



Province of the
EASTERN CAPE
EDUCATION

**NATIONAL
SENIOR CERTIFICATE**

GRADE 11

NOVEMBER 2019

**ELECTRICAL TECHNOLOGY:
DIGITAL ELECTRONICS
MARKING GUIDELINE**

MARKS: 200

This marking guideline consists of 14 pages.

INSTRUCTIONS TO MARKERS

- 1.1 All questions with multiple answers imply that any relevant, acceptable answer should be considered.
- 1.2 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 recalculate 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 guidelines, depending on how and where in the calculation rounding off was used.
3. This marking guideline is 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 Regulations refer in general to the physical conditions of the work environment ✓ including: thermal requirements, lighting. windows, ventilation, housekeeping, precautions against flooding and fire precautions and evacuations procedures. ✓ (2)
- 1.2 Faulty tools or equipment ✓
Poor or missing guards on machinery ✓
Poor house-keeping ✓
Excessive noise ✓
Poor ventilations ✓
Congestion in the workshop ✓ (2)
- 1.3 Ergonomics is the science of fitting task, ✓ equipment and surroundings to the end user to make their work more comfortable and to assist in their overall performance. ✓ (2)
- [6]**

QUESTION 2: TOOLS AND MEASURING INSTRUMENTS

- 2.1 It is used to present a visual display ✓ of voltage being measured at its inputs. ✓ (2)
- 2.2 A jigsaw is used for the cutting ✓ and shaping of materials. ✓ (2)
- 2.3 Maximum distance between tool rest and grinding wheel of grindstone is 3 mm. ✓ (1)
- 2.4 Better utilisation of electrical machines ✓
Better utilisation of electrical lines
Reduction of losses
Reduction of harmonics
Reduction of voltage drops. (1)
- [6]**

QUESTION 3: LOGIC

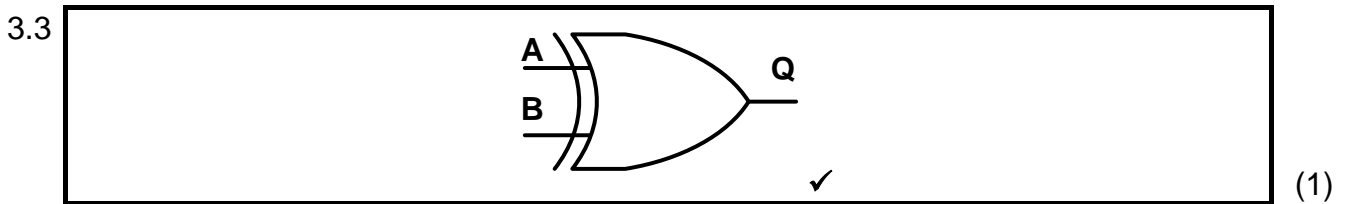
3.1 3.1.1 OR Gate ✓ (1)

3.1.2 $Q ✓ = A + B + C ✓$ (2)

3.2

INPUT		OUTPUT
A	B	Q
0	0	1 ✓
1	0	0 ✓
0	1	0 ✓
1	1	1 ✓

(4)

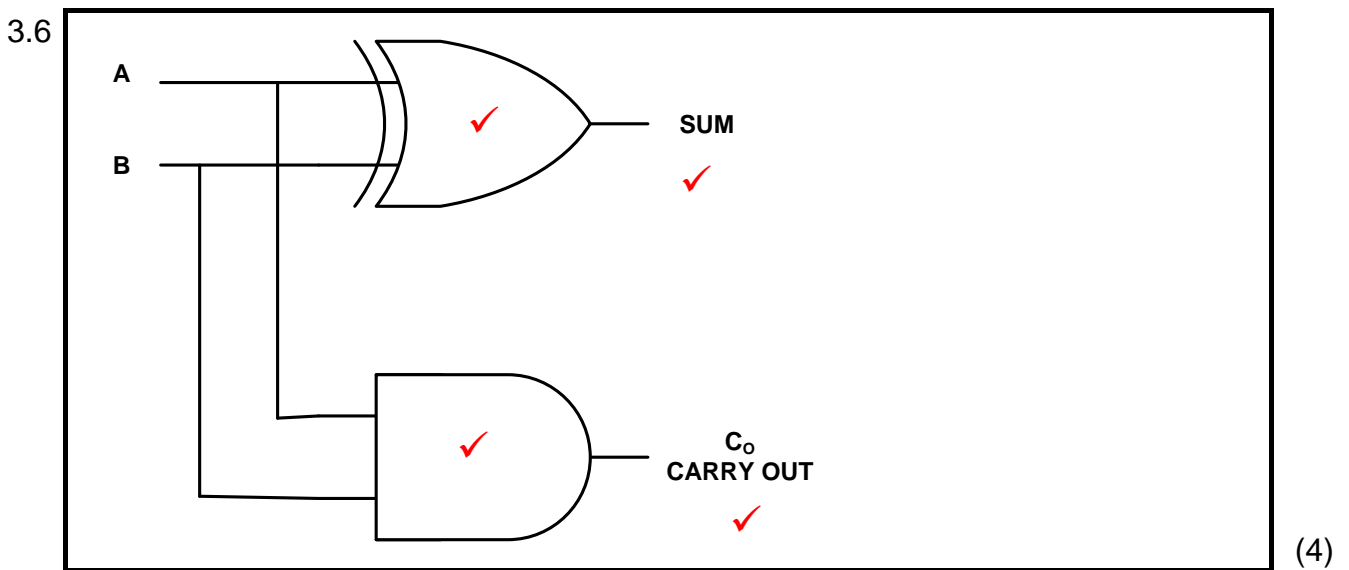


3.4 3.4.1 $X ✓ = A + B ✓$ (2)

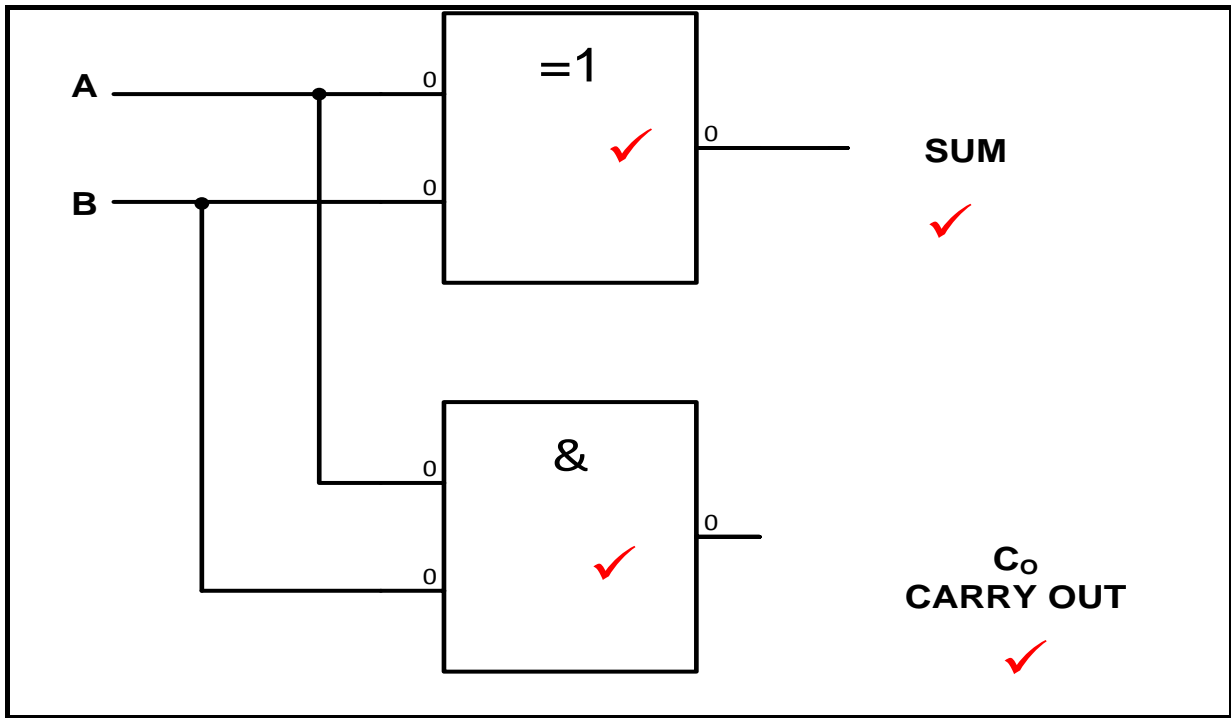
3.4.2 $Y ✓ = A + C ✓$ (2)

3.4.3 $Z ✓ = (A + B) ✓ (A + C) ✓$ (3)

3.5 $X = A.B.C + \bar{A} + A.\bar{B}.C$
 $= AC (B + \bar{B}) ✓ + \bar{A} ✓$
 $= AC ✓ + \bar{A} ✓$
 $= A + C ✓$ (5)



OR



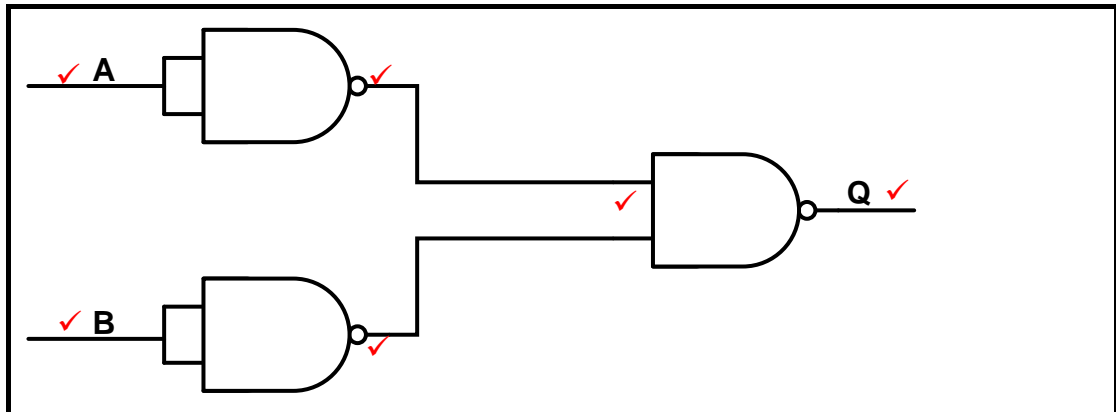
(4)

3.7 3.7.1

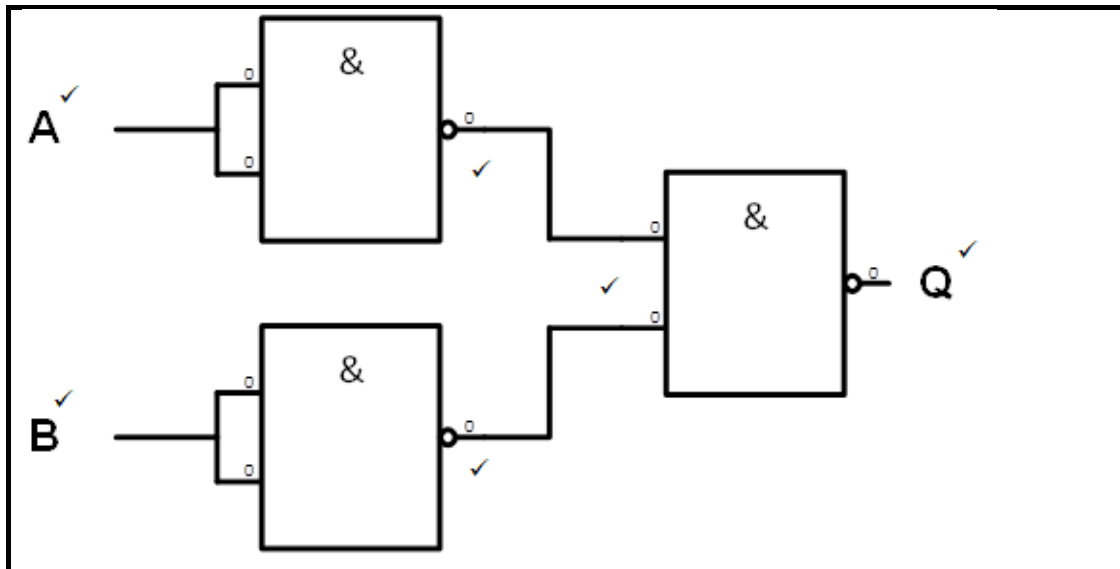
INPUT A	INPUT B	RED INDICATOR
0	0	1 ✓
0	1	1 ✓
1	0	1 ✓
1	1	0 ✓

(4)

3.7.2

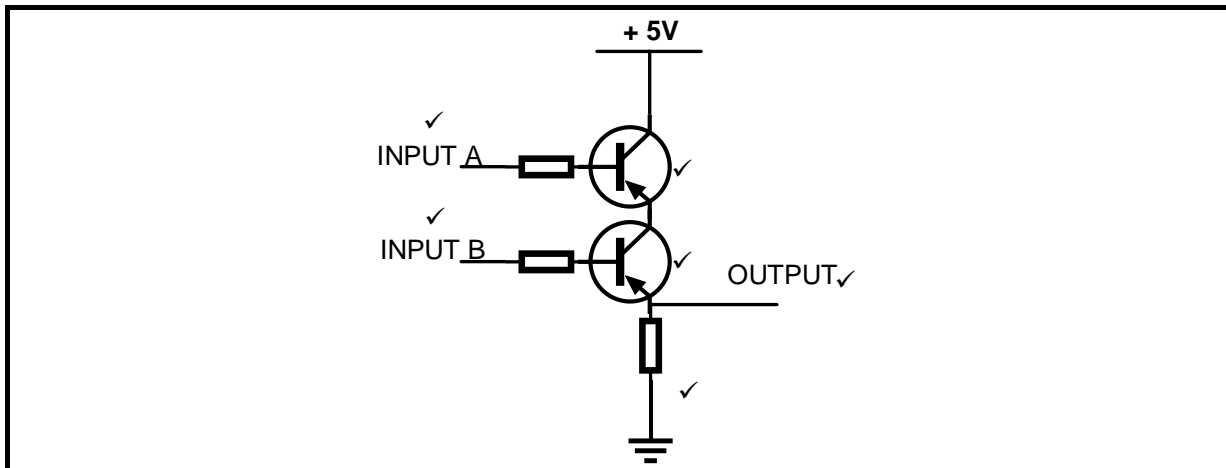


OR



(6)

3.8



(6)

[40]

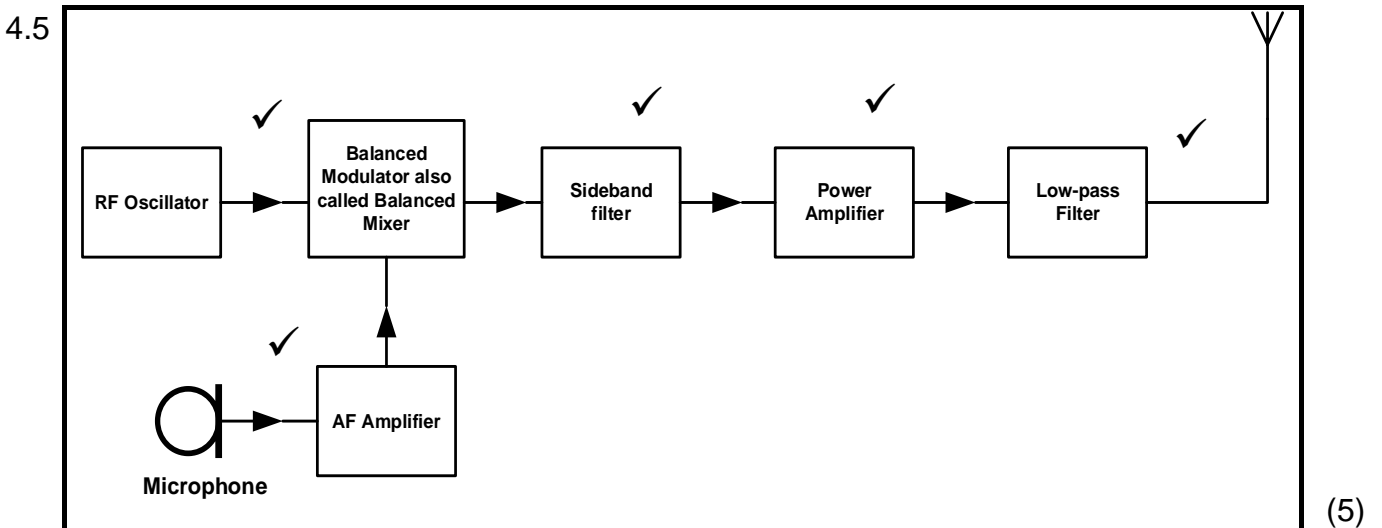
QUESTION 4: COMMUNICATION SYSTEMS

4.1 Modulation in radio transmission is to change a high frequency signal ✓ in such a way that it is able to carry information. ✓ (2)

4.2 Advantages: narrow bandwidth which needs less output power. ✓
It is able to be understood even under extreme noise conditions like when the receiver is close to a loud operating machine or else in a thunderstorm. ✓ (2)

4.3 The circuit's output is fed to the detector which not only detects the RF carrier signal and returns it to the tuned circuit amplifier ✓ but it also detects the wanted audio and demodulates it into an audio signal which is passed to the AF amplifier before feeding the speaker. ✓ The signal which is fed back first passes through a phase shifting circuit that ensures that it received a 180° phase shift. ✓ On passing through the RF amplifier the signal is again further amplified while also receiving another 180° shift in phase. ✓ (4)

4.4 1 – RF amplifier ✓
2 – Mixer ✓
3 – IF amplifier ✓ (3)



4.6 SSB used in any areas where both power-saving ✓ and low-band width ✓ are important.
Used in areas, land, mobile communication, telemetry, military communications, navigators and amateur radio. (2)

4.7 Phase detector ✓
Low pass filter ✓
Voltage control oscillator ✓ (3)

4.8 Is used mainly for radiotelegraphy communication using Morse code or another coded signal. ✓ it relies on the transmission of long and short pulses of energy ✓ that represent either a dot or dash in Morse code terms. ✓ (3)

QUESTION 5: RLC CIRCUITS

5.1 A vector is a line that identifies a quantity which shows both magnitude and direction. ✓ (1)

5.2 5.2.1 Capacitive reactance will increase ✓ (1)

5.2.2 Inductive reactance will decrease ✓ (1)

5.3 5.3.1 $Z = \sqrt{R^2 + (X_C - X_L)^2}$ ✓
 $Z = \sqrt{60^2 + (200 - 175)^2}$ ✓
 $Z = 54,54 \Omega$ ✓ (3)

5.3.2 $IT = \frac{VT}{ZT}$ ✓
 $IT = \frac{280}{54,54}$ ✓
 $IT = 5,134 A$ ✓ (3)

5.3.3 $P = I^2 R$ ✓
 $P = 5,133^2 \times 60$ ✓
 $P = 1\,580,86 W$ ✓ (3)

5.3.4 $Pr = I^2 \times (XC - XL)$ ✓
 $Pr = 5,133^2 \times (200 - 175)$ ✓
 $Pr = 658,69 VAR$ ✓ (3)

5.3.5 $P = I^2 Z$ ✓
 $P = (5,133)^2 \times 54,54$ ✓
 $P = 1437,002 VA$ ✓ (3)

5.4 5.4.1 $Fr = \frac{1}{2\pi\sqrt{LC}}$ ✓
 $Fr = \frac{1}{2\pi\sqrt{(4 \times 10^{-3}) \times (5 \times 10^{-6})}}$ ✓
 $Fr = 355,9 Hz$ ✓ (3)

5.4.2 $XL = 2\pi fL$ ✓
 $= 2\pi \times 355,9 \times 40 \times 10^{-3}$ ✓
 $= 89,44 \Omega$ ✓ (3)

[24]

QUESTION 6: WAVEFORMS

- 6.1 Sine wave ✓
 Square wave ✓
 Triangular wave ✓
 Sawtooth wave
 Ramp wave
 Radio wave (3)
- 6.2 6.2.1 This is the value reached by a waveform ✓ at any ✓ instant during its cycle. This could be at any point between 0° and 360°. ✓ (3)
- 6.2.2 This is the time a rising pulse takes ✓ to make a change from the lower "off" state "0" ✓ to the higher "on" state "1". ✓ (3)
- 6.2.3 This is the average value ✓ of voltage a circuit receives ✓ when supplied by a varying voltage. ✓ (3)
- 6.2.4 The RMS value of a pure sine wave is equal to that DC ✓ voltage value that produces the same heat ✓ as the AC wave. ✓ (3)
- 6.2.5 This is the ratio of RMS ✓ value to the Average value. ✓ (2)
- 6.3 6.3.1 $F = \frac{1}{T} \text{ hz} \checkmark$
 $= \frac{1}{0,02} \text{ hz} \checkmark$
 $= 50 \text{ hz} \checkmark$ (3)
- 6.5 The circuit relies on the charging rate of the RC circuit. ✓ The output is connected directly across the capacitor, ✓ therefore the shape of the output wave will be an exact representation of how the capacitor charges and discharges. ✓ (3)
- 6.6 Diode clipping circuits are used to:
 Squares off the peaks of an incoming signal. ✓
 Converts a sinusoidal input to a rectangular output. ✓
 Eliminates any unwanted positive or negative portions of a waveform. ✓
 Keeps an input amplitude at a constant level.
 Shift a waveform up or down to a preset level. (3)

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QUESTION 7: POWER SUPPLIES

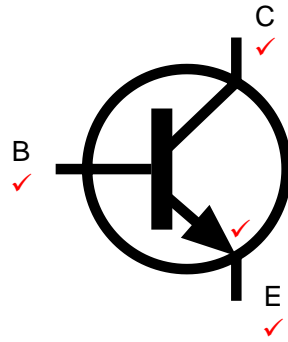
- 7.1 7.1.1 The transformer increases ✓ or decreases ✓ the higher AC supply voltage to a lower AC voltage required. (2)
- 7.1.2 The rectifier changes the Alternating Current (AC) ✓ into a Direct Current (DC). ✓ (2)
- 7.1.3 The regulator regulates the output ✓ to a smooth controlled DC output. ✓ (2)
- 7.2 Cellphone chargers ✓
Desktop computer power supplies ✓
Fuel cell charging in the international space station (2)
- 7.3 This Pulse Width Modulation stage monitors the size of voltage ✓ in the feedback circuit and controls the ON/OFF switching time ✓ of the transistor. Maximum power is achieved when the ON/OFF switching time is (duty cycle) 50%. ✓ Maximum energy will then pass through the transformer. ✓ (4)

[12]

QUESTION 8: SEMI-CONDUCTOR DEVICES

- 8.1 8.1.1 This is when impurities are added in a controlled manner to a silicon or germanium crystal to form a semiconductor. ✓ (1)
- 8.1.2 Once silicon or germanium has been doped ✓ with the impurities, ✓ we call the new formed material an extrinsic material. (2)
- 8.1.3 A semiconductor extrinsic material ✓ which has been doped with an impurity with 5 ✓ valence electrons. (2)
- 8.2 In a N-Type material the minority charge carriers are holes, ✓ as there are more free electrons than holes. ✓ (2)
- 8.3 When a diode is reversed biased, ✓ the holes will attract the electrons and the electrons will attract the holes ✓ This will cause the depletion region to become bigger around the PN Junction. ✓ (3)
- 8.4 Stage 1: High reversed biased ✓
 Stage 2: Reversed biased ✓
 Stage 3: Low forward biased ✓
 Stage 4: High forward biased ✓ (4)
- 8.5 Maximum rating ✓
 General description and mechanical properties ✓
 Electrical properties
 Dynamic electrical properties
 Rating reduction (2)
- 8.6 In the forward biased position, the Zener diode operates just like any other diode, allowing current flow once the voltage has reached 0,6 V. ✓
 However, in reverse biased position it initially does not allow current flow. As soon as a very specific, pre-selected value is achieved, the Zener breaks down and allows current to flow. ✓ (2)
- 8.7.1 $I_F = \frac{E}{R} \text{ mA} \checkmark$
 $= \frac{12}{15} \text{ mA} \checkmark$
 $= 800 \text{ mA} \checkmark$ (3)
- 8.7.2 $E = V_F \checkmark$
 $E = 12 \text{ V} \checkmark$ (2)

8.8



(4)

- 8.9 Switches ✓
- Digital logics ✓
- Oscillators
- H-Bridge
- Amplifiers
- Op-Amp

(2)

- 8.10 Cut off region ✓
- Active region ✓
- Saturation region ✓

(3)

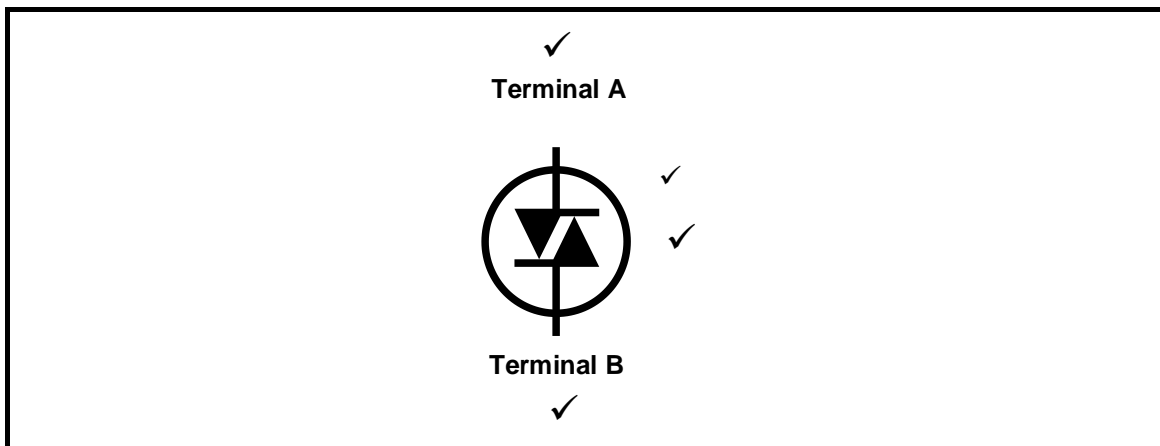
- 8.11 Forward biasing the anode/cathode connectors, ✓ and then applying a positive gate signal. ✓
By increasing the anode/cathode forward bias voltage ✓ to a level that it would break through the reverse biased PN junction. ✓ This will cause the SCR to start conducting immediately without any gate pulses.

(4)

- 8.12 When one connector is positive with reference to the other connector, two of the internal junctions are forward biased. ✓
The third connector is reversed biased and blocks any conduction, until the supply voltage is higher than the breakthrough voltage. ✓
When this point is reached, avalanche breakdown ✓ over the junction will happen and the voltage across the DIAC will drop and it will start to conduct. ✓
As soon as the current is less than the holding current, ✓ the connector voltage drops to zero and switch off. ✓

(6)

8.13



(4)

- 8.14 The TRIAC can conduct for both, ✓ positive and negative half cycles of a waveform. ✓

(2)

[48]

QUESTION 9: SENSORS AND TRANSDUCERS

- 9.1 A proximity sensor is a device which detects objects ✓ without having any physical contact with them. ✓ (2)
- 9.2 Detector relies on the oxidation of a thin film of heated metal oxide, ✓ deposited on a silicon slice when it comes into contact with a gas. ✓ This oxidation changes the metal's resistance. ✓ (3)
- 9.3 A photodiode is semiconductor P-N junction device ✓ that converts light ✓ into electric current. ✓ (3)
- 9.4 Negative Temperature Coefficient ✓
Positive Temperature Coefficient ✓ (2)
- 9.5 Transducer is device that changes energy ✓ from one form into another. ✓ (2)
- [12]**

TOTAL: 200