



higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

INDUSTRIAL ELECTRONICS N3

28 March 2024

This marking guideline consists of 11 pages.

SECTION A

QUESTION 1

1.1	1.1.1	D		
	1.1.2	C		
	1.1.3	C		
	1.1.4	A		
	1.1.5	D		
			(5 × 1)	(5)
1.2	1.2.1	True		
	1.2.2	True		
	1.2.3	True		
	1.2.4	False		
	1.2.5	False		
			(5 × 1)	(5)
1.3	1.3.1	Cathode-ray oscilloscope (CRO)		
	1.3.2	Sweep time		
	1.3.3	Voltage follower		
	1.3.4	Fermi level		
	1.3.5	Drift current		
			(5 × 1)	(5)
1.4	1.4.1	E - Breakdown voltage		
	1.4.2	I - Diffusion current		
	1.4.3	A - Reverse recovery time		
	1.4.4	C - Holding current		
	1.4.5	G - Transients		
			(5 × 1)	(5)
				[20]
TOTAL SECTION A:				20

SECTION B

QUESTION 2

2.1	2.1.1	Loop ABCFGA: $V_T = V_{R1} + V_{R2} + V_{R6}$ $24 = 20.I_1 + 12.I_1 + 15I_2 \quad \checkmark$ $24 = 32.I_1 + 15I_2 \quad \underline{\underline{(1)}} \quad \checkmark$		(2)
	2.1.2	Loop ABCDEFGA: $V_T = V_{R1} + V_{R2} + V_{R3} + V_{R4} + V_{R5}$ $24 = 32.I_1 + (28 + 32 + 15)(I_1 - I_2) \quad \checkmark$ $24 = 107.I_1 - 75I_2 \quad \underline{\underline{(2)}} \quad \checkmark$		

$$2.1.3 \quad (1) \times 5 \Rightarrow \quad \checkmark$$

$$120 = 160I_1 + 75I_2 \rightarrow (3)$$

$$(3) + (2)$$

$$120 = 160I_1 + 75I_2$$

$$\underline{24 = 107I_1 + 75I_2}$$

$$144 = 267I_1 \checkmark$$

$$I_1 = \underline{0,539A}$$

Replace I_1 in (1):

$$24 = 160(0,539) + 75I_2 \quad \checkmark$$

$$24 = 86,24 + 75I_2$$

$$-62,24 = 75I_2$$

$$I_2 = \underline{-0,8299A}$$

(4)

$$2.2 \quad 2.2.1 \quad X_L = 2\pi fL$$

$$X_L = 2\pi(60)(35 \times 10^{-3}) \quad \checkmark$$

$$\underline{X_L = 13,195\Omega} \quad \checkmark$$

(2)

$$2.2.2 \quad X_C = \frac{1}{2\pi fC}$$

$$X_C = \frac{1}{2\pi(60)(55 \times 10^{-6})} \quad \checkmark$$

$$\underline{X_C = 48,229\Omega} \quad \checkmark$$

(2)

$$2.2.3 \quad Z = \sqrt{R^2 + (X_C - X_L)^2}$$

$$Z = \sqrt{9^2 + (48,229 - 13,195)^2} \quad \checkmark$$

$$Z = \sqrt{81 + (35,034)^2}$$

$$Z = \sqrt{1308,381}$$

$$\underline{Z = 36,172\Omega} \quad \checkmark$$

(2)

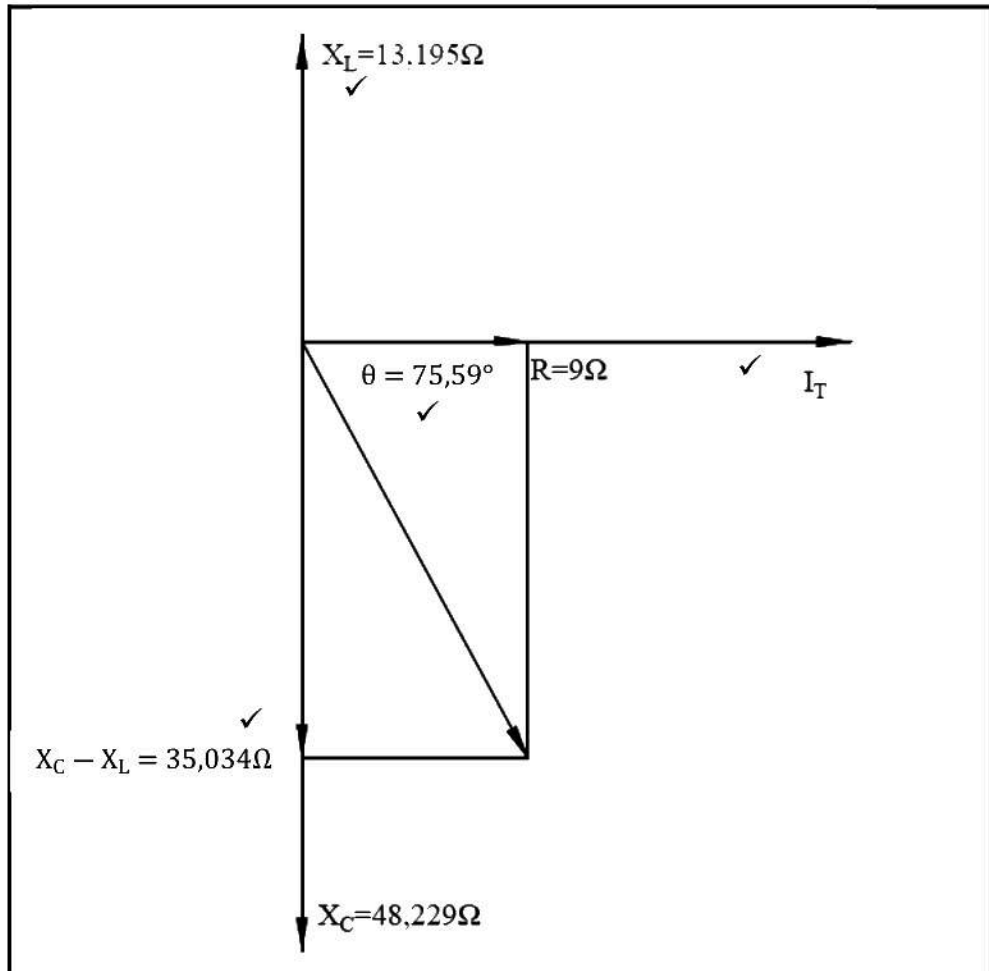
$$2.2.4 \quad \theta = \cos^{-1} \frac{R}{Z}$$

$$\theta = \cos^{-1} \frac{9}{36,171}$$

$$\underline{\theta = 75,59^\circ} \quad \checkmark$$

(1)

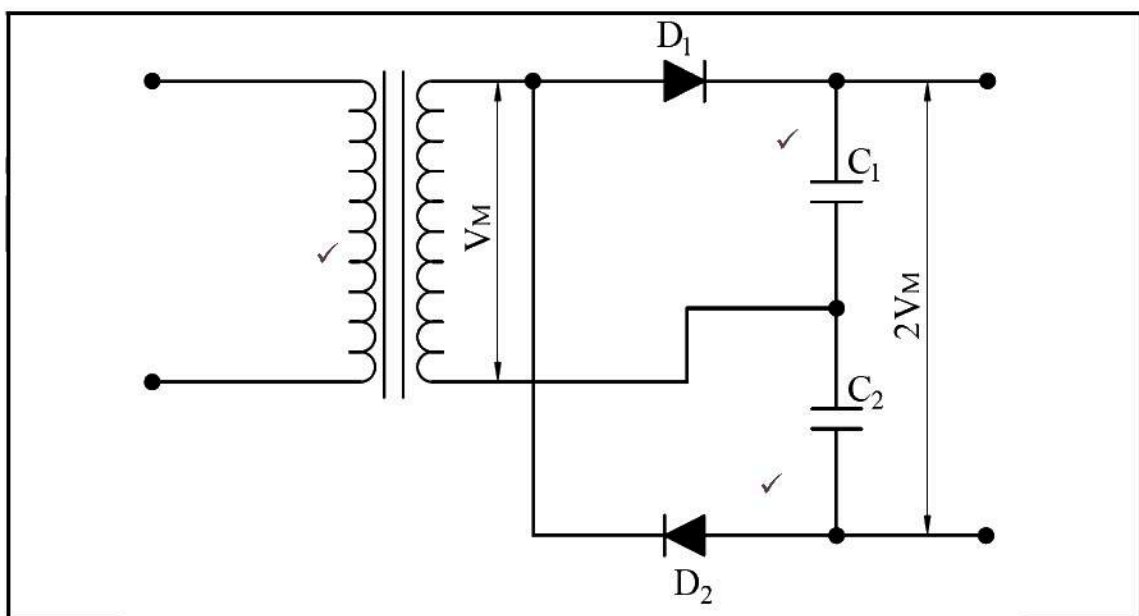
2.2.5



(4)
[19]

QUESTION 3

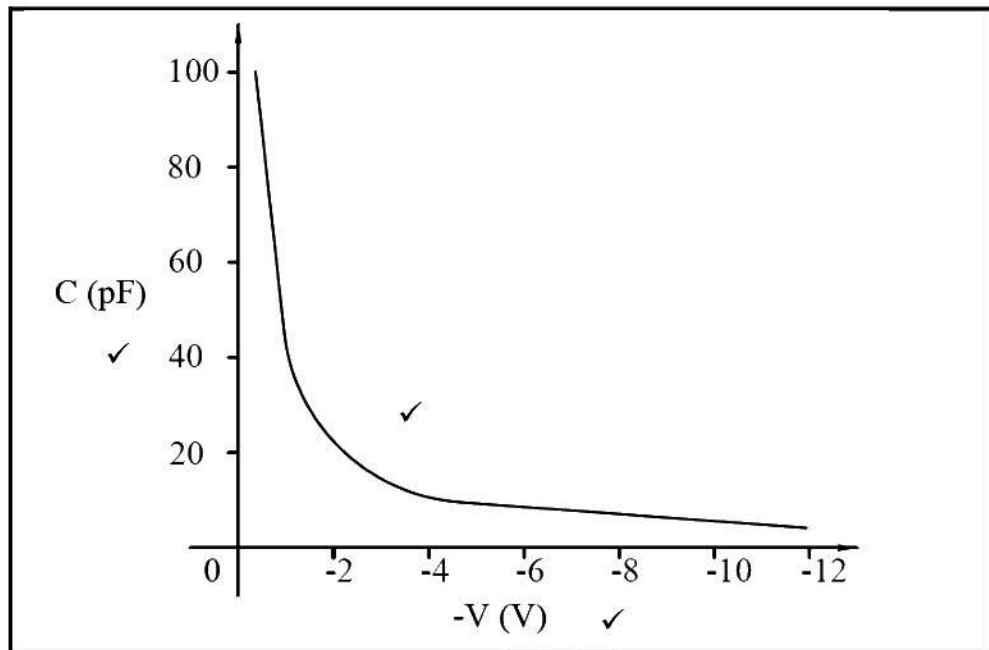
3.1



(MARKER TO USE DISCRETION)

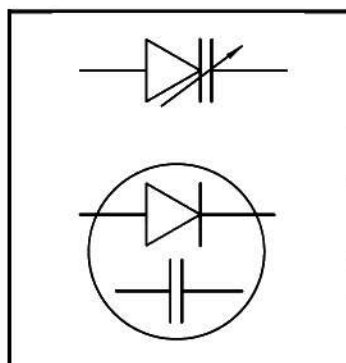
(2)

3.2 3.2.1



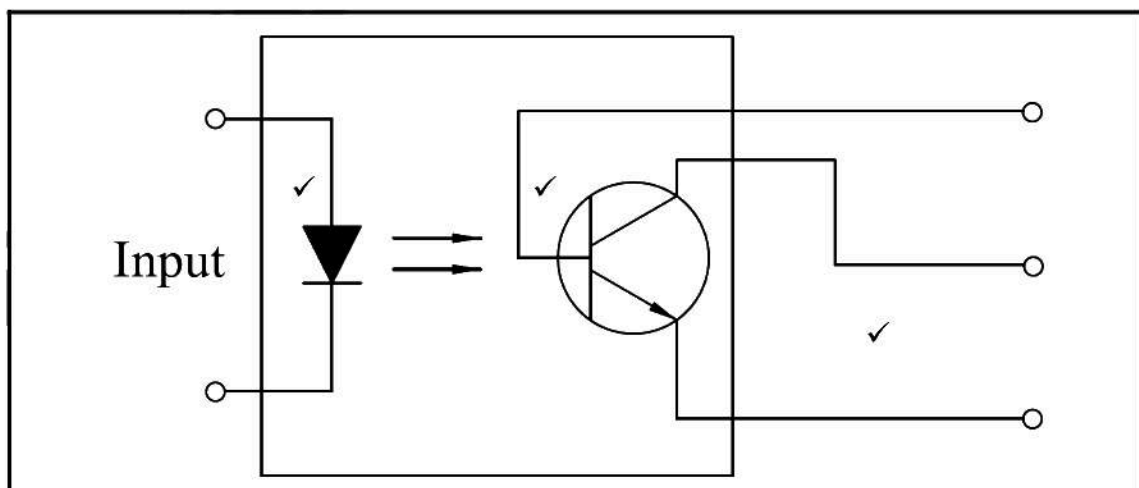
(3)

3.2.2



(1)

3.3

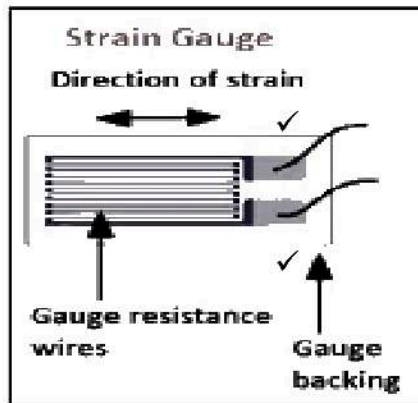


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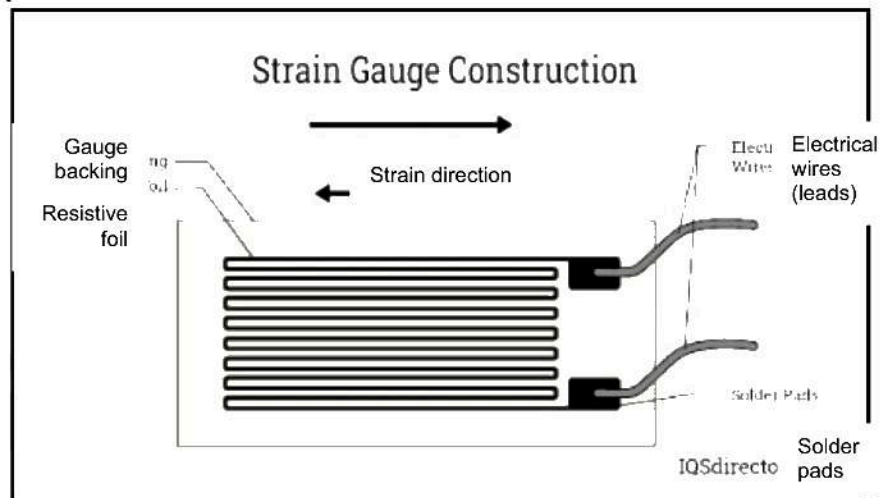
(3)

- 3.4 3.4.1
- When a mechanical strain is applied to a strain gauge, the wire or foil undergoes deformation.✓
 - This results in a change in its length and cross-sectional area (it either becomes narrower and longer or shorter and broader).✓
 - This causes a change in the electrical resistance of the wire or foil. OR As a result there is a change in resistance.✓
- (MARKER TO USE DESCRETION) (3)

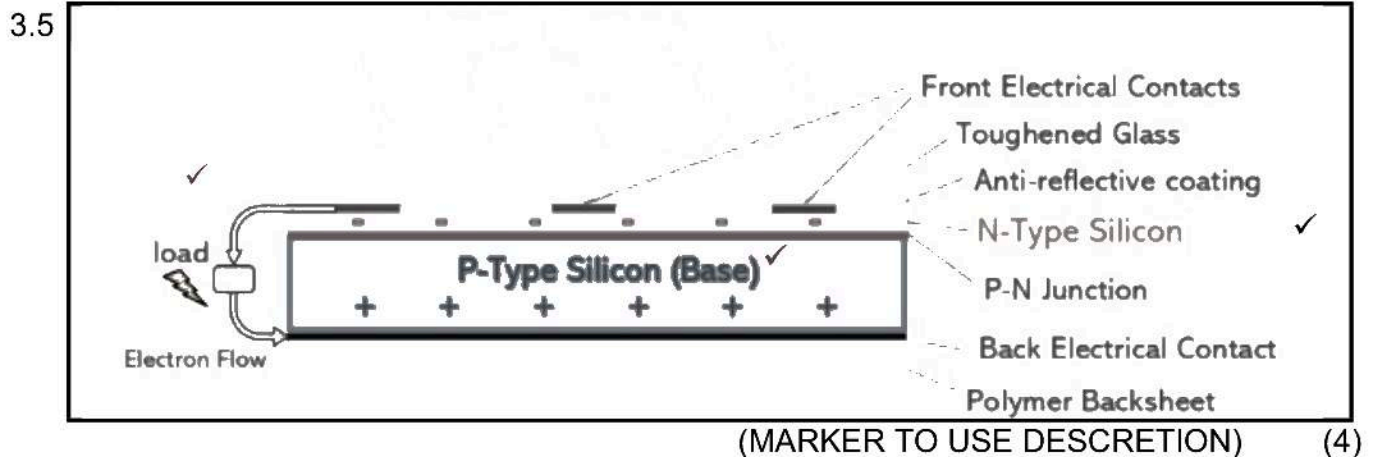
3.4.2



OR

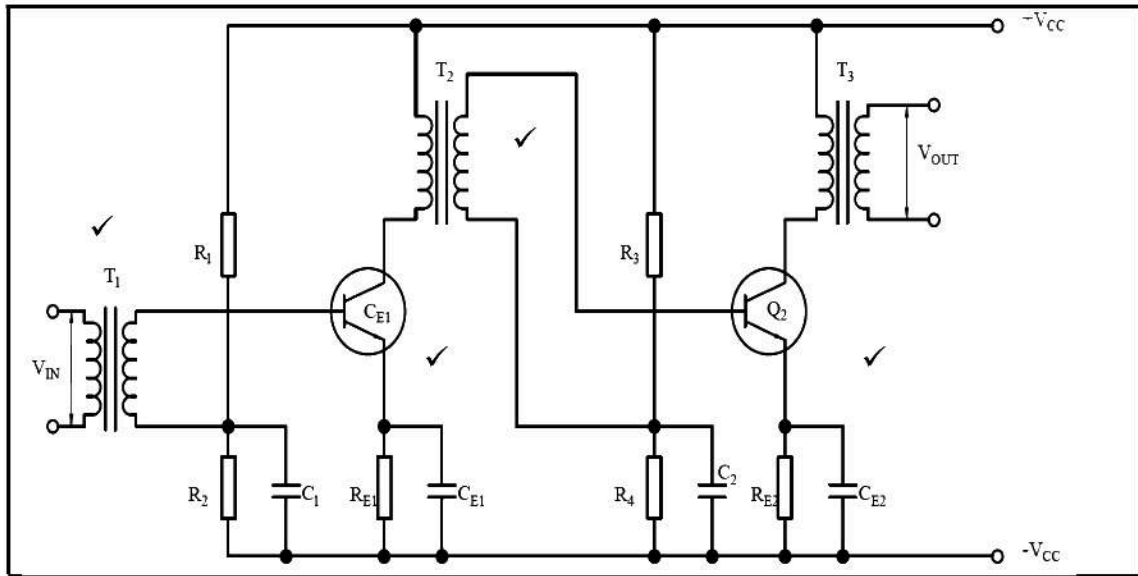


(MARKER TO USE DESCRETION) (3)



QUESTION 4

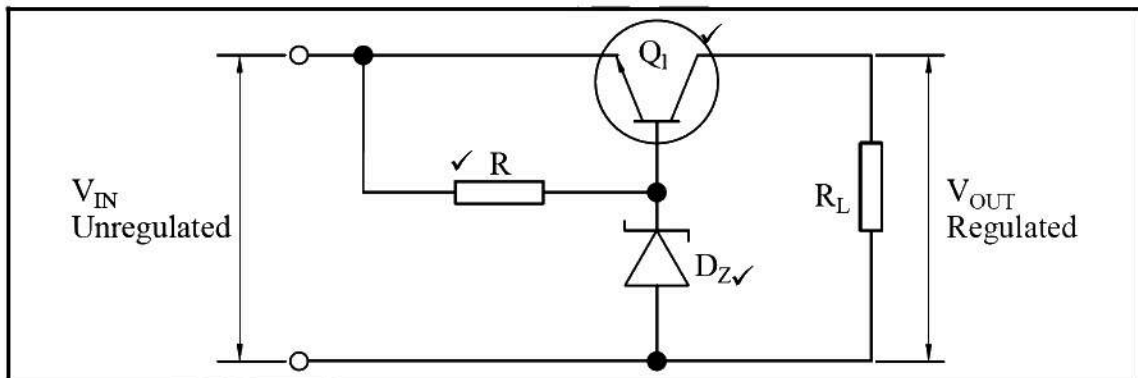
4.1



(MARKER TO USE DESCRETION)

(5)

4.2

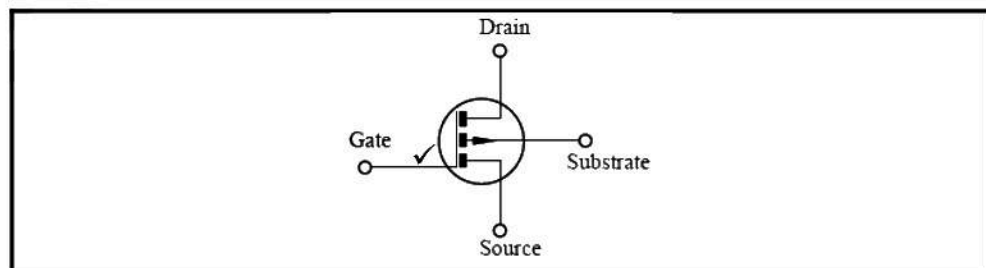


(MARKER TO USE DESCRETION)

(3)

4.3

4.3.1

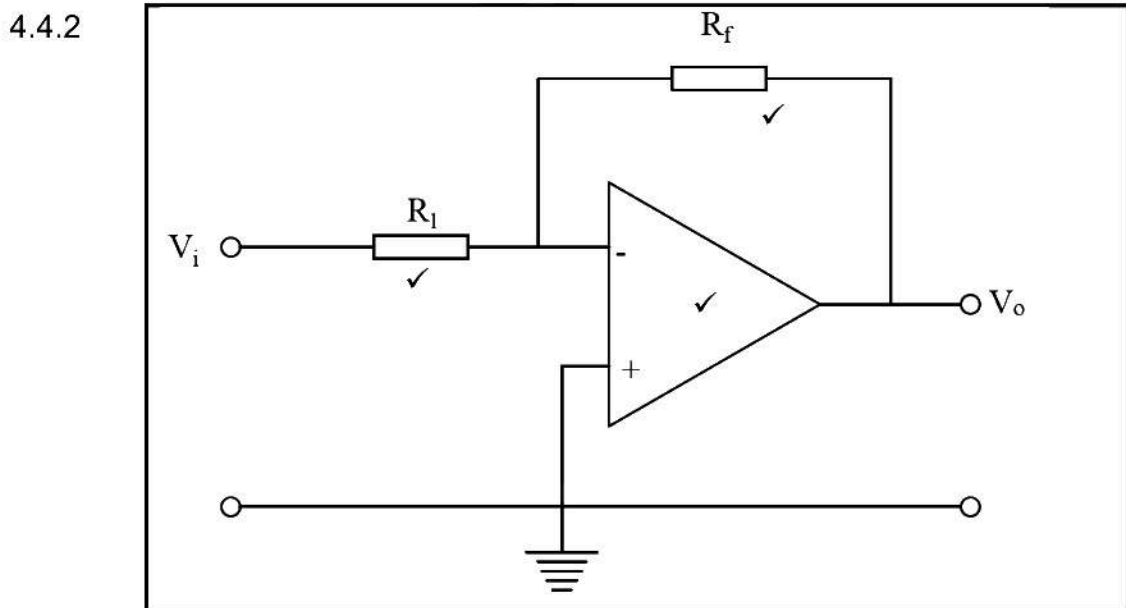


(1)

- 4.3.2
- The current flow in an N-type MOSFET happens because of negatively charged electrons. When a positive voltage is applied with repulsive force at the gate terminal, the holes present under the oxide layer are pushed downward into the substrate.✓
 - The depletion region is populated by the bound negative charges which are associated with the acceptor atoms. Upon the reach of electrons, the channel is formed. The positive voltage also attracts electrons from the N+ source and drain regions into the channel. If a voltage is applied between the drain and source the current flows freely between the source and drain and the gate voltage controls the electrons in the channel.✓

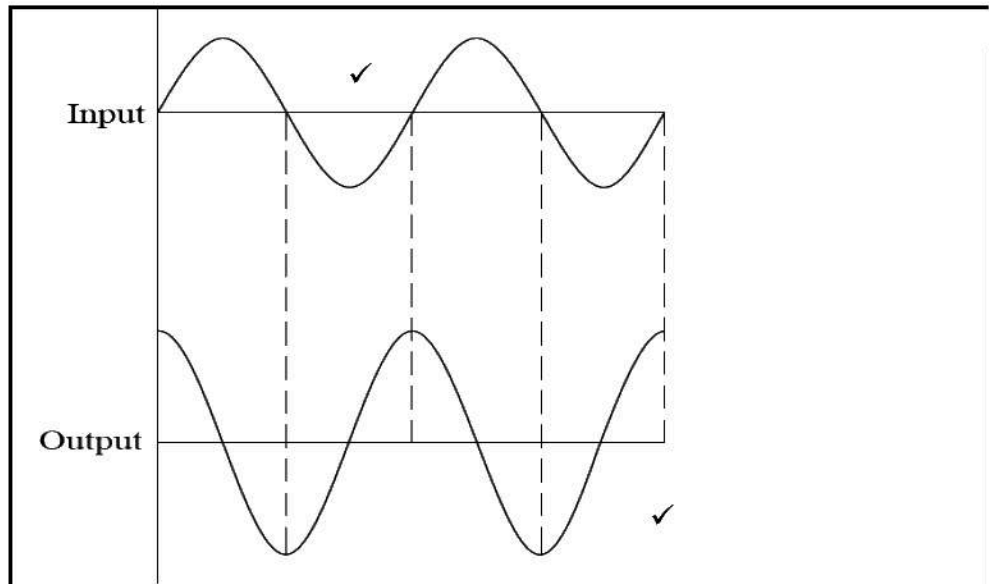
(MARKER TO USE DESCRETION) (2)

- 4.4 4.4.1
- It has a smaller size.
 - It is more reliable than a conventional amplifier.
 - It costs less due to the type of circuit parts.
 - Less power consumption.
 - Easy to replace.
 - An OP-amp can be used for different applications. (Any 3 × 1) (3)



- 4.4.3
- Voltage followers have a high input impedance and a low output impedance. This is the essence of their buffering action.✓
 - They strengthen a signal and thereby allow a high-impedance source to drive a low-impedance load.✓
- (2)

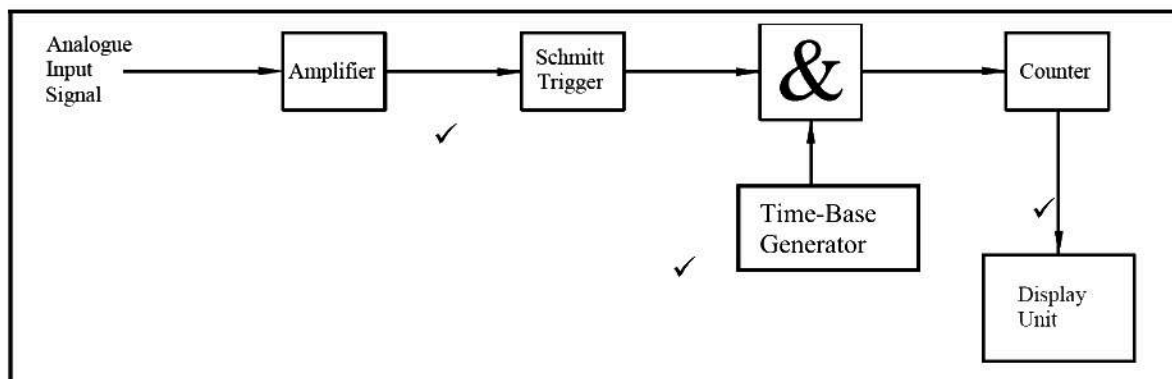
4.4.4



(2)
[21]

QUESTION 5

5.1



(MARKER TO USE DISCRETION) (4)

5.2

5.2.1

- The vertical deflection plate turns the ray up and down ✓
- and the horizontal ray moves the electron beams from the left side to the right side. ✓

OR

- A positive voltage applied to the vertical deflection plate causes the beam to deflect vertically upward due to the attraction forces, while a negative voltage applied to the vertical deflection plate will cause the electron beam to deflect vertically downward, due to the repulsion forces. ✓
- Similarly, a positive voltage applied to the horizontal deflection plate will cause the electron beam to deflect horizontally towards the right, while a negative voltage applied to the horizontal deflection plate will cause the electron beam to deflect horizontally towards the left of the screen. ✓

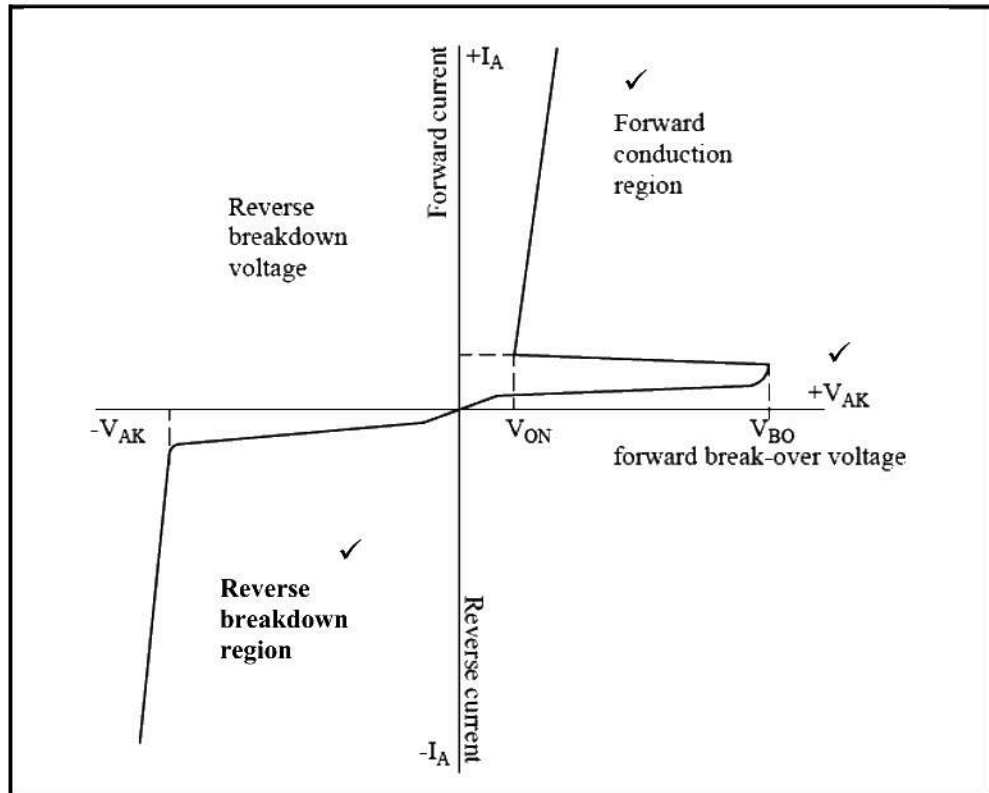
(Any applicable CORRECT answer) (2)

5.2.2

- Time-base generators produce very high frequency sawtooth waves ✓
- specifically designed to deflect the beam of a cathode-ray tube (CRT) smoothly across the face of the tube and then return it to its starting position. ✓

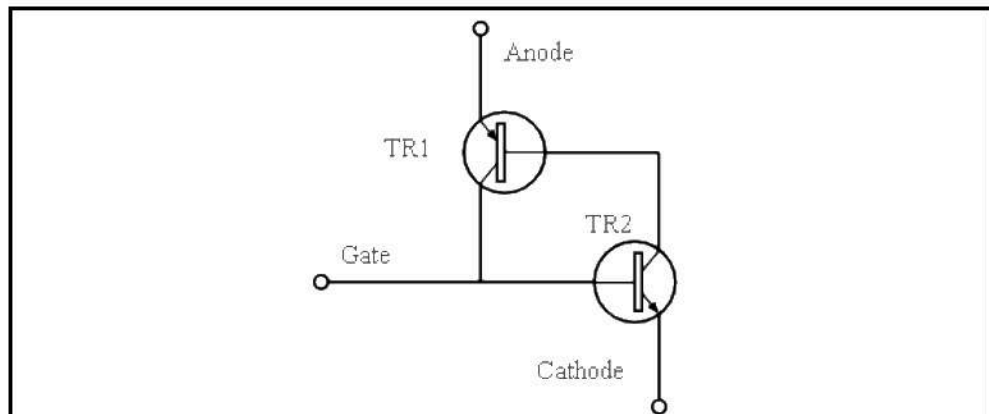
(MARKER TO USE DISCRETION) (2)

5.3 5.3.1



(3)

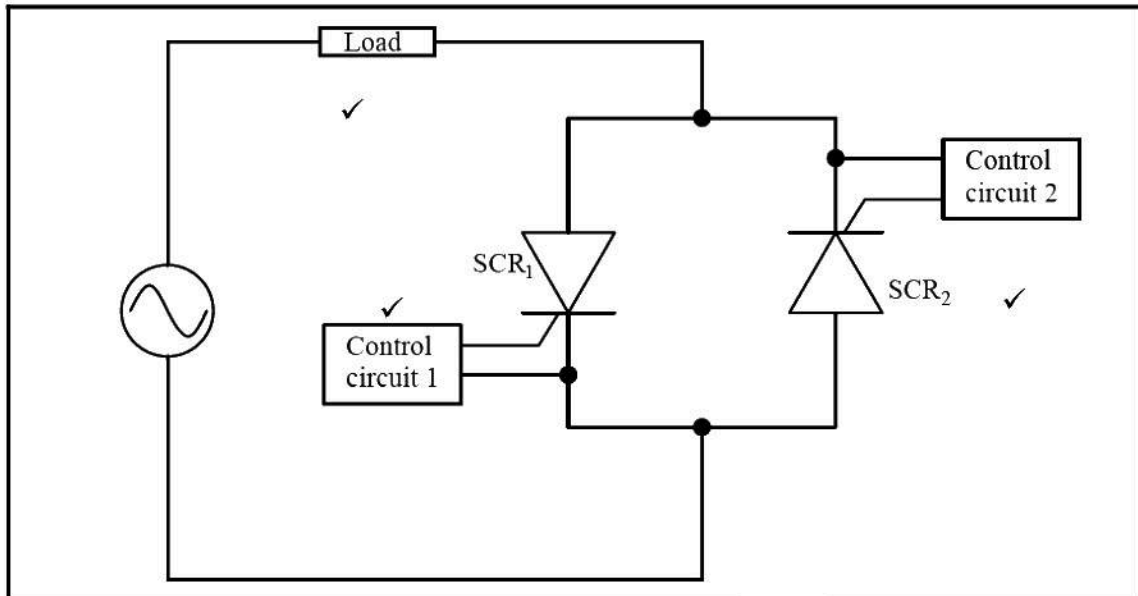
5.3.2



- When a voltage is applied across a thyristor, no current flows because neither transistor is conducting. As a result there is no complete path across the device. If a small current is passed through the gate electrode, this will turn on the transistor TR2. When this occurs it will cause the collector of TR2 to fall towards the voltage on the emitter, i.e. the cathode of the whole device.✓
- When this occurs it will cause the current to flow through the base of TR1✓ and turn this transistor on. It will now try to pull the voltage on the collector of TR1 towards its emitter voltage.
- This will cause the current to flow in the emitter of TR2, causing its on-state to be maintained. In this way it only requires a small trigger pulse on the gate to turn the thyristor on. Once switched on, the thyristor can only be turned off by removing the supply voltage.✓

(MARKER TO USE DISCRETION)

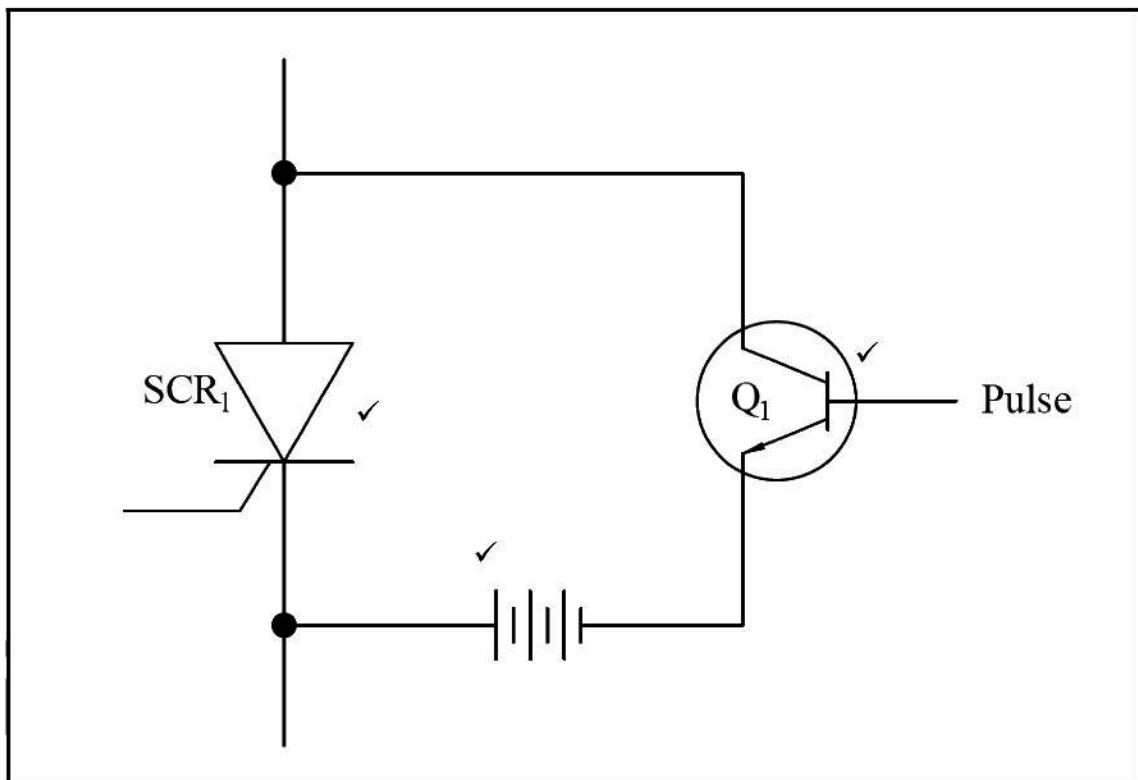
5.4



(MARKER TO USE DISCRETION)

(3)

5.5



(MARKER TO USE DISCRETION)

(3)

[20]

TOTAL SECTION B: 80
GRAND TOTAL: 100