show all working and write your answer in the space provided.

2.1 The following diagram represents a conductor carrying an electric current.

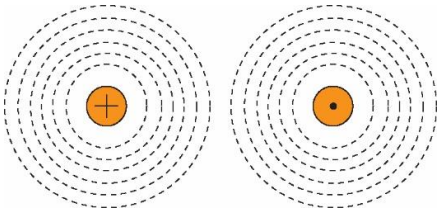


Based on the direction of current flow, the direction of the magnetic field would be:

Table 12 Multiple choice

Answer choices	Put X next to your answer
a) clockwise around the conductor	x
b) anticlockwise around the conductor	

2.2 The following diagram represents two adjacent conductors carrying an electric current.



With the direction of current shown for each conductor and the resultant magnetic fields:

Table 13 Multiple choice

Answer choices	Put X next to your answer
a) the conductors would be attracted to one another	x
b) the conductors would repel one another	

2.3 A DC circuit supplying an electric solenoid has its positive and negative cables lying next to one another in a cable duct. The cables are 30m long and spaced apart by 1mm. The circuit current is 80A. Calculate the force produced per metre of length between the two conductors. (13)

Show all working and write your answer in the space provided

$$F = \frac{2 \times 10^{-7} \times I_1 \times I_2}{S}$$

2x $10^{-7} x\ 80x80$

F=----------= 1.28 N

1x 10^{-3}

F=	

2.4 The coil below is connected to a DC supply to produce an electromagnet. Based on the direction of current flow, determine which end of the electromagnet is the **north** pole?

Table 14 Multiple choice

Answer choices	Put X next to your answer
a) The north pole is end “A”	
b) The north pole is end “B”	x

2.5 A coil with 240 turns has a current of 3 amperes flowing through it. Determine the

Show all working and write your answer in the space provided.

$$F_m = IN = 3x240 = 720N$$

magnetomotive force produced by the coil.

2.6 Which of the following devices incorporate an electromagnet with a ferromagnetic circuit in their design?

*Select **ALL** that apply*

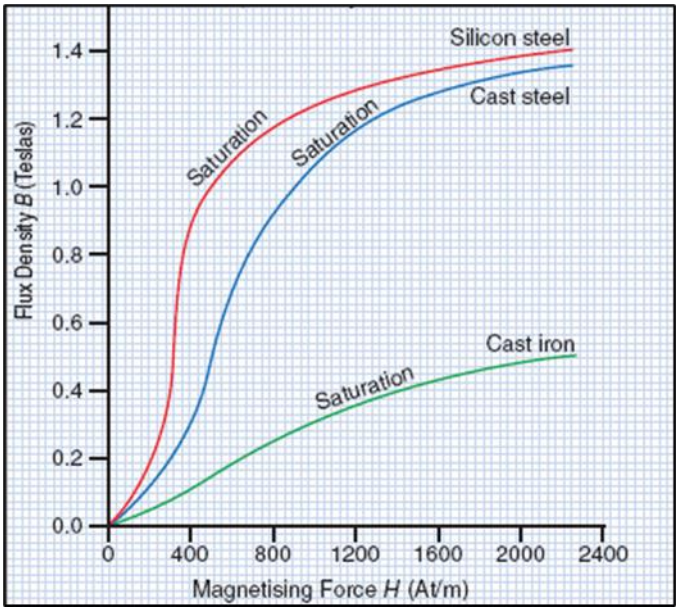
Table 15 Multiple choice

Answer choices	Put X next to your answer
a) Contactor	
b) Reed switch	
c) Relay	x
d) Solenoid	x

Part 3 – Magnetic Circuits

(Time allowed - 20 minutes)

Instructions: For multiple choice questions, place an X in the appropriate box. For short answer questions, write the answer in the space provided. For questions that require calculations, show all working and write your answer in the space provided.



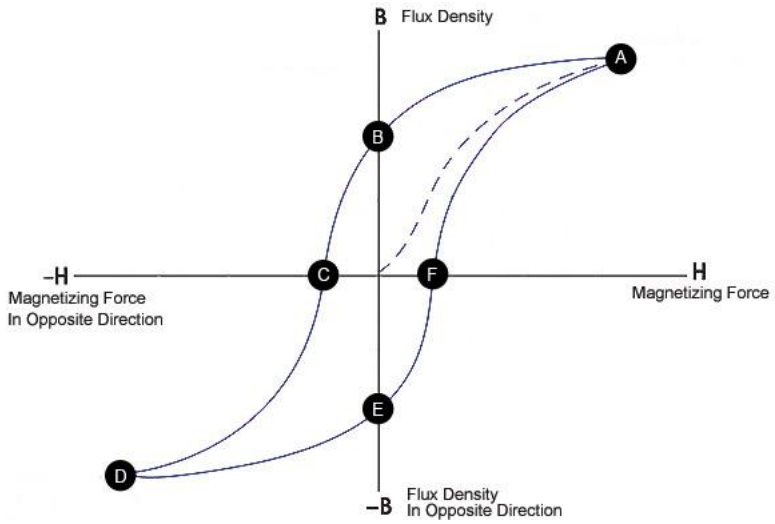
3.1 The following diagram represents the magnetisation curves for three (3) different magnetic materials.

Note that the slope of each curve and saturation regions differ significantly.

Table 9 True/false

Question Statement	Write *True* or *False*
When the value of H is in the lower ranges, much greater flux density will be produced in silicon steel compared with cast steel or cast iron.	True
Cast iron saturates at much higher values of flux density than either silicon steel or cast steel.	False

3.2 The following diagram is a hysteresis loop for a magnetic material. Identify the two points on the curve that indicate **magnetic saturation** of the material.



Magnetic saturation is indicated by points ___A____ and____D____.

3.3 To reduce **hysteresis loss** in a magnetic circuit, core materials should be made from:

Table 16 Multiple choice

Answer choices	Put X next to your answer
a) carbon steel	
b) cast iron	
c) silicon steel	x
d) stainless steel	

3.4 In some magnetic circuits, the magnetic core is l**aminated** to:

Table 17 Multiple choice

Answer choices	Put X next to your answer
a) reduce eddy current loss	x
b) increase the permeability	
c) reduce the hysteresis loss	x

Answer choices	Put X next to your answer
d) increase retentivity	

3.5 **Magnetic flux** can be defined as:

Table 18 Multiple choice

Answer choices	Put X next to your answer
a) the strength of a magnetic field per unit area	
b) the total magnetic field produced by a magnetic source	x
c) the ease with which a magnetic flux can be created in a material	
d) the magnetomotive force required to magnetise a unit length of a magnetic path	

3.6 The symbol and unit for **magnetic flux** is:

Table 19 Multiple choice

Answer choices	Put X next to your answer
a) μ - Henry per meter (H/m)	
b) H - Ampere-turns per metre (At/m)	
c) B - Tesla (T)	
d) Φ - Weber (Wb)	x

3.7 The opposition to the establishment of a magnetic flux in a material is called:

Table 20 Multiple choice

Answer choices	Put X next to your answer
a) impedance	
b) resistance	

Answer choices	Put X next to your answer
c) reluctance	x
d) reactance	

3.8 Magnetic permeability can be defined as:

Table 21 Multiple choice

Answer choices	Put X next to your answer
a) the strength of a magnetic field per unit area	
b) the total magnetic field produced by a magnetic source	
c) the ease with which a magnetic flux can be created in a material	x
d) the magnetomotive force required to magnetise a unit length of a magnetic path	

3.9 The symbol and unit for **magnetic permeability** is:

Table 22 Multiple choice

Answer choices	Put X next to your answer
a) μ - Henry per meter (H/m)	x
b) H - Ampere-turns per metre (At/m)	
c) B - Tesla (T)	
d) Φ - Weber (Wb)	

3.10 When compared with non-magnetic materials, ferromagnetic materials typically have:

Table 23 Multiple choice

Answer choices	Put X next to your answer

Answer choices	Put X next to your answer
a) low reluctance and low permeability	
b) low reluctance and high permeability	x
c) high reluctance and low permeability	
d) high reluctance and high permeability	

3.11 **Flux density** can be defined as:

Table 24 Multiple choice

Answer choices	Put X next to your answer
a) the strength of a magnetic field per unit area	x
b) the total magnetic field produced by a magnetic source	
c) the ease with which a magnetic flux can be created in a material	
d) the magnetomotive force required to magnetise a unit length of a magnetic path	

3.12 The symbol and unit for **flux density** is:

Table 25 Multiple choice

Answer choices	Put X next to your answer
a) μ - Henry per meter (H/m)	
b) H - Ampere-turns per metre (At/m)	
c) B - Tesla (T)	x
d) Φ - Weber (Wb)	

3.13 **Magnetising force** can be defined as:

Table 26 Multiple choice

Answer choices	Put X next to your answer

Answer choices	Put X next to your answer
a) the strength of a magnetic field per unit area	
b) the total magnetic field produced by a magnetic source	
c) the ease with which a magnetic flux can be created in a material	
d) the magnetomotive force required to magnetise a unit length of a magnetic path	x

3.14 The symbol and unit for **magnetising force** is:

Table 27 Multiple choice

Answer choices	Put X next to your answer
a) μ - Henry per meter (H/m)	
b) H - Ampere-turns per metre (At/m)	
c) B - Tesla (T)	
d) Φ - Weber (Wb)	

3.15 The coil of an electromagnet has 2000 turns and draws a current of 2 amperes when connected to rated voltage. If the magnetic circuit has a reluctance of 2500 At/Wb, calculate the flux produced by the coil.

Show all working and write your answer in the space provided.

$\Phi = \frac{IN}{R_m}$= 2x2000/2500= 1.6 wb

Flux:

3.16 The magnetic circuit of a relay with a cross-sectional area of 400mm² has a total flux of 25mWb. Calculate the flux density in the magnetic circuit.

Show all working and write your answer in the space provided.

$B = \varphi/A = 25x10^{-3}/400\ (10^{-3})^2 = 62.5\ T$

Flux Density:

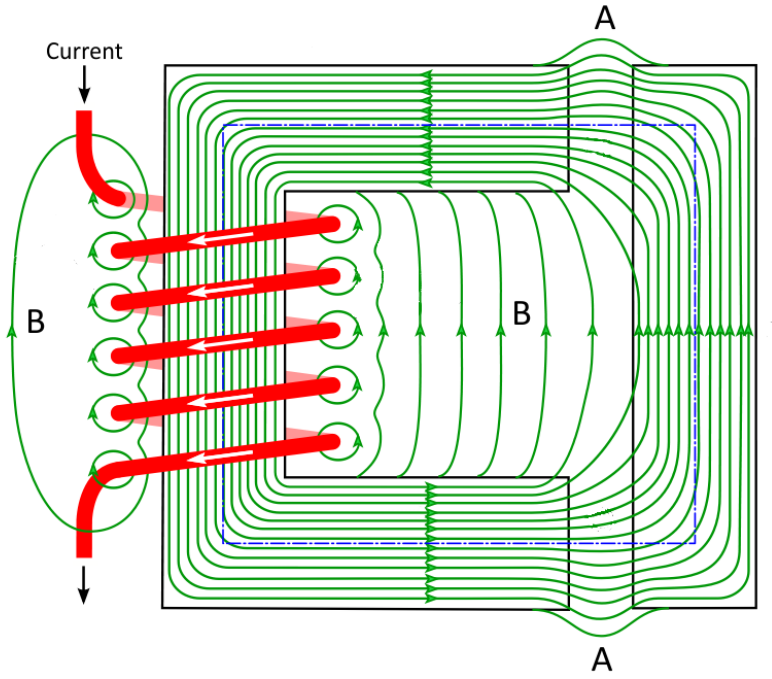
3.17 If an air gap is introduced into a magnetic circuit, the reluctance will:

Table 28 Multiple choice

Answer choices	Put X next to your answer
a) increase	x
b) be unaffected	
c) decrease	
d) reduce to zero	

3.18 The diagram below shows the magnetic circuit of a contactor.

Magnetic losses occur in the magnetic at the points labelled ‘A’ and ‘B’.



Identify these losses as either **magnetic leakage** or **magnetic fringing** by writing the associated letter in the table below.

Type of Loss	Letter
Magnetic Leakage	A
Magnetic Fringing	B

Part 4 – Electromagnetic Induction (time allowed 10 minutes)

Instructions: For multiple choice questions, place an X in the appropriate box. For short answer questions, write the answer in the space provided. For questions that require calculations, show all working and write your answer in the space provided.

4.1 "The value of the EMF induced in a circuit depends on the number of conductors in the circuit and the rate of change of the magnetic flux linking the conductors." This is known as:

Table 29 Multiple choice

Answer choices	Put X next to your answer
a) Faraday's Law	
b) Fleming's Law	
c) Kirchhoff's Law	
d) Lenz's Law	

4.2 When using "Fleming's Right Hand Rule for Generators", the thumb indicates:

Table 30 Multiple choice

Answer choices	Put X next to your answer
a) current flow	
b) magnetic field	
c) conductor motion	
d) induced EMF	

4.3 Calculate the induced EMF in a conductor of length 250 mm when passing through a field of 1.5 T at a rate of 10 m/s.

Show all working and write your answer in the space provided.

E=BLV= 1.5x250/1000 x10= 3.75Volt

e=	

4.4 Calculate the induced EMF in a coil of 1000 turns if the flux changes from 45 mWb to zero in 5 milliseconds.

Show all working and write your answer in the space provided.

e=	

4.5 Calculate the force on a conductor of length 300mm when carrying a current of 6A and placed in a field of flux density 2.5 T.

Show all working and write your answer in the space provided.

F=BIL= 2.5x6x300/1000 = 4.5 N

F=	

4.6 *"The direction of an induced EMF will be such that the resultant current flow will produce a magnetic field that opposes the original motion that caused the induced EMF."* This is known as:

Table 31 Multiple choice

Answer choices	Put X next to your answer
a) Faraday's Law	
b) Fleming's Law	
c) Kirchhoff's Law	
d) Lenz's Law	

4.7 Which of the following devices rely on the principle of **electromagnetic induction** for correct operation?

Table 32 Multiple choice

Answer choices	Put X next to your answer
a) LED lamp	
b) Transformer	
c) Wall oven	
d) Water heater	

Part 5 – Inductance

(Time allowed - 25 minutes)

Instructions: For multiple choice questions, place an X in the appropriate box. For short answer questions, write the answer in the space provided. For questions that require calculations, show all working and write your answer in the space provided.

5.1 Increasing the **number of turns** on an inductor will cause the value of inductance to:

Table 33 Multiple choice

Answer choices	Put X next to your answer
a) increase	x
b) remain the same	
c) decrease	
d) fall to zero	

5.2 Increasing the amount of iron in the magnetic circuit of an iron core inductor will cause the value of inductance to:

Table 34 Multiple choice

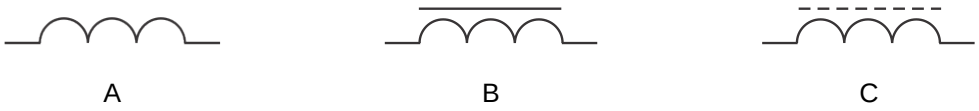
Answer choices	Put X next to your answer
a) increase	
b) remain the same	
c) decrease	
d) fall to zero	

5.3 A bifilar coil is wound in such a way as to have:

Table 35 Multiple choice

Answer choices	Put X next to your answer
a) negative self-inductance	
b) normal self-inductance	
c) negligible self-inductance	
d) maximum self-inductance	

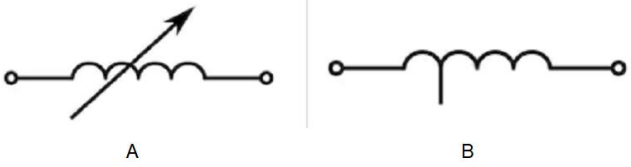
5.4 Use the letters A, B and C to identify the inductor symbols below.



A B C

Symbol	Letter
Air core inductor	A
Ferrite core inductor	C
Iron core inductor	B

5.5 Two variations of a standard inductor symbol are shown below. Use the letters A and B to identify each.



A B

Symbol	Letter
Tapped inductor	B
Variable inductor	A

5.6 What type of inductor is typically used for power applications at 50Hz?

Table 36 Multiple choice

Answer choices	Put X next to your answer
a) Air core	
b) Ferrite core	
c) Iron core	x

5.7 What type of inductor is typically used in electronics for noise suppression?

Table 37 Multiple choice

Answer choices	Put X next to your answer
a) Air core	
b) Ferrite core	x
c) Iron core	

5.8 Inductance is the ability of a coil to oppose changes in:

Table 38 Multiple choice

Answer choices	Put X next to your answer
a) current	x
b) voltage	
c) resistance	
d) impedance	

5.9 If a voltage is applied to a coil, an EMF is induced in the coil that opposes the applied EMF. This is due to:

Table 39 Multiple choice

Answer choices	Put X next to your answer
a) self-inductance	x
b) inductive reactance	
c) mutual inductance	
d) capacitive reactance	

5.10 Where a variation in current in a conductor causes an induced EMF in a nearby conductor, this is due to :

Table 40 Multiple choice

Answer choices	Put X next to your answer
a) self-inductance	
b) inductive reactance	
c) mutual inductance	x
d) capacitive reactance	

5.11 An inductor of 0.2 H has a current of 2A flowing through it. If the current falls to zero in 4ms, calculate the value of induced EMF in the inductor.

Show all working and write your answer in the space provided.
V= L di/dt = $0.2x2/4x10^{-3}$=100 volt

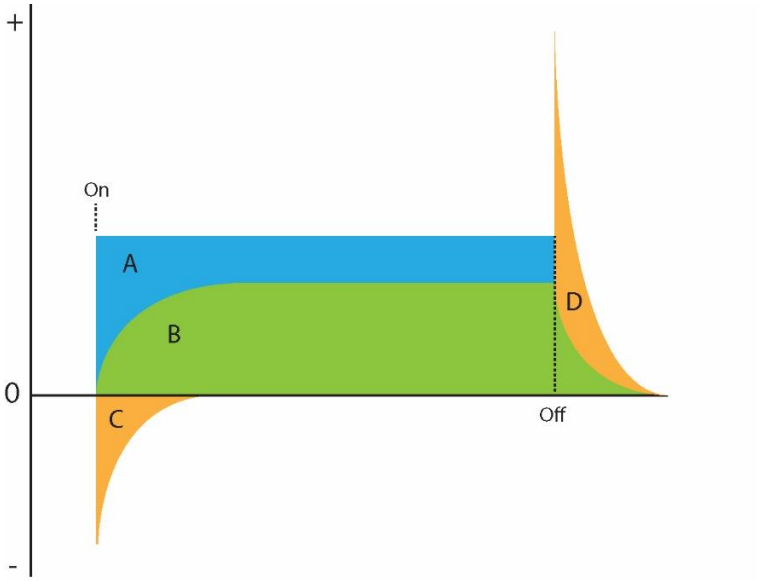
e =

5.12 When two coils are linked by a magnetic circuit, any changes in the magnetic field produced by one coil will induce a voltage in the other. This is due to:

Table 41 Multiple choice

Answer choices	Put X next to your answer
a) self-inductance	
b) inductive reactance	
c) mutual inductance	x
d) capacitive reactance	

5.13 The following graph shows the voltage and current values associated with an inductor at switch on and switch off when connected to a DC circuit.



Use the letters A, B, C and D to identify the following areas of the graph listed below.

Curve	Letter
Supply voltage applied to load	A
Induced EMF at switch on	C
Induced EMF at switch off	D
Current flow	B

5.14 Inductors used to limit the running current associated with discharge lighting (e.g. fluorescent lights) is a practical application of the effects of:

Table 42 Multiple choice

Answer choices	Put X next to your answer
a) self-inductance	x
b) mutual inductance	

5.15 Power transformers are a practical application of the effects of:

Table 43 Multiple choice

Answer choices	Put X next to your answer
a) self-inductance	
b) mutual inductance	x

5.16 When measuring voltages in cables with high impedance digital multimeters:

Table 44 Multiple choice

Answer choices	Put X next to your answer
a) care should be taken to avoid the effects of induced voltages from nearby cables due to mutual induction	
b) common terminal of the meter should be connected to ground	
c) always select the DC voltage measurement setting	x
d) always select the resistance measurement setting.	

5.17 When contacts controlling the relay coil is opened, rapidly collapsing magnetic fields can induce high voltages into the coil by:

Table 45 Multiple choice

Answer choices	Put X next to your answer
a) Self-induction	x
b) Mutual induction	

5.18 Where power cables are installed in close proximity to telecommunications cables, the effects of mutual inductance are likely to cause:

Table 46 Multiple choice

Answer choices	Put X next to your answer
a) overheating of the power cables	
b) overheating of the telecommunications cables	
c) interference in the power cables	
d) interference in the telecommunications cables	x

5.19 The **time constant** of a DC circuit containing resistance and inductance will determine:

Table 47 Multiple choice

Answer choices	X
a) the value of resistance in the circuit	
b) the number of turns on the inductor in the circuit	
c) the rate at which current is able to increase or decrease in the circuit	x
d) the value of induced voltage in the circuit	

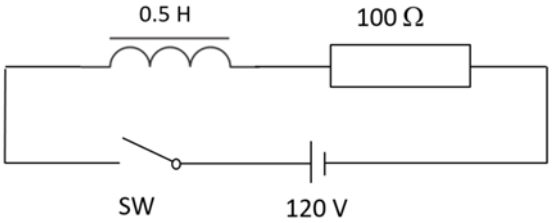
5.20 An inductor of 1 H has a resistance of 20 Ω. Calculate the time constant of the inductor.

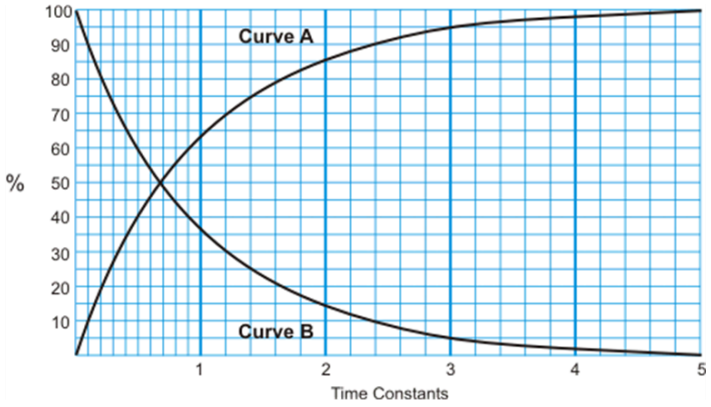
Show all working and write your answer in the space provided.

$\tau = L/R = 1/20 = 0.05$

τ =

5.21 A series RL circuit contains an inductor of 0.5 H and a resistor of 100 Ω. If 120V DC is applied to the circuit by pressing the switch SW.





Show your workings when answering following questions.

(a) How long it would take for the circuit to reach a maximum value of current after switch on?

5 sec

t =	

(b) What would be the current in the circuit after 5 time constants?

100 %

I_{5T}=	A

(c) What would be the current in the circuit after 1 time constant?

70%

I_{1T}=	mA

(d) What would be the induced voltage in the inductor after 1 time constant?

35V

e_{1T} =	V

Part 6 – Measuring Instruments

(Time allowed - 20 minutes)

Instructions: For multiple choice questions, place an X in the appropriate box. For short answer questions, write the answer in the space provided. For questions that require calculations, show all working and write your answer in the space provided.

6.1 **Analogue multimeters** are usually constructed using:

Table 48 Multiple choice

Answer choices	Put X next to your answer
a) a “moving coil” meter movement	x
b) a “moving iron” meter movement	
c) an “iron vane” meter movement	
d) a “dynamometer” meter movement.	

6.2 Analogue ammeters and voltmeters with a **moving iron** meter movement typically have:

Table 49 Multiple choice

Answer choices	Put X next to your answer
a) a linear scale	
b) a non-linear scale	x
c) no zero adjustment	
d) a ‘Category 3’ rating.	

6.3 A **dynamometer** type meter movement is used in analogue instruments to measure:

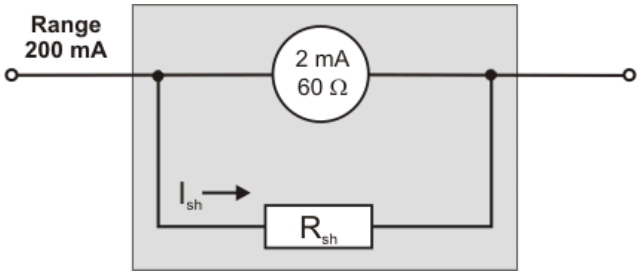
Table 50 Multiple choice

Answer choices	Put X next to your answer
a) voltage	
b) current	
c) power	
d) resistance.	

6.4 **Clamp testers** used for measuring current:

Table 51 Multiple choice

Answer choices	Put X next to your answer
a) can help determine prospective short-circuit currents	
b) allow measurement without interruption to a circuit	x
c) contain both moving coil and moving iron meter movements	
d) apply a clamping voltage to the circuit during testing	



6.5 The following diagram shows the internal connections of an ammeter, including the meter movement details.

Calculate the value of resistor R_{sh} so that the meter operates correctly on a 200mA scale.
Your answers must be given in the units shown corrected to 3 significant figures as appropriate.

(a) Calculate *Vfsd*

= $2x10^{-3}x60=0.12v$

V_{fsd}	

(b) Calculate I_{sh}

200-2 = 198 mA

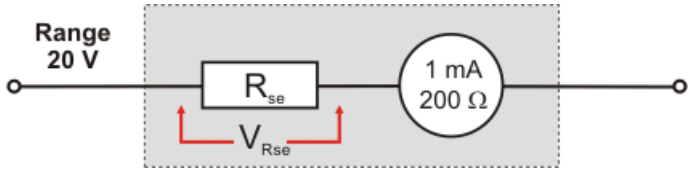
I_{sh} =	

(c) calculate R_{sh}

$2x10^{-3}x60/(200-2)x10^{-3}=0.606$ ohm

R_{sh} =	

6.6 The following diagram shows the internal connections of a voltmeter, including the meter movement details.



Calculate the value of resistor R_{se} so that the meter operates correctly on the 20V range.

Your answers must be given in the units shown corrected to 3 significant figures as appropriate.

(a) Calculate *Vfsd 200x 1ma= 0.2v*

Vfsd	

(b) Calculate V_{Rse} *20-0.2= 19.8V*

V_{Rse}	

(c) calculate R_{se} *19.8/1x10^{-3}=19.8Kohm*

R_{se} =	

6.7 To reduce loading effect, a good quality **analogue ammeter** would have an internal resistance in the range:

Table 52 Multiple choice

Answer choices	Put X next to your answer
a) 0.001 Ω to 0.1 Ω	
b) 10 Ω to 100 Ω	
c) 1 kΩ to 1M Ω	

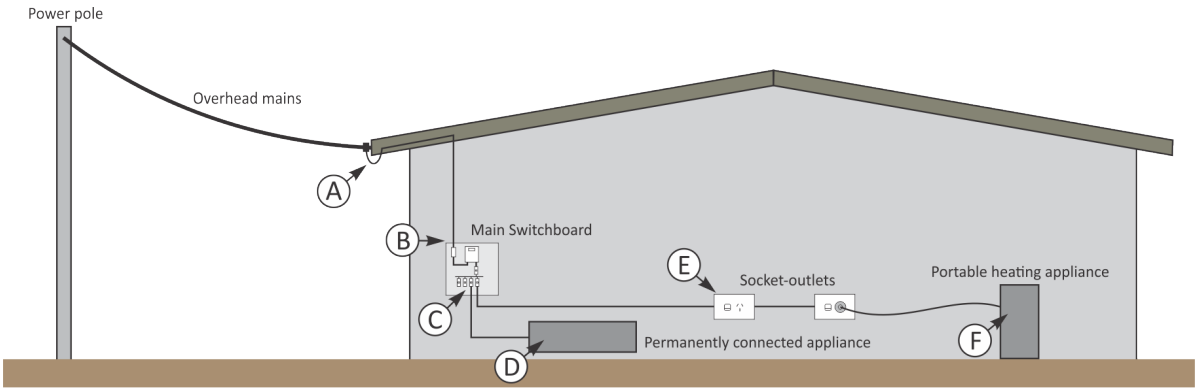
Answer choices	Put X next to your answer
d) 10 MΩ to 100 MΩ	

6.8 To reduce loading effect, a good quality **digital voltmeter** would have an internal resistance in the range:

Table 53 Multiple choice

Answer choices	Put X next to your answer
a) 0.001 Ω to 0.1 Ω	
b) 10 Ω to 100 Ω	
c) 1 kΩ to 1M Ω	
d) 10 MΩ to 100 MΩ	

6.9 The installation below is supplied via 230V mains.



What is the **minimum** *Category Rating* required for a multimeter used for live testing at locations A to F?

Location	Multimeter Category Rating			
A	○ CAT I	○ CAT II	○ CAT III	○ CAT IV
B	○ CAT I	○ CAT II	○ CAT III	○ CAT IV
C	○ CAT I	○ CAT II	○ CAT III	○ CAT IV
D	○ CAT I	○ CAT II	○ CAT III	○ CAT IV
E	○ CAT I	○ CAT II	○ CAT III	○ CAT IV
F	○ CAT I	○ CAT II	○ CAT III	○ CAT IV

- **CAT I** describes secondary circuits not intended to be connected to the mains electricity supply, such as electronics, including a typical laptop PC, and circuits powered by regulated low voltage sources.
- **CAT II** is defined as local-level electrical distribution, such as a standard mains socket and plug-in loads. This category includes household appliances, such as washing machines, and portable plug-in power tools.
- **CAT III** references a building's electrical installations, including circuit-breakers, wiring, switches and industrial equipment.

- **CAT IV** involves the source of the low-voltage power installation, essentially the power grid infrastructure, such as underground utility vaults or outdoor power lines.

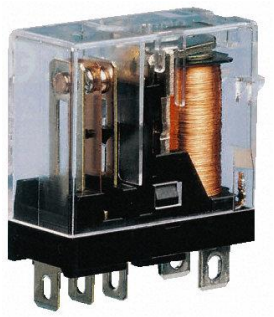
1.

Part 7 – Magnetic Devices

(Time allowed - 10 minutes)

Instructions: For multiple choice questions, place an X in the appropriate box. For short answer questions, write the answer in the space provided. For questions that require calculations, show all working and write your answer in the space provided.

7.1 Identify the following magnetic devices by writing the letter for each device beside the types listed in the table below.



Device 'A'

Device 'B'

Device 'C'

Device	Letter
Contactor	B
Relay	A
Solenoid	C

7.2 The magnetomotive force in a relay or contactor is produced by the:

Table 54 Multiple choice

Answer choices	Put X next to your answer
a) contacts	
b) spring	
c) coil	x
d) iron core	

7.3 Low current switching in control circuits is usually performed using:

Table 55 Multiple choice

Answer choices	Put X next to your answer
a) relays	x
b) solenoids	
c) contactors	

7.4 The main difference between a *relay* and a *contactor* is that a **contactor** usually has:

Table 56 Multiple choice

Answer choices	Put X next to your answer
a) a heavier duty operating coil	
b) contacts with a higher current rating	x

Answer choices	Put X next to your answer
c) more than one set of normally open contacts	
d) both normally open and normally closed contacts	

7.5 A **blowout coil** is often used on DC contactors to assist with:

Table 57 Multiple choice

Answer choices	Put X next to your answer
a) carrying excess current	
b) lowering the resistance between contact faces	
c) extinguishing the arc when the contacts open	x
d) reducing the voltage across the contacts when closed	

7.6 A **Hall Effect Device** is used to detect the presence of a magnetic field and is commonly used in electrical instruments for measuring:

Hall Effect sensor produces an output voltage depending on the magnetic field. The ratio of the output voltage is proportional to the magnetic field. During the current sensing process, the current is measured by measuring the magnetic field

Table 58 Multiple choice

Answer choices	Put X next to your answer
a) current	x
b) voltage	
c) resistance	
d) impedance	

7.7 Some devices incorporate materials that rely on **magnetostriction** for their operation. When magnetised, these materials:

Magnetostriction can be defined as the change in dimension of a piece of magnetic material induced by a change in its magnetic state. Generally, a magnetostrictive material changes its dimension when subjected to a change of the applied magnetic field.

Table 59 Multiple choice

Answer choices	Put X next to your answer
a) change their size or shape	x
b) align themselves with magnetic north	
c) produce a voltage when placed under mechanical stress	
d) generate an emf due to self-induction	

7.8 A sensing device that's buried in the road surface to detect vehicles at traffic lights is commonly referred to as:

Table 60 Multiple choice

Answer choices	Put X next to your answer
a) a reed switch	
b) a pressure switch	
c) a solenoid valve	
d) an inductive loop	x

Part 8 – DC Machine Principles

(Time allowed - 10 minutes)

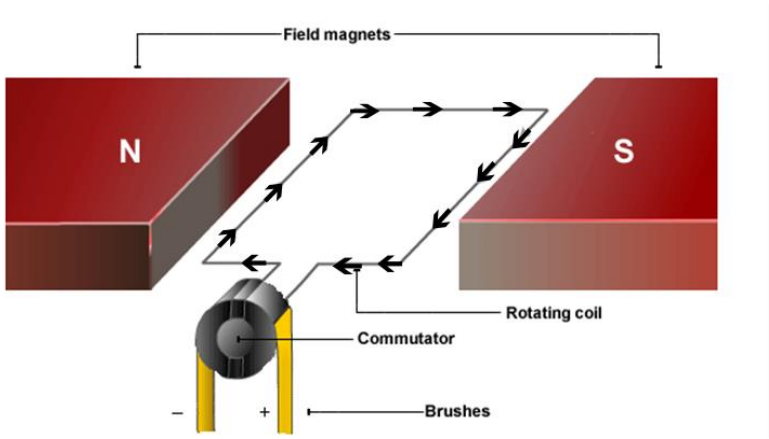
Instructions: For multiple choice questions, place an X in the appropriate box. For short answer questions, write the answer in the space provided. For questions that require calculations, show all working and write your answer in the space provided.

8.1 A DC generator converts:

Table 61 Multiple choice

Answer choices	Put X next to your answer
a) electrical energy into mechanical energy	
b) mechanical energy into electrical energy	x

8.2 The following diagram shows a simple DC machine.



If the machine was operating as a **generator**, what direction would the coil need to rotate to generate a voltage with the polarity shown at the brushes?

Table 62 Multiple choice

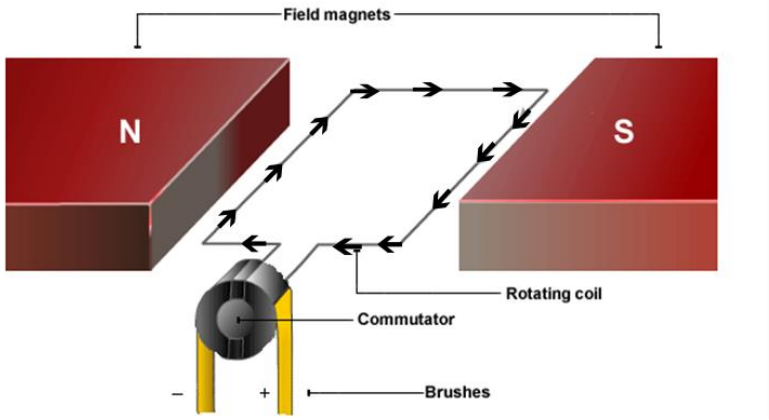
Answer choices	Put X next to your answer
a) Clockwise	x
b) Anticlockwise	

8.3 A DC motor converts:

Table 63 Multiple choice

Answer choices	Put X next to your answer
a) electrical energy into mechanical energy	x
b) mechanical energy into electrical energy	

8.4 The following diagram shows a simple DC machine.



If the machine was operating as a **motor**, what direction would the coil need to rotate to generate a voltage with the polarity shown at the brushes?

Table 64 Multiple choice

Answer choices	Put X next to your answer
a) Clockwise	
b) Anticlockwise	x

8.5 **One side** of a motor coil produces a force of 2N when connected to the supply. If the distance from the motor shaft to the coil side is 200mm, how much torque would the **entire coil** produce (assuming equal force is produced on both sides)?

Show all working and write your answer in the space provided.

T=F r= 2x0.2= 0.4 Nm

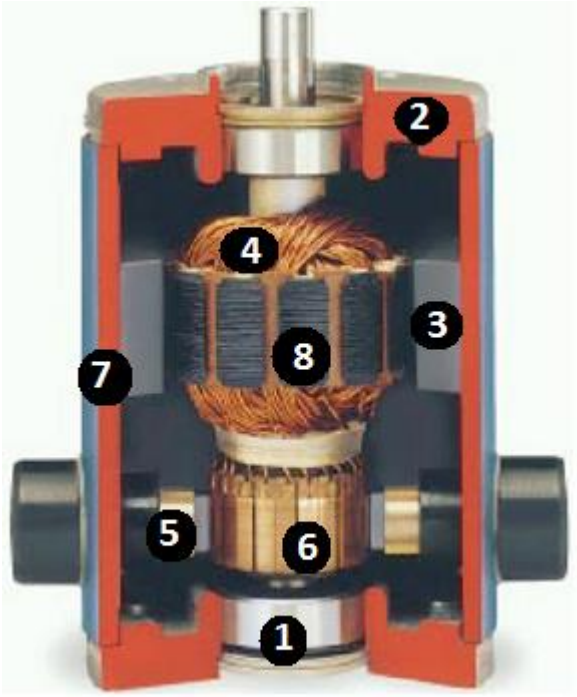
T=	

Part 9 – DC Machine Construction, Testing and Maintenance

(Time allowed - 10 minutes)

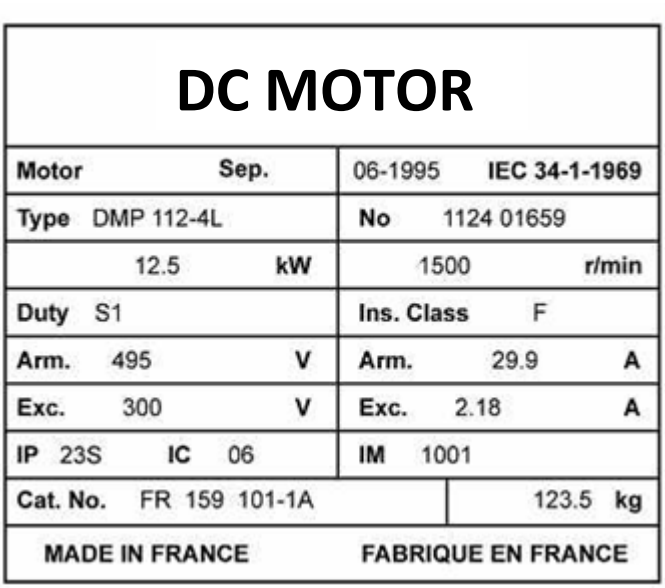
Instructions: For multiple choice questions, place an X in the appropriate box. For short answer questions, write the answer in the space provided. For questions that require calculations, show all working and write your answer in the space provided.

9.1 The photo shown below is a cutaway of a DC machine. Identify the components by writing the associated number beside each item.



Component	Letter
Armature laminations	8
Armature winding	4
Bearing	2
Brush holder	5
Commutator	6
End shield	1
Field magnet	3
Frame	7

9.2 The following nameplate is from a DC motor.



DC MOTOR			
Motor	Sep.	06-1995	IEC 34-1-1969
Type	DMP 112-4L	No	1124 01659
12.5	kW	1500	r/min
Duty	S1	Ins. Class	F
Arm.	495 V	Arm.	29.9 A
Exc.	300 V	Exc.	2.18 A
IP	23S IC 06	IM	1001
Cat. No.	FR 159 101-1A		123.5 kg
MADE IN FRANCE		FABRIQUE EN FRANCE	

Identify the machine specifications listed below. .

Power output	12.5KW
Motor speed	1500RPM

9.3 A volt drop test performed on the field coils of a 250V 4 pole DC shunt motor resulted in the following readings.

$V_{Coil\ 1}$	65.3 V
$V_{Coil\ 2}$	64.8 V
$V_{Coil\ 3}$	65.1 V
$V_{Coil\ 4}$	54.8 V

The readings above indicate that coil 4:

Table 65 Multiple choice

Answer choices	Put X next to your answer
a) is open circuit	x
b) has shorted turns	
c) is short-circuited	
d) has high resistance	

9.4 The part of a DC motor that usually requires the **most** maintenance is:

Table 66 Multiple choice

Answer choices	Put X next to your answer
a) the bearings	
b) the end shields	
c) the field system	
d) the commutator and brush gear	x

9.5 When compared with other types of electromagnetic devices such as relays and contactors, DC machines present an additional safety hazard due to the presence of:

Table 67 Multiple choice

Answer choices	Put X next to your answer
a) rotating parts	x
b) high fault currents	
c) electromagnetic induction	

9.6 When operating and servicing a DC machine you should:

Table 68 Multiple choice

Answer choices	Put X next to your answer
a) remove machine guards and your safety glasses so you can see better	
b) expose live electrical wires and get the operator to hold them for you to test	
c) hold onto the shaft whilst energising to determine the magnetic field strength	
d) have suitable PPE, sleeves that are tight fitting, and long hair tied back	x

Part 10 – DC Generators

(Time allowed - 20 minutes)

Instructions: For multiple choice questions, place an X in the appropriate box. For short answer questions, write the answer in the space provided. For questions that require calculations, show all working and write your answer in the space provided.

10.1 Calculate the voltage generated (Eg) by the armature of a 4 pole lap wound shunt connected DC generator that contains a total of 200 effective conductors. The magnetic flux is 50mWb per pole and the speed of rotation is 1500 rpm.

Show all working and write your answer in the space provided.

Eg=øZNP/60a= $50x10^{-3}$x200x1500x4/60x1x4=250V

E_g=	

10.2 Calculate the terminal voltage (VT) of a 4 pole wave wound self-excited shunt connected DC Generator with the following specifications:

- Generated voltage: 211 V
- Armature current: 50 A
- Shunt field resistance: 150 Ω
- Armature circuit resistance: 0.22 Ω

Show all working and write your answer in the space provided.

Eg=Vt+IaRa=> vt=Eg-IaRa = 211-50x0.22=200V

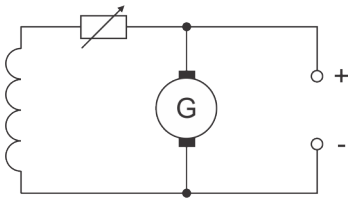
V_T=	

10.3 Select **three** energy sources from the choices below that are suitable as prime movers for a DC generator:

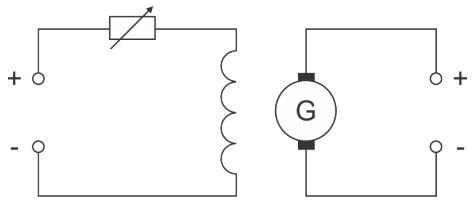
Table 69 Multiple choice

Answer choices	Put X next to your answer
a) Diesel engine	x
b) Solar panels	
c) Water turbine	x
d) Wind turbine	x

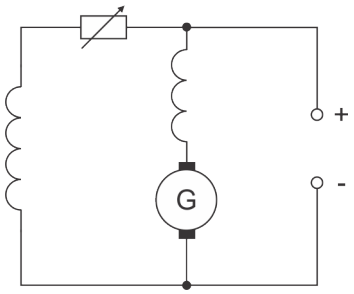
10.4 Identify the following DC generator circuits by writing the letter for each generator beside the types listed in the table below.



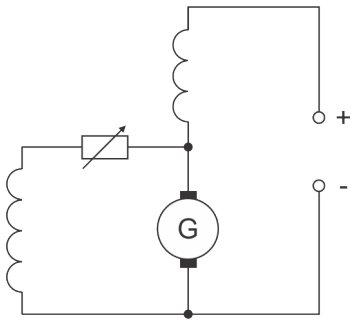
A



B



C



D

Generator	Letter
Separately excited DC generator	B
Self-excited **shunt** DC generator	A
Self-excited **compound** DC generator (short shunt)	D
Self-excited **compound** DC generator (long shunt)	A

10.5 Self-excited shunt DC generators are typically used for:

Table 70 Multiple choice

Answer choices	Put X next to your answer
a) welding machines	
b) general purpose applications	
c) process control	
d) low cost applications	x

10.6 Self-excited compound DC generators are typically used for:

Table 71 Multiple choice

Answer choices	Put X next to your answer
a) welding machines	
b) general purpose applications	x
c) process control	
d) low cost applications	

10.7 If a self-excited DC generator has no residual magnetism then its rated output voltage will be:

Table 72 Multiple choice

Answer choices	Put X next to your answer
a) zero	x
b) normal	
c) higher than normal	
d) reversed	

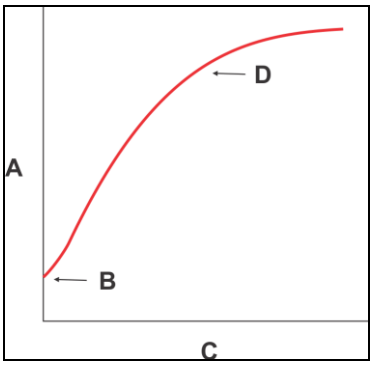
10.8 To reverse the polarity of the output voltage of a separately excited DC generator, it is necessary to:

Table 73 Multiple choice

Answer choices	Put X next to your answer
a) Increase the speed of rotation of the armature	
b) reverse the polarity of the field windings **or** the armature	x
c) reverse the polarity of the field windings **and** the armature	

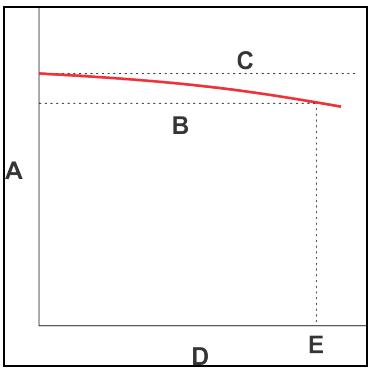
10.9 Below is an **open-circuit characteristic** (excitation) curve of a self-excited shunt DC generator. Identify the labelled elements by writing the appropriate letter against each element in the table below.

1. 11



Element	Letter
Field current	C
Generated voltage	A
Voltage due to residual magnetism	B
Saturation	D

10.10 Below is a **load characteristic** curve of a self-excited shunt DC generator. Identify the labelled elements by writing the appropriate letter beside each element in the table below.



Element	Letter
Load current	D
Terminal voltage	A
Full load current	E

Full load voltage	B
No load voltage	C

10.11 A DC generator is connected up and run at **rated speed**. Which **two** of the following parameters would you measure when performing a **no-load test**?

Table 74 Multiple choice

Answer choices	Put X next to your answer
a) field current	
b) armature current	x
c) load current	
d) terminal voltage	x

10.12 A DC generator is connected up and run at **rated speed**. Which **two (2)** of the following parameters would you measure when performing a **LOAD test**?

Table 75 Multiple choice

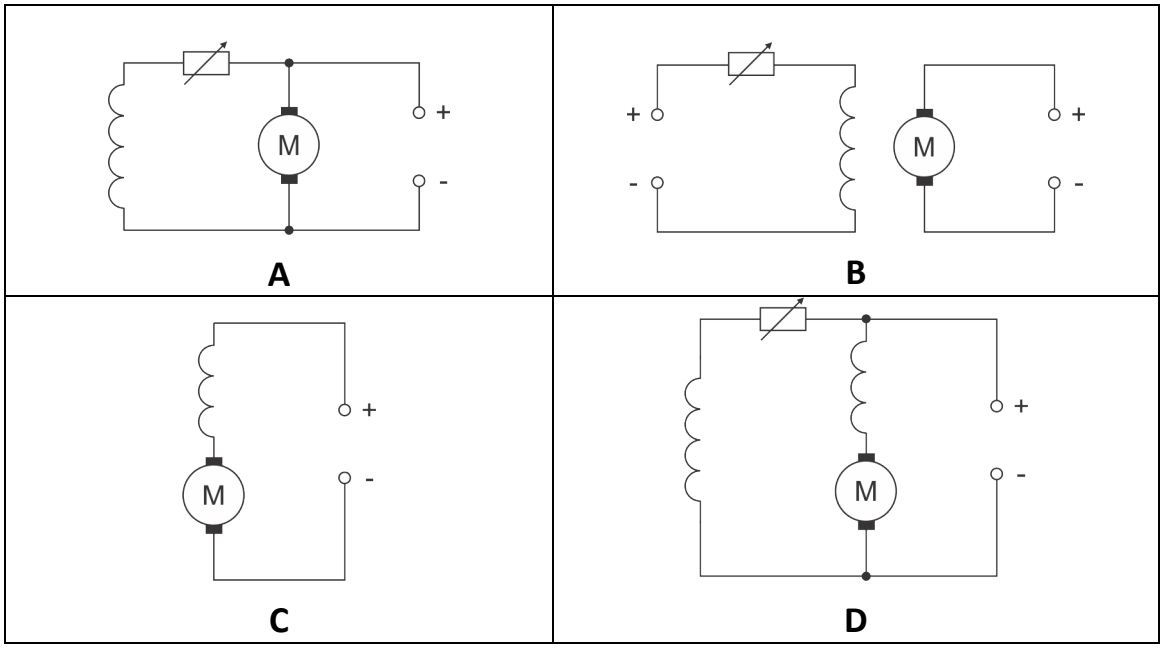
Answer choices	Put X next to your answer
a) field current	
b) armature current	
c) load current	x
d) terminal voltage	x

Part 11 – DC Motors

(Time allowed - 15 minutes)

Instructions: For multiple choice questions, place an X in the appropriate box. For short answer questions, write the answer in the space provided. For questions that require calculations, show all working and write your answer in the space provided.

11.1 1dentify the following DC motor circuits by writing the letter for each motor beside the types listed in the table below.



Motor	Letter
Separately excited DC motor	B
Self-excited **series** DC motor	C
Self-excited **shunt** DC motor	A
Self-excited **compound** DC motor	D

11.2 When DC motors are operating normally on load, the main limiting factor of armature current is:

Table 76 Multiple choice

Answer choices	Put X next to your answer
a) main field strength	
b) armature resistance	
c) back EMF	x
d) supply voltage	

11.3 Which DC motor has the best speed regulation and is therefore most suitable for applications requiring a relatively **constant speed?**

Table 77 Multiple choice

Answer choices	Put X next to your answer
a) Series motor	
b) Shunt motor	x
c) Compound motor	

11.4 Which DC motor is most suitable for applications requiring **high torque** (e.g. vehicle starter motor)?

Table 78 Multiple choice

Answer choices	Put X next to your answer
a) Series motor	
b) Shunt motor	
c) Compound motor	x

11.5 Which DC motor provides a good balance between **high torque** and **good speed regulation** for applications requiring relatively constant speed but with intermittent heavy loading?

Table 79 Multiple choice

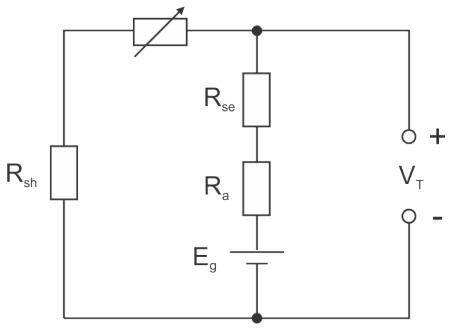
Answer choices	Put X next to your answer
a) Series motor	x
b) Shunt motor	
c) Compound motor	

11.6 **Separately excited motors** and **permanent magnet motors** both have a similar speed regulation and torque characteristic to a:

Table 80 Multiple choice

Answer choices	Put X next to your answer
a) series motor	
b) shunt motor	x
c) compound motor	

11.7 Below is the equivalent circuit of a typical DC motor. Identify each element by writing the corresponding letter notation beside each item in the table below.



Element	Notation
Back EMF	Ef
Terminal voltage	Vt
Armature resistance	Ra
Shunt field resistance	Rsh
Series field resistance	Rse

11.8 Calculate the power output of a DC motor that develops a torque of 31.85 Nm at a speed of 1500 RPM.

Show all working and write your answer in the space provided.

P=2 Pi NT=2.3.1416x1500x31.85=300.27Kw

P_{OUT}	

11.9 The DC motor most at risk of running at dangerous speeds if started without a load connected is the:

Table 81 Multiple choice

Answer choices	Put X next to your answer
a) series motor	x
b) shunt motor	
c) compound motor	
d) separately excited motor	

Part 12 – DC Machine Efficiency

(Time allowed - 20 minutes)

Instructions: For multiple choice questions, place an X in the appropriate box. For short answer questions, write the answer in the space provided. For questions that require calculations, show all working and write your answer in the space provided.

12.1 Losses due to **friction** in a DC machine are primarily associated with:

Table 82 Multiple choice

Answer choices	Put X next to your answer
a) the bearings and end shields	
b) the armature and field windings	
c) the armature winding only	
d) the brushes and bearings	x

12.2 The **hysteresis** loss in the armature of a DC generator is due to the:

Table 83 Multiple choice

Answer choices	Put X next to your answer
a) induced EMF in the armature core	
b) load current in the armature winding	
c) continual reversal of the flux in the armature	x
d) current in the field windings	

12.3 **Eddy currents** in DC machines cause:

Table 84 Multiple choice

Answer choices	Put X next to your answer
a) wrong readings in ammeters	
b) reduction of flux in fields	
c) heating of the armature laminations	x
d) spurious magnetic fields	

12.4 To determine the **fixed losses** of a DC machine it is necessary to do a:

Table 85 Multiple choice

Answer choices	Put X next to your answer
a) no-load test	x
b) load test	
c) drop test	
d) locked rotor test	

12.5 The total **copper losses** in a DC machine are the sum of the:

Table 86 Multiple choice

Answer choices	Put X next to your answer
a) armature and field winding power losses	x
b) armature and field voltage drops	
c) armature circuit power losses	
d) friction and windage losses	

12.6 Maximum efficiency in a DC machine occurs when:

Table 87 Multiple choice

Answer choices	Put X next to your answer
a) fixed losses are at a maximum	
b) variable losses are at a maximum	
c) fixed losses are equal to variable losses	x
d) total losses are at a maximum	

12.7 A DC motor runs at a speed of 1500 RPM while driving a load of 35 Nm. If the supply current is 28A at 240V. Calculate the following parameters of the motor.

Show all working and write your answers in the spaces provided, corrected to 3 significant figures.

Input power

Pin = VI=240x28=6720watt

P_{IN}=	

Output power

Pout=2 pi NT= 2x3.1416x1500x35/60=5495 watts

P_{OUT}	

Total losses

6720-5495=1225 watts

P_{LOSS}	

Efficiency

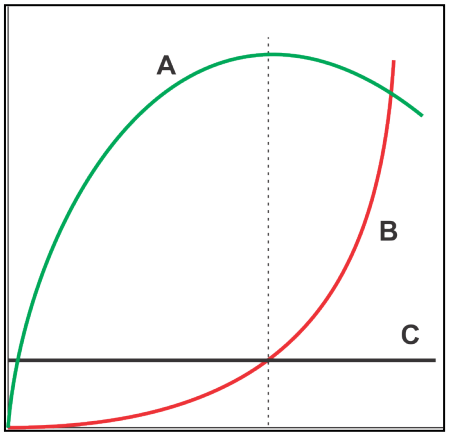
5495/6720 x 100 =81.7 %

η	

12.8 Minimum Energy Performance Standards (MEPS):

Table 88 Multiple choice

Answer choices	Put X next to your answer
a) apply to all types of DC machines worldwide	x
b) only apply to DC machines greater than 0.75kW	
c) do not apply to standalone DC machines in Australia	



12.9 The curves below show the relationship between losses and efficiency in a DC machine. Identify the labelled elements by writing the appropriate letter beside each element in the table below.

Element	Letter
Fixed losses	C
Variable losses	B
Efficiency	A

12.10 Silicon steel is used in the manufacture of DC machine armatures:

Table 89 Multiple choice

Answer choices	Put X next to your answer
a) to reduce eddy currents	
b) for mechanical strength	
c) to reduce hysteresis loss	x
d) because it is light	

12.11 The core of a DC machine armature is laminated to:

Table 90 Multiple choice

Answer choices	Put X next to your answer
a) simplify construction	
b) reduce copper losses	
c) reduce hysteresis losses	
d) reduce eddy current losses	x

Part 13: Assessment Feedback

*NOTE: This section **must** have the assessor signature and student signature to complete the feedback.*

Assessment outcome

☐ Satisfactory

☐ Unsatisfactory

Assessor Feedback

☐ Has the Assessment Declaration on page 1 of the assessment been signed and dated by the student?

☐ Are you assured that the evidence presented for assessment is the student's own work?

☐ Was the assessment event successfully completed?

☐ If no, was the resubmission/re-assessment successfully completed?

☐ Was reasonable adjustment in place for this assessment event?

If yes, ensure it is detailed on the assessment document.

Comments:

Assessor name, signature and date:

Student acknowledgement of assessment outcome

Would you like to make any comments about this assessment?

Student name, signature and date

NOTE: Make sure you have written your name at the bottom of each page of your submission before attaching the cover sheet and submitting to your assessor for marking.