Province of the
EASTERN CAPE
EDUCATION

NATIONAL
SENIOR CERTIFICATE

GRADE 11

NOVEMBER 2020

ELECTRICAL TECHNOLOGY: POWER SYSTEMS (EXEMPLAR)

MARKS: **200**

TIME: **3 hours**

IELTTE1

This question paper consists of 12 pages, including a formula sheet.

INSTRUCTIONS AND INFORMATION

1. This question paper consists of NINE questions.

2. Sketches and diagrams must be large, neat, and fully labelled.

3. Show ALL calculations and round off answer correctly to TWO decimal places. Show the units for ALL answers of calculations.

4. Number the answers correctly according to the numbering system used in this question paper.

5. You may use a non-programmable calculator.

6. A formula sheet is provided at the end of this question paper.

7. Write neatly and legibly.

QUESTION 1: OCCUPATIONAL HEALTH AND SAFETY

1.1 Name TWO instances where the user is not required to supply an earth to roofs, gutters, downpipes and wastepipes, on a premise to which electrical energy is supplied. (2)

1.2 Explain how the following environmental factors could impact negatively on a worker in a workshop.

1.2.1 Lack of space (1)

1.2.2 Lighting (1)

1.3 Describe the term *anthropometrics*. (2)
[6]

QUESTION 2: TOOLS AND MEASURING INSTRUMENTS

2.1 What is the purpose of a crimping lug? (1)

2.2 Explain the advantage of a clamp meter over a digital multimeter when measuring current. (2)

2.3 Why is it important to stand aside to allow a grinder wheel to run up to full speed before using it? (2)

2.4 Explain the purpose of a time-base generator in an oscilloscope. (1)
[6]

QUESTION 3: DC MACHINES

3.1 State TWO purposes of the yoke of DC machines. (2)

3.2 Name TWO losses that occur in the iron core of a DC machine. (2)

3.3 Mention TWO disadvantages of DC machines. (2)

3.4 Define *efficiency* in DC machines. (2)

3.5 Draw a neatly, labelled diagram of a compound wound DC machine. (5)

3.6 Explain how an increase in load will affect the speed of a compound wound DC machine. (2)

3.7 A shunt wound machine has armature losses of 425 W and field losses of 225 W. The field circuit resistance is 25 Ω and the output is given as 4 000 W. The rotational losses amount to 300 W.

Given: Armature losses = 425 W
Field losses = 225 W
$R_F = 25\ \Omega$
Output = 4 000 W
Rotational losses = 300 W

Calculate:

3.7.1 The field current (3)

3.7.2 The total losses (3)

3.7.3 The efficiency of the machine (3)

3.8 Explain why series machines are well suited for power tools and automobile starters. (2)

[26]

QUESTION 4: SINGLE-PHASE AC GENERATION

4.1 Define the term *frequency*. (2)

4.2 State the standard operating frequency used in South Africa. (1)

4.3 Mention TWO factors that influence the induced electromotive force during generation. (2)

4.4 Explain the difference between *magnetic lines of flux* and *magnetic flux density.* (2)

4.5 An AC signal has an RMS value of 220 V. The frequency of the wave is 25 kHz.

Given: RMS = 220 V
f = 25 kHz

Calculate:

4.5.1 The maximum value of the waveform (3)

4.5.2 The period of the waveform (3)

4.6 A coil with an area of 2 000 mm^2 is rotated in a magnetic field with a density of 50 mT. It is rotated at 3 000 rpm at right angles to the direction of the flux. The coil has 300 turns.

Given: $A = 2\ 000\ \text{mm}^2$
$\beta = 50\ \text{mT}$
$n = 3\ 000\ \text{rpm}$
$N = 300\ \text{turns}$

Calculate:

4.6.1 The frequency (3)

4.6.2 The maximum EMF generated at right angles to the flux (3)

4.6.3 The instantaneous value of the generated emf at 45° (3)

4.7 Calculate the flux density over an area of 1,5 cm^2, if the total magnetic flux is 20 mWb. (3)

[25]

QUESTION 5: SINGLE-PHASE TRANSFORMERS

5.1 State *Faraday's First Law* of electromagnetic induction. (2)

5.2 Define *magneto motive force (mmf)*. (2)

5.3 Explain why the cores of transformers are constructed using laminations. (2)

5.4 State ONE application of transformers. (1)

5.5 Draw a labelled vector diagram showing the three power components of a transformer. (5)

5.6 Name the TWO basic core constructions used in transformers. (2)

5.7 A circular coil with a circumference of 0,06 m has a magnetic field strength of 8 000 A/m. The coil is wound with 400 turns.

Given: $l = 0{,}06\ \text{m}$
$H = 8\ 000\ \text{A/m}$
$N = 400\ \text{turns}$

Calculate:

5.7.1 The magneto motive force (mmf) (3)

5.7.2 The current flowing to create the magnetomotive force (mmf) (3)

5.8 A 20 kVA transformer has a transformer ratio of 50 : 1 and total losses amounting to 800 W. It has a primary voltage of 440 V and 800 turns on the primary winding. The output power at a power factor of 0,901 is 18,02 kW.

Given:
$S = 20\ \text{kVA}$
$P_{OUTPUT} = 18{,}02\ \text{kW}$
$\text{T. RATIO} = 50 : 1$
$\text{total losses} = 800\ \text{W}$
$V_P = 440\ \text{V}$
$N_P = 800\ \text{turns}$
$\cos\theta = 0{,}901$

Calculate:

5.8.1 The number of turns on the secondary winding (3)

5.8.2 The primary current (3)
[26]

QUESTION 6: RLC-CIRCUITS

6.1 Mention ONE factor that directly affects the capacitive reactance of an AC circuit with RC components. (1)

6.2 Draw a neatly labelled graph showing the relationship between the inductive reactance and the frequency in an RLC series circuit. (3)

6.3 Study FIGURE 6.3 below and answer the questions that follow.

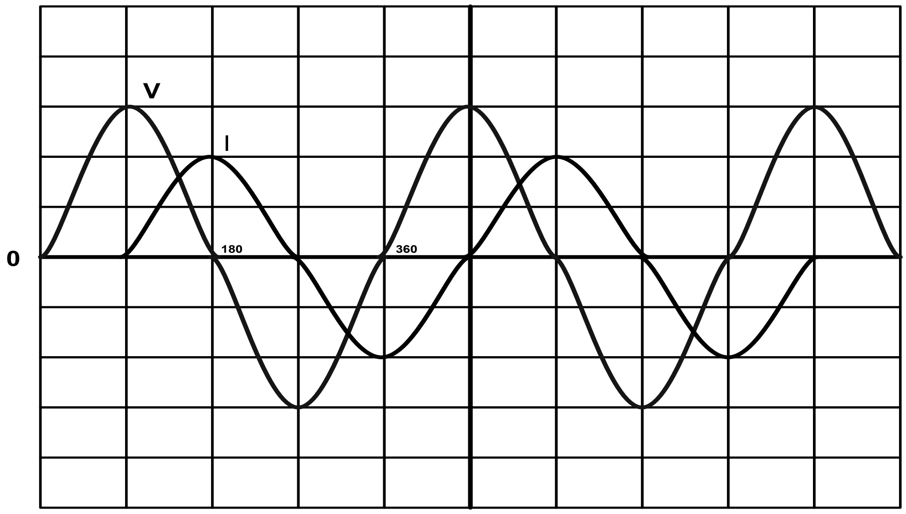


FIGURE 6.3: RL CIRCUIT WAVEFORMS

6.3.1 Describe the relationship between the voltage and the current waveforms. (1)

6.3.2 Explain how an increase in frequency would affect the current waveform. (3)

6.4 Refer to the circuit diagram in FIGURE 6.4 and answer the questions that follow.

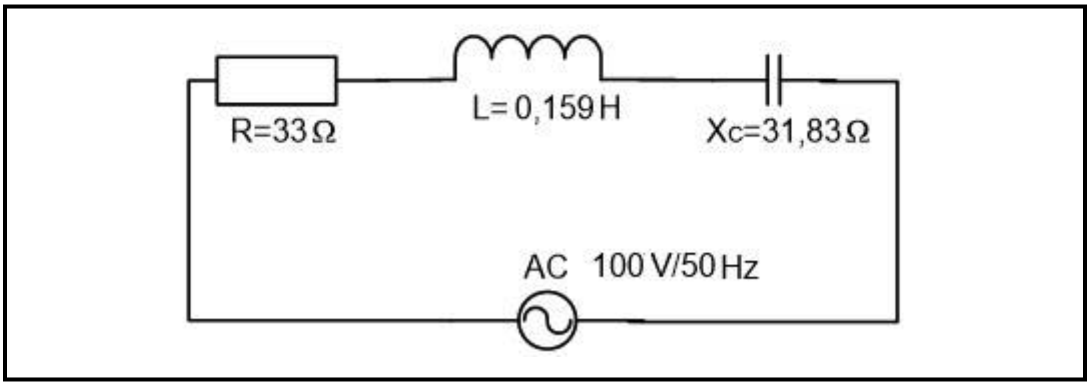


FIGURE 6.4

Given:
$R = 33\ \Omega$
$L = 0{,}159\ H$
$X_C = 31{,}83\ \Omega$
$V = 100\ V$
$f = 50\ Hz$

Calculate:

6.4.1 The inductive reactance of the coil (3)

6.4.2 The total impedance of the circuit (3)

6.4.3 The current flowing through the circuit (3)

6.4.4 The value of the capacitor in the circuit (3)
[20]

QUESTION 7: CONTROL DEVICES

7.1 Name the TWO conditions fuses are designed to respond to. (2)

7.2 Explain the function of a no volt coil as used in DOL starters. (3)

7.3 State TWO types of overload relays in use. (2)

7.4 Explain why it is advantageous to use circuit breakers instead of fuses in domestic installations. (2)

7.5 Briefly explain the function of a Direct-On-Line starter. (2)

7.6 Refer to FIGURE 7.6 and explain what happens when the ON button is pushed.

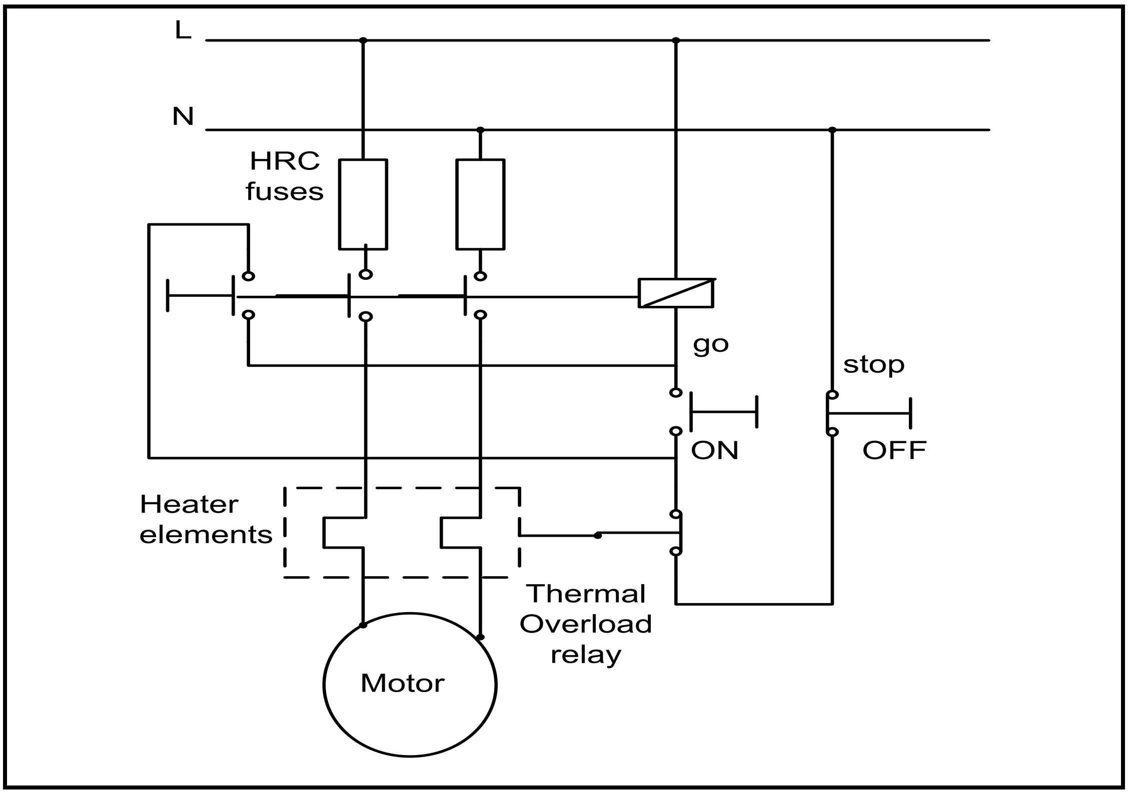


FIGURE 7.6 (4)

7.7 Draw the following ladder diagram logic symbols:

7.7.1 A push-to-make-switch (1)

7.7.2 A normally closed contact (1)

7.8 Explain the following steps of a PLC's scan cycle:

7.8.1 Input scan (2)

7.8.2 Process scan (2)

7.8.3 Output scan (2)

7.9 Name the circuit that makes it possible for an event to remain triggered on, after the activation trigger has been removed. (1)

7.10 Name ONE interconnection system which is used to interconnect and terminate computer systems. (1)

7.11 Refer to FIGURE 7.11 below of the AND logic function and answer the questions that follow.

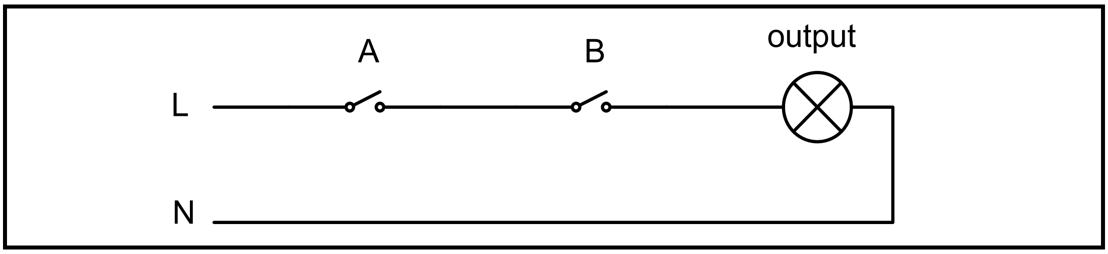


FIGURE 7.11

7.11.1 Draw the logic symbol of the function represented in FIGURE 7.11. (2)

7.11.2 Draw the ladder logic diagram of this circuit. (3)

7.11.3 Redraw and complete the truth table of the logic function represented in your ANSWER BOOK.

A	B	OUTPUT
0	0	
0	1	
1	0	
1	1	

(4)
[34]

QUESTION 8: SINGLE-PHASE MOTORS

8.1 State TWO disadvantages of DC motors when compared to AC motors. (2)

8.2 Mention THREE uses of a universal motor. (3)

8.3 Write down TWO characteristics of a split phase motor. (2)

8.4 Answer the following questions with reference to a capacitor-start, capacitor-run motor:

8.4.1 Mention THREE uses of the capacitor-start, capacitor-run motor. (3)

8.4.2 Explain how the combined capacitance affects this motor. (4)

8.5 Name the TWO main parts of an induction motor. (2)

8.6 Discuss the construction of the following parts of a universal motor:

8.6.1 The field poles (3)

8.6.2 The brushes (3)

8.7 Explain with the aid of the following tests how you would differentiate between the main winding and the start winding of a capacitor-start motor.

8.7.1 Visual test (1)

8.7.2 Continuity test (2)

8.8 Explain fully how you would perform an insulation resistance test between windings and earth, using an insulation tester. (4)

8.9 Explain why it is necessary to test a single-phase motor before it is put into service. (3)

[32]

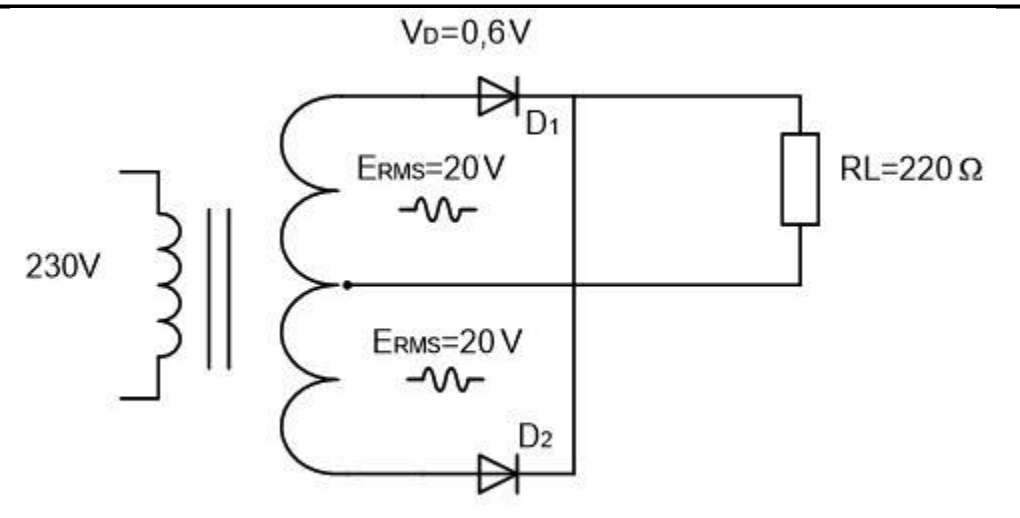
QUESTION 9: POWER SUPPLIES

9.1 Answer the following questions with reference to a Zener diode.

9.1.1 Draw a labelled circuit symbol. (2)

9.1.2 State TWO unique features of a Zener diode. (2)

9.2 Refer to FIGURE 9.2 of a full wave rectification with centre tap transformer below and answer the questions that follow.



Full wave rectification with centre tap transformer

FIGURE 9.2

Calculate:

9.2.1 Determine the peak voltage of each of the secondary half windings (3)

9.2.2 The peak load voltage (3)

9.2.3 The average load voltage (3)

9.2.4 The current drawn by the load (3)

9.2.5 Draw at least two complete waveforms of the voltage across the load resistor. (2)

9.3 Mention TWO types of filter circuits used in power supplies. (2)

9.4 State the purpose of the following components of a standard power supply.

9.4.1 Transformer (1)

9.4.2 Rectifier (1)

9.4.3 Filter (1)

9.4.4 Regulator (1)

9.4.5 Zener diode (1)
[25]

TOTAL: 200

FORMULA SHEET

DC MACHINES

$$\text{Armature losses} = I_{A^2} R_A$$

$$\text{Field losses} = I_{A^2} R_F$$

$$\eta = \frac{\text{output}}{\text{output} + \text{losses}} \times 100$$

$$P_{OUT} = V \times I_L$$

RLC-CIRCUITS

$$X_L = 2\pi f L$$

$$X_C = \frac{1}{2\pi f C}$$

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

SINGLE-PHASE AC GENERATION

$$E = \frac{\Delta\phi}{\Delta T}$$

$$V_{RMS} = V_{MAX} \times 0{,}707$$

$$f = \frac{1}{T}$$

$$V_{MAX} = 2\pi\beta A N n$$

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

POWER SUPPLIES

$$E_{RMS} = E_{PK} \times 0{,}707$$

$$V_{PK} = E_{PK} - V_D$$

$$V_{AVE} = V_{DC} = 0{,}318 \times V_{PK}$$

$$\gamma = \frac{1}{2\sqrt{3} C f R_L}$$

SINGLE-PHASE TRANSFORMERS

$$\text{Transformation ratio} = \frac{N_P}{N_S} = \frac{V_P}{V_S} = \frac{I_S}{I_P}$$

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ELECTRICAL TECHNOLOGY: POWER SYSTEMS MARKING GUIDELINE (EXEMPLAR)

MARKS: 200

This marking guideline consists of 12 pages.

INSTRUCTIONS TO MARKERS

1. All questions with multiple answers imply that any relevant, acceptable answer should be considered.

2. Calculations:

   2.1 All calculations must show the formulae.

   2.2 Substitution of values must be done correctly.

   2.3 All answers MUST contain the correct unit to be considered.

   2.4 Alternative methods must be considered, provided that the correct answer is obtained.

   2.5 Where an incorrect answer could be carried over to the next step, the first answer will be deemed incorrect. However, should the incorrect answer be carried over correctly, the marker has to re-calculate the values using the incorrect answer from the first calculation. If correctly used, the candidate should receive the full marks for subsequent calculations.

   2.6 Markers should consider that candidates' answers may deviate slightly from the marking guideline depending on how and where in the calculation rounding off was used.

3. These marking guidelines are only a guide with model answers.

4. Alternative interpretations must be considered and marked on merit. However, this principle should be applied consistently throughout the marking session.

QUESTION 1: OCCUPATIONAL HEALTH AND SAFETY

1.1 Where the operating voltage does not exceed 50 V. ✓
Roofs, gutters, downpipes, and wastepipes made of non-conductive material.
On premises which receive electricity by means of underground service connections. ✓
All metallic parts that are not part of the electrical circuit, that can become live, have an insulated covering. (2)

1.2 1.2.1 Lack of space can lead to chances of mistakes or even injury. ✓ (1)

1.2.2 Incorrect lighting can lead to eye strain. ✓ (1)

1.3 It is the study of the human body ✓ and its movement. ✓ (2)
[6]

QUESTION 2: TOOLS AND MEASURING INSTRUMENTS

2.1 A crimping lug offers a quick and permanent solution of terminating a cable. ✓ (1)

2.2 The clamp meter is safer and easier to use ✓ because there is no need to connect to the circuit to make measurements. ✓ (2)

2.3 This is the time the bonding of the wheel is liable to disengage and break apart. ✓ Therefore, it is not safe to be standing in the direct path of any pieces that may be thrown out by centrifugal force. ✓ (2)

2.4 The time base generator generates the internal saw tooth waveform to control the horizontal sweep of the trace. ✓ (1)
[6]

QUESTION 3: DC MACHINES

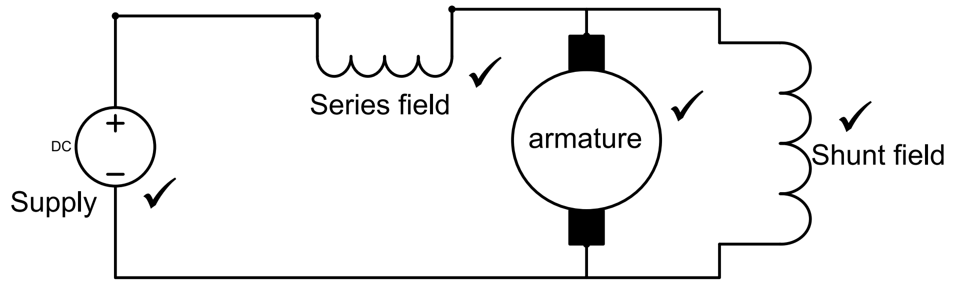
3.1
- Provides protection from moisture, dust, etc. to the rotating and other parts of the machine. ✓
- The iron body provides the path for the flux to complete the magnetic circuit. ✓
- It provides mechanical support for the field poles. (2)

3.2
- Hysteresis losses ✓
- Eddy current losses ✓ (2)

3.3
- High maintenance ✓
- Large and expensive ✓
- Not suitable for high-speed operation due to the commutator and brushes. (2)

3.4 Efficiency is the ratio ✓ of the useful output power to the total input power ✓ and is expressed as a percentage. (2)

3.5



(5)

3.6 The speed stays virtually constant with an increase in load. ✓ It has the constant speed of shunt machines and the high starting torque of series machines. ✓ (2)

3.7 3.7.1 $\text{Field losses} = I_F{}^2 . R_F$

$$I_F = \sqrt{\frac{\text{field losses}}{R_F}} \checkmark$$

$$= \sqrt{\frac{225}{25}} \checkmark$$

$$= 3\ \text{A} \checkmark$$

(3)

3.7.2 $\text{Total losses} = \text{copper losses} + \text{rotational losses} \checkmark$

$$= 425 + 225 + 300 \checkmark$$

$$= 950\ \text{W} \checkmark$$

(3)

3.7.3 $\eta = \frac{output}{output + losses} \times 100\% \quad \checkmark$

$$= \frac{4\ 000}{4000 + 950} \times 100 \quad \checkmark$$

$$= 80{,}81\% \quad \checkmark$$

(3)

3.8 They have a high starting torque, ✓ which makes them suitable for these high torque loads. ✓ (2)

[26]

QUESTION 4: SINGLE-PHASE AC GENERATION

4.1 Frequency is the number of cycles completed ✓ by a loop in one second. ✓ (2)

4.2 50 Hz ✓ (1)

4.3
- The change of magnetic lines of flux. ✓
- The time taken for the change of flux. ✓ (2)

4.4 Magnetic flux refers to the magnetic field lines that exist around a magnet. ✓
Magnetic flux density is a measure of the lines of flux which exist in a given area. ✓ (2)

4.5 4.5.1
$$V_{RMS} = V_{MAX} \times 0{,}707 \checkmark$$
$$V_{MAX} = \frac{V_{RMS}}{0{,}707} \checkmark$$
$$= 311{,}17\ V \checkmark$$
(3)

4.5.2
$$T = \frac{1}{f} \checkmark$$
$$= \frac{1}{25\ 000} \checkmark$$
$$= 4 \times 10^{-5} s = 40\ \mu s \checkmark$$
(3)

4.6 4.6.1
$$f = \frac{\text{revolutions per minute}}{60} \checkmark$$
$$= \frac{3\ 000}{60} \checkmark$$
$$= 50\ Hz \checkmark$$
(3)

4.6.2
$$V_{MAX} = 2\pi\beta AnN \checkmark$$
$$= 2 \times \pi \times 50 \times 10^{-3} \times 2000 \times 10^{-6} \times 50 \times 300 \checkmark$$
$$= 9{,}42\ V \checkmark$$
(3)

4.6.3
$$v = V_{MAX} \sin\theta \checkmark$$
$$= 9{,}42 \times \sin 45 \checkmark$$
$$= 6{,}66\ V \checkmark$$
(3)

4.7
$$\beta = \frac{\emptyset}{A} \checkmark$$
$$= \frac{20 \times 10^{-3}}{1{,}5 \times 10^{-4}} \checkmark$$
$$= 133{,}33\ T \checkmark$$
(3)

[25]

QUESTION 5: SINGLE-PHASE TRANSFORMERS

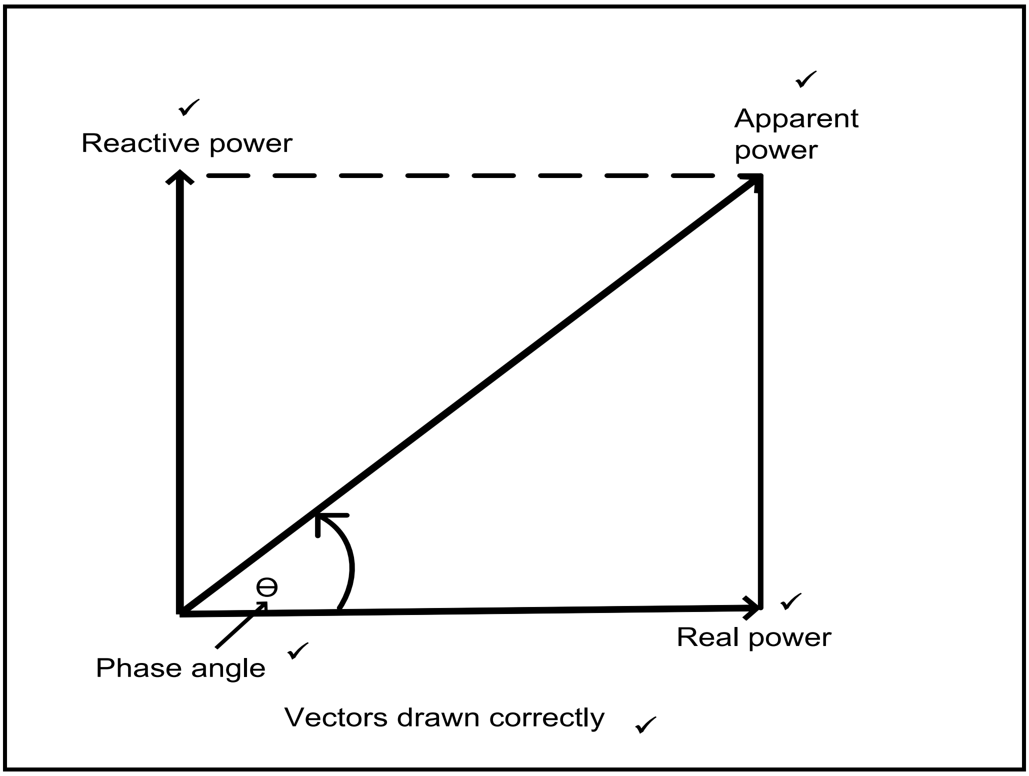
5.1 When there is relative movement between a magnetic field and a conductor, ✓ then an emf will be induced in the conductor. ✓ (2)

5.2 It is a force that develops in a coil ✓ when a current is passed down its length. ✓ (2)

5.3 To keep the core losses through eddy currents ✓ down to a minimum. ✓ (2)

5.4
- To raise or lower voltage and current levels in AC circuits. ✓
- They can prevent DC from passing from one circuit to another.
- They can be used to isolate two circuits from each other electrically. (1)

5.5



(5)

5.6
- Shell type ✓
- Closed-core type ✓ (2)

5.7 5.7.1 $F_m = H \times l$ ✓
$= 8\,000 \times 0{,}06$ ✓
$= 480$ ampere-turns ✓ (3)

5.7.2 $F_M = N \times I$
$I = \frac{F_M}{N}$ ✓
$= \frac{480}{400}$ ✓
$= 1{,}2\ A$ ✓ (3)

5.8 5.8.1 $\frac{N_P}{N_S} = \frac{50}{1}$

$N_S = \frac{N_P}{50}$ ✓

$= \frac{800}{50}$ ✓

$= 16 \text{ turns}$ ✓ (3)

5.8.2 $S = V_P I_P$

$I_P = \frac{S}{V_P}$ ✓

$= \frac{20\,000}{440}$ ✓

$= 45{,}45 \text{ A}$ ✓

OR

$P = V_P I_P \cos\theta$

$I_P = \frac{P}{V_P \cos\theta}$

$= \frac{18\,020}{440 \times 0{,}901}$

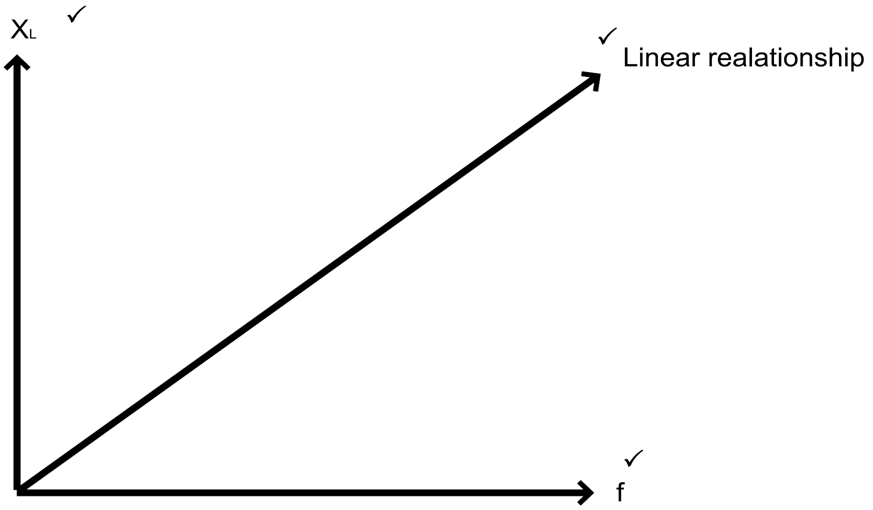
$= 45{,}45 \text{ A}$ (3)

[26]

QUESTION 6: RLC-CIRCUITS

6.1
- The capacitance of the capacitor ✓
- The frequency of the supply (1)

6.2



(3)

6.3 6.3.1 The current lags the voltage by 90 degrees. ✓ (1)

6.3.2 An increase in frequency causes the inductive reactance to increase. ✓ This will cause the impedance to increase ✓and the maximum value of the current waveform to decrease. ✓ (3)

6.4 6.4.1

$$X_L = 2\pi fL \checkmark$$
$$= 2 \times \pi \times 50 \times 0{,}159 \checkmark$$
$$= 49{,}95\ \Omega \checkmark$$

(3)

6.4.2

$$Z = \sqrt{R^2 + (X_L - X_C)^2} \checkmark$$
$$= \sqrt{33^2 + (49{,}95 - 31{,}83)^2} \checkmark$$
$$= 37{,}65\ \Omega \checkmark$$

(3)

6.4.3

$$I = \frac{V}{Z} \checkmark$$
$$= \frac{100}{37{,}65} \checkmark$$
$$= 2{,}66\ A \checkmark$$

(3)

6.4.4

$$X_C = \frac{1}{2\pi fC}$$
$$C = \frac{1}{2\pi fC} \checkmark$$
$$= \frac{1}{2 \times \pi \times 50 \times 31{,}83} \checkmark$$
$$= 1 \times 10^{-4}\ F = 100\ \mu F \checkmark$$

(3)

[20]

QUESTION 7: CONTROL DEVICES

7.1
- Overload conditions ✓
- Short circuit conditions ✓ (2)

7.2 It does not allow motors to self start after a power outage, ✓ to prevent serious injuries ✓ or damage to equipment. ✓ (3)

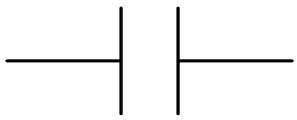
7.3
- Thermal relay ✓
- Magnetic relay ✓
- Electronic relay (2)

7.4 Circuit breakers are safer as they can be reset, ✓ and there is no risk of replacing with the incorrect rating as with fuses. ✓ (2)

7.5 This starter acts as a method of switching the motor ON and OFF, ✓ while at the same time offering over current and short circuit protection. ✓ (2)

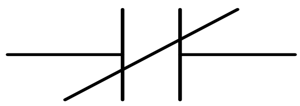
7.6 The relay coil will be energised from the supply main contactor. ✓
The energised coil produces a magnetic field and the contactor closes. ✓
The contactor connects the motor to the supply, ✓ and at the same time keeps the relay coil energised. ✓ (4)

7.7 7.7.1



✓ (1)

7.7.2



✓ (1)

7.8 7.8.1 Sequentially scans all input terminals to see if the conditions are ON or OFF in the correct sequence ✓ and reads each condition to the input memory. ✓ (2)

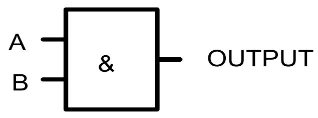
7.8.2 Executes instructions from the input memory in sequential order. ✓ This execution result will be stored in sequence into the memory. ✓ (2)

7.8.3 Activates each output according to the conditions stored in the memory, ✓ and the load devices receive the appropriate output. ✓ (2)

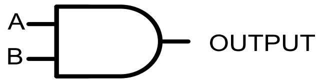
7.9 Latching circuit ✓ (1)

7.10
- Twisted-pair cabling ✓
- Fibre-optic cabling
- Parallel communication
- Serial communication (1)

7.11 7.11.1

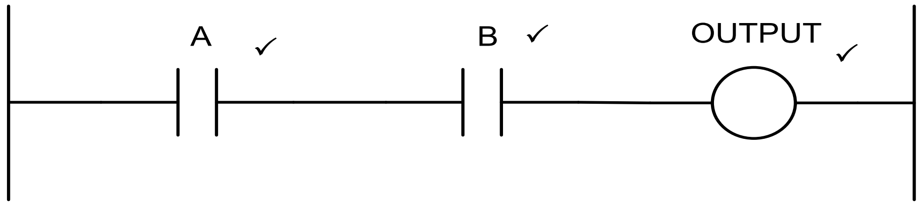


1 Mark for symbol correct ✓
1 mark for labelling ✓



(2)

7.11.2



(3)

7.11.3

A	B	OUTPUT
0	0	0 ✓
0	1	0 ✓
1	0	0 ✓
1	1	1 ✓

(4)
[34]

QUESTION 8: SINGLE-PHASE MOTORS

8.1
- High initial cost ✓
- High operation and maintenance cost due to the brushes and commutator ✓
- Cannot be operated in explosive and hazardous conditions (2)

8.2
- Electric hand drills ✓
- Vacuum cleaners ✓
- Food mixers ✓
- Sewing machines
- Power tools (3)

8.3
- Starting torque of 1,5 to 2 times the full load torque ✓
- Low starting current ✓
- Power ratings of between 60 W and 250 W
- Constant speed motors (2)

8.4 8.4.1
- Conveyor belt drives ✓
- Power tools ✓
- Washing machines ✓
- Tumble dryers
- Dishwashers
- Vacuum cleaners
- Air conditioners
- Compressors (3)

8.4.2 On start up it ensures a large starting current ✓ which flows immediately when induced through the rotor, giving it added torque ✓ while at the same time reducing the motor's phase angle ✓ and hence its load demand on the supply. ✓ (4)

8.5
- Stator ✓
- Rotor ✓ (2)

8.6 8.6.1 The field poles are made up of stacks of punched, ✓ laminated sheet metal ✓ with a shape recessed and designed to contain the field coils of the motor. ✓ (3)

8.6.2 Usually made of carbon ✓ with a tension spring ✓ and flexible connecting wire. ✓ (3)

8.7 8.7.1 The start winding is made of narrower, finer copper conductors. ✓ (1)

8.7.2 Set the meter to the ohm scale. ✓ The resistance reading of the run winding will be lower than the start winding. ✓ (2)

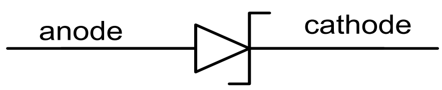
8.8 Set the meter to the 500 V / MΩ scale. ✓
Take the reading by placing one lead on the earth terminal of the motor and the other on the main winding. ✓
Repeat the process but place the leads on the earth and start winding. ✓
To be acceptable the readings should be at least 1 MΩ. ✓ (4)

8.9 To ensure that the motor is fully operational. ✓ This will prevent unnecessary damage to equipment and assembly lines. ✓ It will also prevent loss of production. ✓ (3)

[32]

QUESTION 9: POWER SUPPLIES

9.1 9.1.1



Symbol correct ✓
Labels correct ✓

(2)

9.1.2 It has a very precise reverse breakdown voltage point. ✓
It maintains the voltage accurately with no change even with rising reverse currents. ✓ (2)

9.2 9.2.1 $E_{RMS} = E_{PK} \times 0{,}707$

$E_{PK} = E_{RMS} \div 0{,}707$ ✓

$= \frac{20}{0{,}707}$ ✓

$= 28{,}29\ V$ ✓ (3)

9.2.2 $V_{PK} = E_{PK} - (2 \times V_D)$ ✓

$= 28{,}29 - (2 \times 0{,}6)$ ✓

$= 27{,}09\ V$ ✓ (3)

9.2.3 $V_{AVE} = V_{DC} = V_{PK} \times 0{,}636$ ✓

$= 27{,}09 \times 0{,}636$ ✓

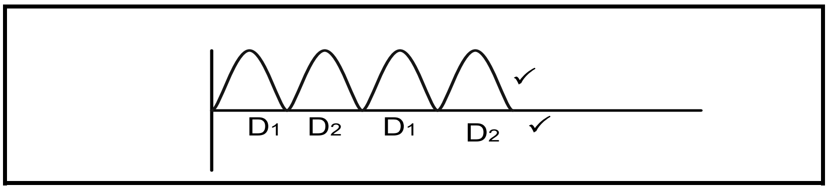
$= 17{,}23\ V$ ✓ (3)

9.2.4 $I_{DC} = \frac{V_{DC}}{R_L}$ ✓

$= \frac{17{,}23}{220}$ ✓

$= 0{,}07832\ A = 78{,}32\ mA$ ✓ (3)

9.2.5



(2)

9.3
- π filter ✓
- RC-filter ✓
- LC-filter
- L-filter (2)

9.4 9.4.1 Steps down the high input AC voltage to a lower AC voltage. ✓ (1)

9.4.2 Converts the lowered AC voltage into a pulsating DC voltage. ✓ (1)

9.4.3 Smooths out the pulsating DC voltage. ✓ (1)

9.4.4 Eliminates any varitions in voltage which are present after filtering. ✓ (1)

9.4.5 Keeps the output voltage at a fixed value. ✓ (1)

[25]

TOTAL: 200