basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

ELECTRICAL TECHNOLOGY

NOVEMBER 2012

MARKS: 200

TIME: 3 hours

This question paper consists of 12 pages and 1 formula sheet.

INSTRUCTIONS AND INFORMATION

1. Answer ALL the questions.

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

3. ALL calculations must be shown and must be correctly rounded off to TWO decimal places.

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

5. Non-programmable calculators may be used.

6. Show the units for all answers of calculations.

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

8. Write neatly and legibly.

QUESTION 1: TECHNOLOGY, SOCIETY AND THE ENVIRONMENT

1.1 Coal is the primary source of energy used by South African power stations.

1.1.1 Name and describe ONE negative impact the use of coal may have on the environment. (2)

1.1.2 Give TWO reasons why coal is still used as an energy source even though it has a negative impact on the environment. (2)

1.2 Name TWO skills that a successful entrepreneur should have. (2)

1.3 The cellular phone is a technological development. Name and describe ONE benefit to society. (2)

1.4 Describe how the term *equal access to employment* relates to electrical technology school leavers. (2)
[10]

QUESTION 2: TECHNOLOGICAL PROCESS

2.1 Name the FOUR steps that are used in the technological process after a product has been identified. (4)

2.2 Describe why it is necessary to use these steps in relation to the product. (2)

2.3 Give FOUR reasons why it is necessary to make a prototype of a product before production of that product. (4)
[10]

QUESTION 3: OCCUPATIONAL HEALTH AND SAFETY

3.1 State TWO unsafe acts that must not take place in an electrical technology workshop. (2)

3.2 Explain why water may not be used to extinguish a fire caused by an electrical fault. (2)

3.3 State TWO safety precautions that must be taken when using a multimeter to measure current in a circuit. (2)

3.4 Give TWO reasons why good ventilation in an electrical technology workshop is important. (2)

3.5 Describe why it is important to use tools with insulated handles when working on electrical circuits. (2)
[10]

QUESTION 4: THREE-PHASE AC GENERATION

4.1 Indicate whether the reading on a voltmeter when measuring an AC voltage is a maximum value, average value or effective/rms value. (1)

4.2 Define the term *apparent power*. (3)

4.3 Explain what is meant by the term *active current*. (3)

4.4 A three-phase balanced load is connected in delta. The phase voltage is 240 V/50 Hz and the phase current is 10 A. If the power factor is 0,8, calculate the line current drawn at full load.

Given:

V_p = 240 V
f = 50 Hz
I_{Ph} = 10 A
Cos θ = 0,8 (3)

[10]

QUESTION 5: RLC CIRCUITS

5.1 Define the term *capacitive reactance*. (3)

5.2 Explain why the brightness of a lamp when connected in series with an inductor will decrease when the frequency of the supply is increased. (3)

5.3 The phasor diagram in FIGURE 5.1 indicates the current values flowing through the components of a parallel circuit connected across a 240 V/50 Hz supply.

Given:

I_C = 10 A
I_R = 15 A
I_L = 15 A
V = 240 V
f = 50 Hz

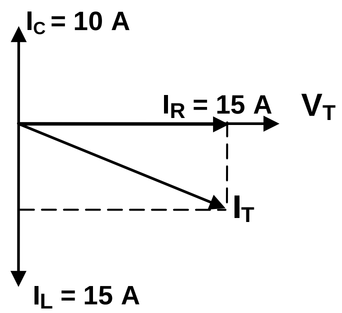


FIGURE 5.1: PHASOR DIAGRAM OF AN RLC PARALLEL CIRCUIT

Calculate:

5.3.1 The total current flow through the circuit (3)

5.3.2 The inductive reactance (3)

5.3.3 The inductance of the coil (3)

5.4 The RC circuit in FIGURE 5.2 consists of a 30 ohm resistor and a 147 microfarad capacitor connected across a 240 V/50 Hz supply.

Given:

R = 30 Ω
C = 147 μF
V = 240 V
f = 50 Hz

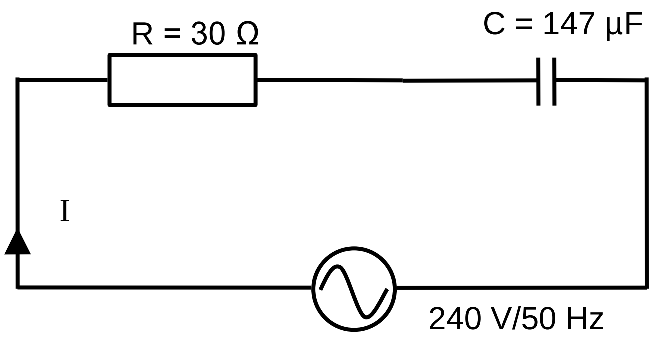


FIGURE 5.2: RC CIRCUIT

Calculate:

5.4.1 The capacitive reactance (3)

5.4.2 The impedance of the circuit (3)

5.4.3 The current flow in the circuit (3)

5.4.4 The phase angle (3)

5.5 With reference to FIGURE 5.2, describe what would happen to the voltage across the resistor if the capacitance of the capacitor was increased. (3)

[30]

QUESTION 6: SWITCHING AND CONTROL CIRCUITS

6.1 Draw a fully labelled symbol of a DIAC. (2)

6.2 The diagram in FIGURE 6.1 shows the characteristic curve of a TRIAC.

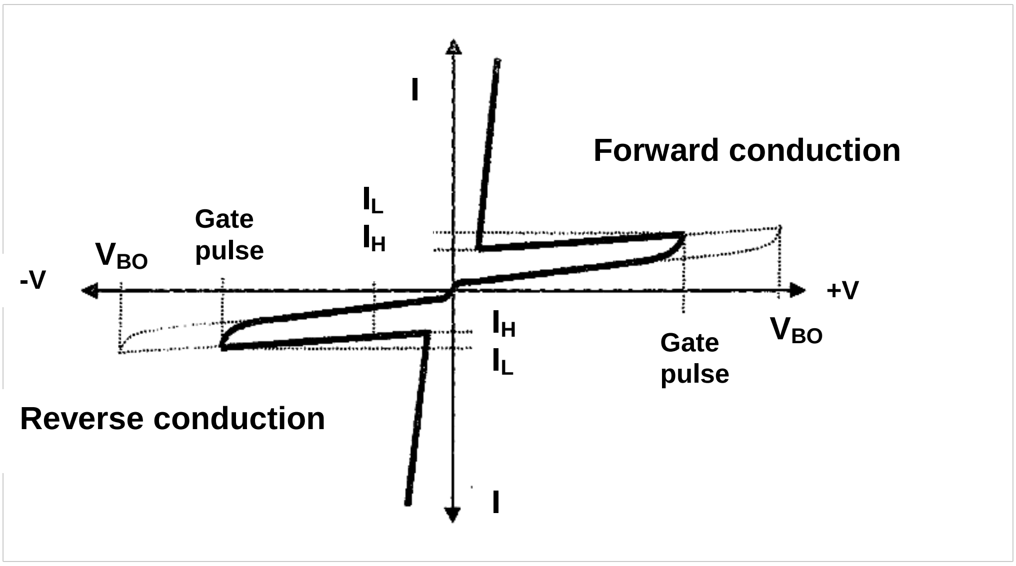


FIGURE 6.1: CHARACTERISTIC CURVE OF A TRIAC

6.2.1 Give ONE application of a TRIAC. (1)

6.2.2 Draw a fully labelled symbol of a TRIAC. (3)

6.2.3 Describe what happens to the TRIAC at the points labelled 'gate pulse'. (2)

6.2.4 Describe what happens to the TRIAC if the voltage across it reaches V_{BO}. (2)

6.2.5 Explain what the value I_H represents on the characteristic curve. (2)

6.2.6 Explain what happens to the voltage across the TRIAC when it begins to conduct. (2)

6.2.7 Name ONE advantage a TRIAC has over an SCR. (1)

6.3 The diagram in FIGURE 6.2 shows a lamp-dimming circuit using an SCR.

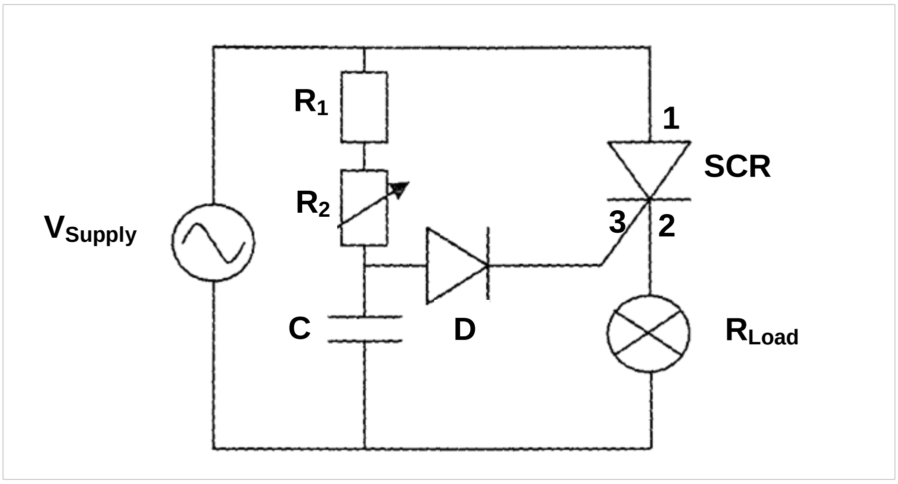


FIGURE 6.2: LAMP-DIMMING CIRCUIT

6.3.1 Label the SCR terminals numbered **1**, **2** and **3**. (3)

6.3.2 Describe the function of R_1 in the circuit. (3)

6.3.3 If the value of R_2 is increased, describe how this will affect the brightness of the lamp. (4)
[25]

QUESTION 7: AMPLIFIERS

7.1 7.1.1 The standard circuit symbol for an op amp is shown in FIGURE 7.1. Label the numbers **1**, **2** and **3**. (3)

7.1.2 Label **4** and **5** AND state their function.

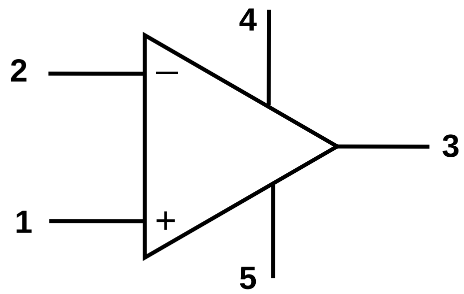


FIGURE 7.1: SYMBOL OF AN OP AMP (2)

7.2 With reference to an op amp, explain the term *feedback*. (2)

7.3 Draw the output wave forms of the op amp circuits below.

7.3.1

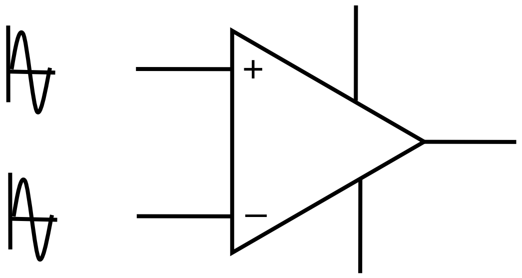


FIGURE 7.2: OP AMP (2)

7.3.2

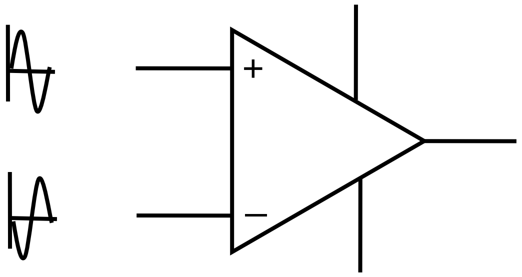


FIGURE 7.3: OP AMP (2)

7.4 Refer to FIGURE 7.4.

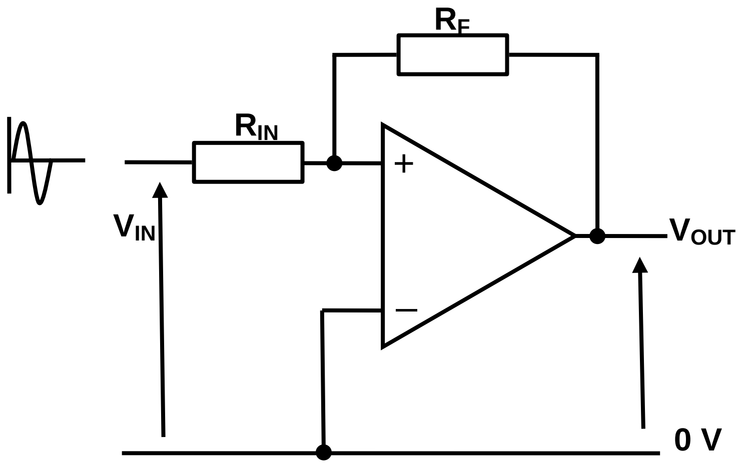


FIGURE 7.4: OP AMP CIRCUIT

7.4.1 Name the circuit. (1)

7.4.2 Draw input and output waveforms on the same axis. (2)

7.4.3 Describe what will happen to the voltage gain of the circuit if R_{IN} is increased. (3)

7.4.4 If the resistive value of R_{IN} and R_F are the same, state what would happen to the phase and amplitude of the output. (2)

7.5 In the amplification process the amplitude of the wave form changes. What happens to the frequency of the wave form? (1)

7.6 Explain what effect the very high input impedance (close to infinity) of an op amp will have on the preceding circuit (circuit connected to the input of the op amp). (5)
[25]

QUESTION 8: THREE-PHASE TRANSFORMERS

8.1 State ONE cause of overheating in a transformer. (1)

8.2 Name the TWO types of circuits in a transformer. (2)

8.3 Describe why the secondary winding of a transformer must be connected in star if the transformer is to supply both a domestic and an industrial load. (3)

8.4 A 240 kVA three-phase transformer supplies power to a soccer stadium. The transformer is connected in delta-star. The input line voltage is 11 kV and the output line voltage is 415 V at a lagging power factor of 0,85.

Given:

$S = 240\ kVA$
$V_{L(p)} = 11\ 000\ V$
$V_{L(s)} = 415\ V$
$\cos\theta = 0{,}85$

Calculate:

8.4.1 The secondary phase voltage (3)

8.4.2 The current drawn from the supply by the transformer at full load (3)

8.4.3 The power delivered at full load to the stadium (3)
[15]

QUESTION 9: LOGIC CONCEPTS AND PLCs

9.1 Describe the function of the following components of a PLC:

9.1.1 Power supply (2)

9.1.2 Control Processing Unit (CPU) (2)

9.1.3 Output module (2)

9.2 With reference to an AND-gate, draw the following:

9.2.1 A circuit diagram using two switches and a lamp to simulate the gate operation (4)

9.2.2 The ladder logic diagram (3)

9.3 Refer to FIGURE 9.1.

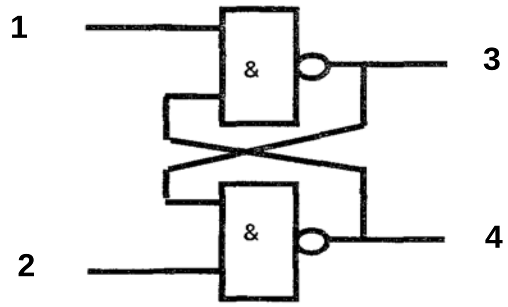


FIGURE 9.1: CIRCUIT OF A LATCH

9.3.1 Name the latch circuit. (1)

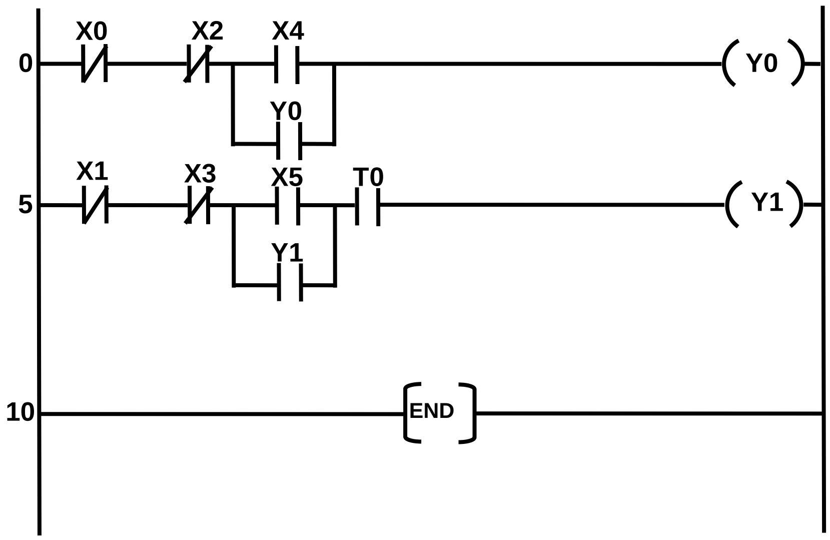
9.3.2 Label the numbers **1**, **2**, **3** and **4**. (4)

9.3.3 State ONE application of this latch. (1)

9.3.4 Give the outputs on **3** and **4** if the input at **1** is logic position 0 and the input at **2** is logic position 1. (2)

9.4 State THREE advantages of PLCs in comparison to relay control. (3)

9.5 Draw the circuit diagram that represents the ladder logic program in FIGURE 9.2.



NOTE:

X0 = N/C
X1 = N/C
X2 = N/C
X3 = N/C
X4 = N/O
X5 = N/O
Y0 = N/O
Y1 = N/O
T0 = N/O

FIGURE 9.2: LADDER LOGIC PROGRAM FOR SEQUENCE CONTROL (11)
[35]

QUESTION 10: THREE-PHASE MOTORS AND CONTROL

10.1 State how the direction of rotation of a three-phase motor may be changed. (1)

10.2 Name TWO electrical inspections that need to be done on a new three-phase motor before it is connected to the power supply. (2)

10.3 State the minimum value of resistance when measuring the insulation resistance between the windings of a motor. (1)

10.4 Describe the function of a star-delta starter. (2)

10.5 Describe why it is necessary to have protective devices as part of motor control. (2)

10.6 The input power of a 415 V/50 Hz, three-phase star-connected induction motor is 9 kW. The motor is 100% efficient with a power factor of 0,9.

$P = 9$ kW
$V_L = 415$ V
$\cos\theta = 0{,}9$
$f = 50$ Hz

Calculate:

10.6.1 The phase voltage (3)

10.6.2 The line current (3)

10.6.3 The apparent power (3)

10.7 List THREE motor properties that will be displayed on its name plate. (3)

10.8 State THREE advantages that a three-phase induction motor has over a single-phase motor. (3)

10.9 The circuit diagram shown in FIGURE 10.1 represents the control circuit and the power circuit of a direct-on-line-starter.

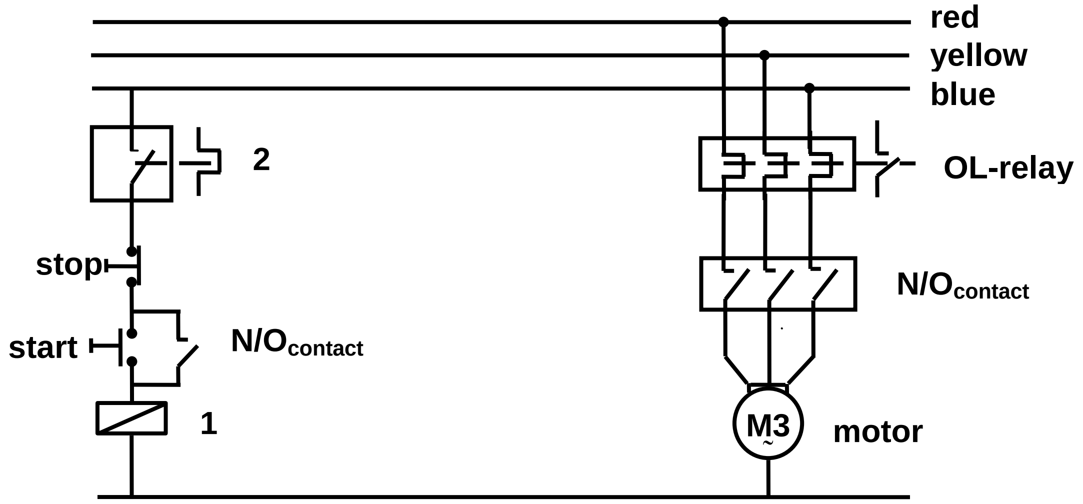


FIGURE 10.1: DIRECT-ON-LINE-STARTER

10.9.1 Identify the components labelled **1** and **2**. (1)

10.9.2 Explain what occurs to the three-phase induction motor if one phase fails. (3)

10.9.3 Describe the protection that the component labelled **2** offers to the motor. (3)

[30]

TOTAL: 200

FORMULA SHEET

$$X_L = 2\pi FL$$

$$X_C = \frac{1}{2\pi FC}$$

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

$$I_T = \sqrt{I_R^2 + \left(I_C \cong I_L\right)^2}$$

$$V_T = \sqrt{V_R^2 + \left(V_C \cong V_L\right)^2}$$

$$V_R = IR$$

$$V_L = IX_L$$

$$V_C = IX_C$$

$$f_r = \frac{1}{2\pi\sqrt{LC}}$$

$$Q = \frac{X_L}{R} = \frac{V_L}{V_R}$$

$$\cos\theta = \frac{I_R}{I_T}$$

$$\theta = \cos^{-1}\frac{I_R}{I_T}$$

$$\cos\theta = \frac{R}{Z}$$

$$\tan\theta = \frac{X_C}{R}$$

$$\theta = \tan^{-1}\frac{X_C}{R}$$

Single phase:

$$P = VI\cos\theta$$

$$S = VI$$

$$Q = VI\sin\theta$$

Three phase:

$$P = \sqrt{3}\, V_L I_L \cos\theta$$

$$P = 3V_{ph} I_{ph} \cos\theta$$

$$S = \sqrt{3}\, V_L I_L$$

$$Q = \sqrt{3}\, V_L I_L \sin\theta$$

Delta:

$$V_L = V_{Ph}$$

$$I_L = \sqrt{3} I_{Ph}$$

Star:

$$V_L = \sqrt{3}\, V_{Ph}$$

$$V_{Ph} = \frac{V_L}{\sqrt{3}}$$

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

$$\frac{V_{ph(P)}}{V_{ph(S)}} = \frac{N_P}{N_S} = \frac{I_{ph(S)}}{I_{ph(P)}}$$

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GRADE 12

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NOVEMBER 2012

MEMORANDUM

MARKS: 200

This memorandum consists of 13 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 formula(e).

    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 same answer is obtained.

    2.5 Where an erroneous 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 learner should receive the full marks for subsequent calculations.

3. The memorandum is only a guide with model answers. Alternative interpretations must be considered, and marked on merit. However, this principle should be applied consistently throughout the marking session at ALL marking centres.

QUESTION 1: TECHNOLOGY, SOCIETY AND THE ENVIRONMENT

1.1 1.1.1 Coal causes air pollution✓ which is harmful to the environment✓ as man, animal and plant life all rely on clean air for healthy living. (2)

1.1.2 Availability of coal✓
Economical✓
(Any acceptable answer) (2)

1.2 Need to be a hard worker.✓
Need to be a creative thinker.✓
Must have sound financial management skills.
Good communication skills; Personal drive and commitment; Good positive attitude and work ethic; Have the desire to succeed; Good marketing skills; Good time management skills; and be a good leader.
(Any TWO relevant competencies) (2)

1.3 The cellphone has given many people more access to a wide range of communication methods✓ which has allowed access to the business world. ✓
Education opportunities.
Cellphones allow access to the Internet, Facebook and Twitter; it is not only just a phone but a computer as well.
(Many possiblities) (2)

1.4 Equal access to employment to school leavers means that all learners leaving school should have had an education✓ that does not disadvantage them in any way that gives them access to economic independence. ✓
No restricted access to education or work opportunities
Affords the opportunity for the school leaver to work in related Electrical Technology fields.
(Alternative answers within the context of Electrical Technology) (2)
[**10**]

QUESTION 2: TECHNOLOGICAL PROCESS

2.1 Investigation✓
Designing✓
Making✓
Evaluation✓ (4)

2.2 To make the product according to the selected design✓ and to improve the product after evaluation. ✓ (2)

2.3 To identify possible improvements of the product. ✓
To collect data and information of the product. ✓
To conduct tests on the prototype. ✓
To check if specifications are met. ✓
To see if the prototype is suitable before the final product is made.
To check costing and other financial constraints.
(Any relevant answer) (4)
[10]

QUESTION 3: OCCUPATIONAL HEALTH AND SAFETY

3.1 Working on a live system with exposed conductors. ✓
Working with portable electric equipment that is not insulated correctly. ✓
Using electrical machines without using the required safety equipment or clothing. (2)
(Any valid answer)

3.2 Because water is a conductor of electricity✓ and will result in electric shock.✓ (2)

3.3 Power to the circuit must be switched off when connecting meter leads. ✓
Make sure that the leads are connected to the correct terminal or sockets of the meter. ✓
Make sure that the multimeter is connected in series when measuring current.
For safety, start with the highest scale of the multimeter.
(Any TWO) (2)

3.4 To prevent drowsiness✓ which could cause loss of concentration resulting in an accident. ✓
To remove vapour and smoke which are harmful to humans. (2)

3.5 To avoid electric shock.✓
Some sections of the circuit may be live. ✓
The power supply could have been switched on by mistake. (2)
[10]

QUESTION 4: THREE-PHASE AC GENERATION

4.1 Effective value✓ or rms value (1)

4.2 Apparent power is the product✓ of the supply voltage and the current✓ in an AC system. ✓

S = VI (3)

4.3 The active current is that component of current✓ which is in phase ✓with the supply voltage of an AC system. ✓ (3)

4.4
$I_L = \sqrt{3} I_{PH}$ ✓
$= \sqrt{3} \times 10$ ✓
$= \underline{17{,}32 A}$ ✓
(3)
[10]

QUESTION 5: RLC CIRCUITS

5.1 Capacitive reactance is the opposition✓ to the flow of current ✓ a capacitor offers when the capacitor is connected across an alternating voltage supply. ✓ (3)

5.2 When the frequency of the supply is increased, the inductive reactance will increase✓ thus increasing the impedance of the circuit✓. The increase in impedance will result in a decrease in current flowing through the circuit✓ thus reducing the brightness of the lamp. (3)

5.3 5.3.1

$$I_T = \sqrt{I_R^2 + (I_L - I_C)^2} \checkmark$$
$$= \sqrt{15^2 + (15-10)^2} \checkmark$$
$$= \underline{15.81A} \checkmark$$
(3)

5.3.2

$$X_L = \frac{V}{I_L} \checkmark$$
$$= \frac{240}{15} \checkmark$$
$$= \underline{16\Omega} \checkmark$$
(3)

5.3.3

$$L = \frac{X_L}{2\pi f} \checkmark$$
$$= \frac{16}{2 x \pi x 50} \checkmark$$
$$= 51mH$$
$$= \underline{51 \times 10^{-3} H} \checkmark$$
(3)

5.4 5.4.1

$$X_C = \frac{1}{2\pi fC} \checkmark$$
$$= \frac{1}{2 x \pi x 50 x 147 x 10^{-6}} \checkmark$$
$$= \underline{21.65\Omega} \checkmark$$
(3)

5.4.2

$$Z = \sqrt{R^2 + X_C^2} \checkmark$$
$$= \sqrt{30^2 + 21.65^2} \checkmark$$
$$= \underline{37\Omega} \checkmark$$
(3)

5.4.3

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

$$= \frac{240}{37} \checkmark$$

$$= \underline{6.49\,A} \checkmark$$

(3)

5.4.4

$$\theta = \tan^{-1}\frac{X_C}{R} \checkmark$$

$$= \tan^{-1}\frac{21.65}{30} \checkmark$$

$$= \underline{35.82^\circ} \checkmark$$

OR

$$\theta = \cos^{-1}\frac{R}{Z}$$

$$= \cos^{-1}\frac{30}{37}$$

$$= \underline{35.82^\circ}$$

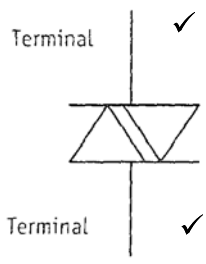
(3)

5.5 If the capacitance of the capacitor is increased the capacitive reactance of the capacitor will decrease✓. The voltage across the capacitor will decrease✓ which will result in an increase of the voltage across the resistor. ✓ (3)

[30]

QUESTION 6: SWITCHING AND CONTROL CIRCUITS

6.1

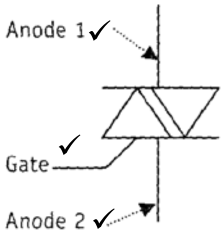


(2)

6.2 6.2.1 The TRIAC may be used in the following applications:

Motor speed control ✓
Lamp dimming
Temperature control
Triacs are used in switching circuits.
(Any ONE application) (1)

6.2.2



(ONE mark for correct symbol with no or incorrect labelling) (3)

6.2.3 At both points labelled 'gate pulse' the TRIAC will be triggered into conduction✓ if there is an appropriate voltage across the terminals of the TRIAC. ✓ (2)

6.2.4 When the voltage across the TRIAC reaches V_{BO} the TRIAC will begin to conduct✓ without the gate being triggered. ✓ (2)

6.2.5 I_H is the holding current of the TRIAC, this is the minimum current that must flow to keep the TRIAC conducting✓ if the current through the TRIAC falls below I_H the TRIAC will switch off. ✓ (2)

6.2.6 When the TRIAC begins to conduct, the internal resistance of the TRIAC decreases✓ therefore the voltage across the TRIAC will decrease.✓ (2)

6.2.7 It conducts in both directions. ✓ (1)

6.3 6.3.1 1 – Anode✓
2 – Cathode✓
3 – Gate✓ (3)

6.3.2 R_1 acts as a current limiting resistor.✓ In the event that R_2 is decreased to zero,✓ a short circuit is prevented. ✓ (3)

6.3.3 If R_2 is increased, the time constant of the trigger circuit is increased (t=RC). ✓ This will prolong✓ the time it takes for the capacitor to charge to the voltage that is equal to the break over voltage of the DIODE increasing the trigger angle (taking longer to trigger) ✓ thus reducing the brightness of the lamp✓ as less time is allowed for current to flow through the lamp. (4)

[25]

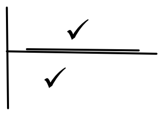
QUESTION 7: AMPLIFIERS

7.1 7.1.1 1 – Non-inverting input ✓
2 – Inverting input ✓
3 – Output ✓ (3)

7.1.2 4 and 5 are the terminals to the dual DC supply✓ that supplies power to the op amp. ✓ (2)

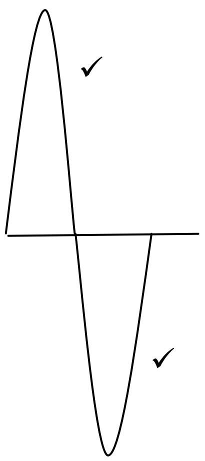
7.2 The concept of feedback is to sample the voltage at the output terminal✓ and to feed it back into one of the input terminals. ✓ (2)

7.3 7.3.1



(2)

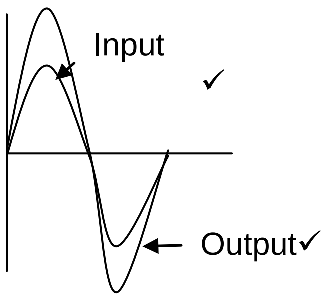
7.3.2



(2)

7.4 7.4.1 Non-inverting op amp✓ (1)

7.4.2



(ONE mark showing phase and ONE mark showing increased amplitude) (2)

7.4.3 $A_V = \frac{R_f}{R_{in}}$

The voltage gain of the circuit will decrease✓ as R_{IN} increases, ✓ because A_V is inversely proportional to R_{IN}. ✓

(ONE mark if only the formula is given) (3)

7.4.4 The input and output waveforms will be in phase. ✓
The input and output amplitudes will be the same. ✓ (2)

7.5 The frequency of the wave form remains unchanged. ✓ (1)

7.6 This will reduce the loading effect on the previous circuit. ✓ In so doing, no current will be drawn✓ from that circuit. Therefore, the voltage appearing ✓at its output terminals✓ will be passed on to the op amp with little or no loss. ✓

OR

When the input impedance of a circuit is high, the current it draws from the preceding circuit is minimal. As a result, the voltage drop is reduced and the input circuit loading is reduced. Circuit loading is when the current exceeds the delivery capacity and as a result the output voltage reduces to zero. (5)

[25]

QUESTION 8: THREE-PHASE TRANSFORMERS

8.1 Insufficient ventilation✓
Short circuit
Overloading
Insufficient cooling substance (Any ONE) (1)

8.2 Electric circuit✓
Magnetic circuit✓ (2)

8.3 To create a three-phase four-wire system✓ so that a transformer can supply both single-phase✓ and three-phase. ✓(To distribute power to both domestic and industrial installations.) (3)

8.4 8.4.1

$$V_{L(s)} = \sqrt{3}V_{Ph(s)}$$

$$\therefore V_{Ph(s)} = \frac{V_{L(s)}}{\sqrt{3}} \quad ✓$$

$$= \frac{415}{\sqrt{3}} \quad ✓$$

$$= \underline{239.6\ V} \quad ✓$$

(3)

8.4.2 $S = \sqrt{3} V_{L(p)} \, I_{L(p)}$

$$\therefore \; I_{L(p)} = \frac{S}{\sqrt{3} V_{L(p)}} \checkmark$$

$$= \frac{240000}{\sqrt{3} \, x \, 11000} \checkmark$$

$$= \underline{12.59 \, A} \checkmark$$

(3)

8.4.3

$$P_O = \sqrt{3} V_{L(p)} \, I_{L(p)} Cos\theta \quad \checkmark$$

$$= \sqrt{3} \, x \, 11000 \, x \, 12.59 \, x \, 0.85 \quad \checkmark$$

$$= \underline{203{,}89 \text{ kW}} \quad \checkmark$$

(3)
[15]

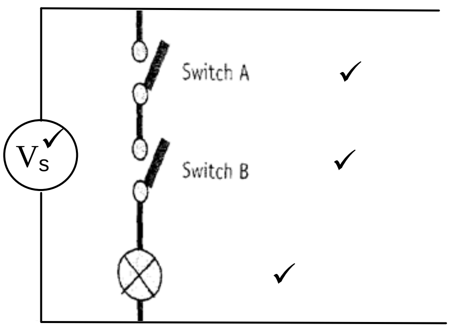
QUESTION 9: LOGIC CONCEPTS AND PLCs

9.1 9.1.1 This provides the power at a specific voltage ✓ to operate the PLC. ✓ (2)

9.1.2 This is the device that is programmed externally✓ to provide the necessary control of the plant (relays, motors, etc.).✓ (2)

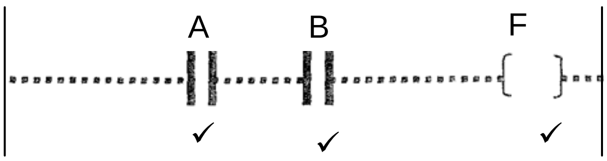
9.1.3 These modules are the interface✓ between the PLC and the plant equipment. ✓ (2)

9.2 9.2.1



(4)

9.2.2



(3)

9.3 9.3.1 R-S Flip-Flop latch✓
Bistable-multivibrator (1)

9.3.2 1 – Set ✓
2 – Reset✓
3 – Q ✓

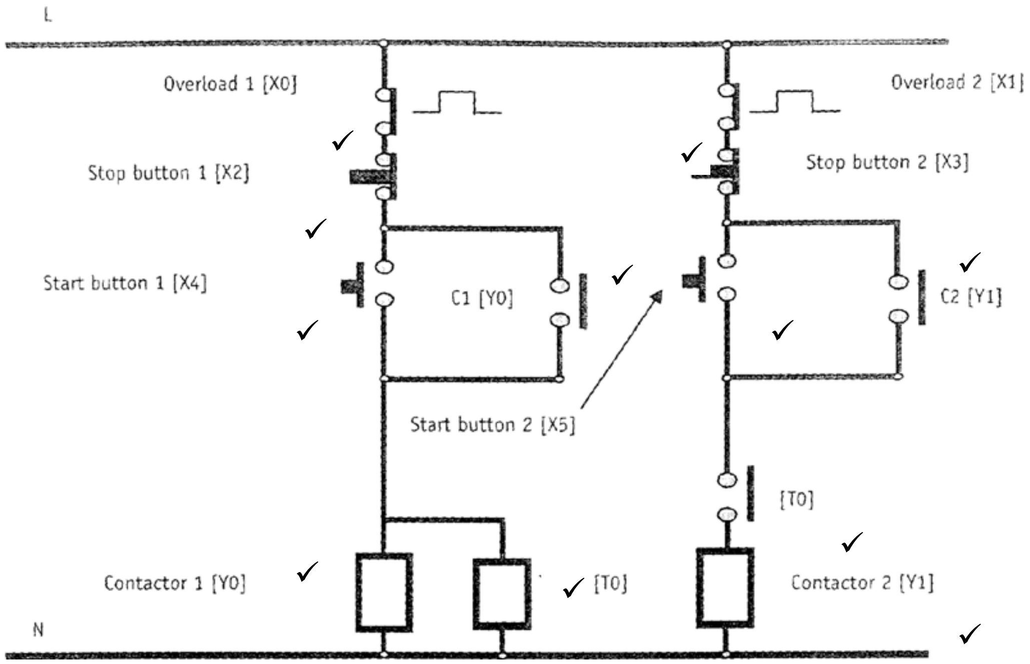
4 – $\overline{Q}$ ✓ (4)

9.3.3 Memory device ✓ (1)

9.3.4 3 – 0✓
4 – 1✓ (2)

9.4 Simplified✓
Economical ✓
Quick delivery ✓
Compact
Changes to circuit design more easy to effect
Improved reliability
Reduced maintenance
(Any THREE) (3)

9.5



(11)
[35]

QUESTION 10: THREE-PHASE MOTORS AND CONTROL

10.1 By reversing the connections of any two of the three supply lines to the stator. ✓ (1)

10.2 To check if the frame is earthed. ✓
To see if all electrical connections are fastened and insulated.✓
To verify if the correct voltage is used.
(Any acceptable answer) (2)

10.3 Minimum of 0,5 M Ω✓. (Very high resistance) (1)

10.4 To limit the starting✓ current of a squirrel cage motor at start.✓ (2)

10.5 To protect electrical equipment from✓ damage during faulty operating conditions and protecting the operator of the equipment. ✓ (2)

10.6 10.6.1

$$V_L = \sqrt{3} V_{ph}$$

$$V_{ph} = \frac{V_L}{\sqrt{3}} \quad ✓$$

$$= \frac{415}{\sqrt{3}} \quad ✓$$

$$= 239.60\,V \quad ✓$$

(3)

10.6.2

$$P_i = \sqrt{3} V_L I_L \cos\theta$$

$$I_L = \frac{P_i}{\sqrt{3} V_L \cos\theta} \quad ✓$$

$$= \frac{9\,000}{\sqrt{3}\, x 415 \, x 0.9} \quad ✓$$

$$= 13.91 A \quad ✓$$

(3)

10.6.3

$$S = \sqrt{3} \times V_L \times I_L \quad ✓$$

$$= \sqrt{3} \times 415 \times 13,9 \quad ✓$$

$$= 10\,kVA \quad ✓$$

OR

$$S = \frac{P}{\cos\phi}$$

$$= \frac{9000}{0.9}$$

$$= 10\,kVA$$

(3)

10.7 It is important that a motor has an information plate because the plate contains crucial information about the motor, for example:
Current rating✓
Power factor✓
Phase✓
Power output (3)

10.8 The advantage of the three-phase induction motor is that for the same size frame a three phase motor delivers more power.✓
It is also more efficient than a single-phase motor as no additional starting circuit is required.✓
Less expensive than single-phase motors with the same output power.✓
Rotation change simple.
Self-starting.
Higher starting torque than single-phase motors for same size frame.
(Any THREE acceptable answers) (3)

10.9 10.9.1 Coil of contactor✓ (1)

10.9.2 The motor will keep on operating, but to maintain the same output power✓ the current on the other two phases will increase. ✓If the protection is set correctly, it will engage, protecting the motor from permanent damage. ✓ (3)

10.9.3 The overload relay is designed to protect the motor✓ and motor wiring against current fault conditions. ✓ It will open and cut power to the motor. ✓ (3)

[30]

TOTAL: 200