

ECH502 INDUSTRIAL ELECTRONICS AND MEDICAL ELECTRONICS, PLC AND ROBOTICS

UNIT – I : POWER DEVICES AND SCR SWITCHING TECHNIQUES

1. A PNP SCR has three junctions J1, J2, and J3. With anode positive and gate open, transition from forward blocking to forward conduction occurs due to:

- a) Avalanche breakdown of J1 at low forward voltage
- b) Breakdown of reverse-biased J2 when forward voltage reaches breakover value
- c) Simultaneous forward biasing of all three junctions
- d) Increase in reverse leakage current through J3

Answer: b

2. Why is SCR widely used in controlled rectifier applications?

- a) It conducts in both forward and reverse directions
- b) It requires continuous gate drive during conduction
- c) It allows controlled unidirectional conduction using short gate pulses
- d) It behaves exactly like a power diode under all conditions

Answer: c

3. During SCR turn-ON, rise time refers to interval in which:

- a) Gate pulse is applied to current initiation
- b) Current rises from 10% to 90% of final value
- c) Voltage rises to maximum blocking value
- d) Current spreads uniformly over junction area

Answer: b

4. A GTO is called fully controllable and unidirectional. What does this mean?

- a) Gate cannot control the device
- b) Gate controls only turn-off
- c) Gate controls both turn-on and turn-off, current flows from anode to cathode
- d) Gate controls only turn-on and current flows in both directions

Answer: c)

5. Why is GTO preferred in HVDC converters and AC motor drives?

- a) Suitable only for low-frequency operation
- b) Works like SCR
- c) Has low on-state loss
- d) No external commutation required and better high-frequency switching

Answer: d)

6. The primary purpose of introducing an anode short in an asymmetrical GTO is to

- a) Enhance reverse blocking capability
- b) Improve turn-OFF performance by faster carrier removal
- c) Increase latching current
- d) Reduce forward conduction current

Answer: b) Improve turn-OFF performance by faster carrier removal

7. Which layer in power BJT decides high voltage blocking capability?

- a) Lightly doped collector drift region
- b) Base-emitter metallization
- c) Collector contact resistance
- d) Emitter sheet resistance

Answer: a) Lightly doped collector drift region

8. Quasi-saturation in power BJT occurs mainly due to?

- a) Lightly doped collector drift region causing charge storage
- b) Heavy base doping
- c) Thin emitter
- d) Wide base

Answer: a) Lightly doped collector drift region causing charge storage

9. Which condition most strongly contributes to secondary breakdown in a power BJT?

- a) Uniform current distribution across junction area
- b) Negative temperature coefficient causing current crowding
- c) High base resistance with low collector voltage
- d) Increased carrier lifetime reducing thermal stress

Answer: b Negative temperature coefficient causing current crowding

10. Positive temperature coefficient in MOSFET helps in paralleling because of increase in?

- a) Gate threshold voltage
- b) ON-state resistance
- c) Gate oxide capacitance
- d) Breakdown voltage

Answer: b

11. How is parasitic BJT turn-on prevented in MOSFET?

- a) Short gate to n+ source
- b) Short drain to n-drift
- c) Short source to p-body
- d) Short drain to gate

Answer: c Short source to p-body

12. Which statement about ON-state losses in power MOSFETs is correct?

- a) Losses are independent of drift region design
- b) ON-state losses can be high, limiting voltage and current
- c) ON-state losses are negligible
- d) Losses are dominated by minority carrier storage

Answer: b ON-state losses can be high, limiting voltage and current

13. Compared with MOSFET, IGBT has which trade-off at high power?

- a) Lower conduction and switching loss

- b) Higher conduction loss with lower switching loss
- c) Higher conduction and switching loss
- d) Lower conduction loss with higher switching loss

Answer: d Lower conduction loss with higher switching loss

14. Why do IGBTs need only modest gate drive power compared with BJTs?

- a) Gate is voltage-controlled with low steady current
- b) Gate is current-controlled with high steady current
- c) Gate requires continuous high-frequency pulsing current
- d) Gate is resistance-controlled with variable bias current

Answer: a Gate is voltage-controlled with low steady current

15. Why choose IGBT over SCR for switching converters at tens of kHz?

- a) No gate drive needed
- b) Lower device cost
- c) Higher frequency operation despite higher cost
- d) Built-in energy storage

Answer: c Higher frequency operation despite higher cost

16. An SCR turns on when the anode current exceeds which threshold parameter?

- a) Latching current of device
- b) Holding current of device
- c) Gate leakage current only
- d) Breakdown current of diode

Answer: a

17. High-intensity light can trigger an SCR. This device is called?

- a) Phototransistor rectifier
- b) Light-activated SCR
- c) Gate-controlled rectifier
- d) Optically gated triac

Answer: b

18. UJT conducts when?

- a) Capacitor voltage exceeds about ηV_Z
- b) Supply voltage equals holding current
- c) Transformer saturates
- d) Emitter current equals leakage resistance

Answer: a

19. For an SCR to turn OFF by current condition, which must happen?

- a) Anode current > latching current
- b) Anode current < holding current
- c) Gate current = holding current
- d) Cathode current > anode current

Answer: b

20. Why is Class C called complementary commutation?

- a) Auxiliary SCR turns OFF main SCR
- b) Diode pair replaces LC
- c) Main SCR self-commutates
- d) Complementary gate pulses

Answer: a

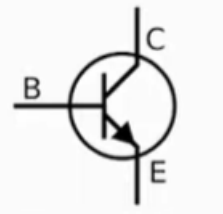
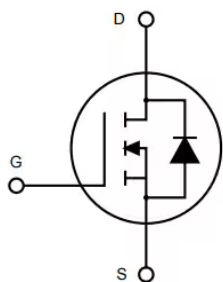
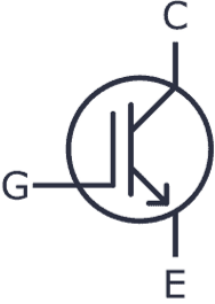
21. Class E commutation applies commutating pulse through?

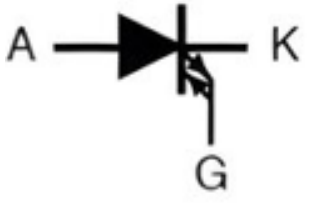
- a) Series RC snubber
- b) Line inductance
- c) Pulse transformer
- d) Gate-cathode path

Answer: c

UNIT 1: ANALYTICAL MCQ

22. Match the following symbols with their corresponding devices and unique features. Select the correct answer from the options given below.

SYMBOL	DEVICE	FEATURES
A) 	I. GTO	1. Requires high base drive
B) 	II. IGBT	2. Controlled rectifier
C) 	III. SCR	3. Negative gate pulse for turn OFF
D) 	IV. Power BJT	4. No secondary breakdown
E)	V. Power MOSFET	5. Combines BJT and MOSFET

		features
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- a) A–III–2, B–IV–1, C–V–4, D–II–5, E–I–3
- b) A–III–2, B–II–1, C–V–4, D–IV–5, E–I–3
- c) A–I–3, B–IV–1, C–III–2, D–II–5, E–V–4
- d) A–III–3, B–IV–1, C–V–4, D–II–5, E–I–2

Answer: a

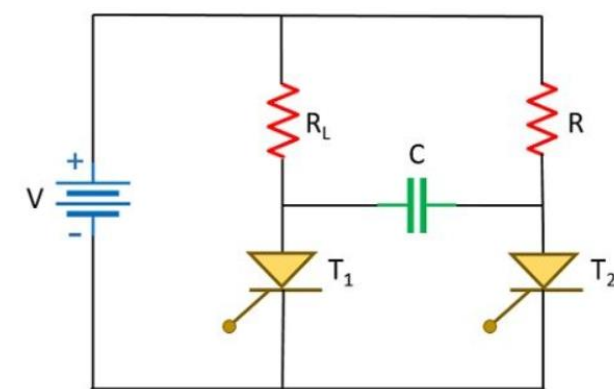
23. Assertion (A): Forward voltage triggering is commonly used in SCR circuits.

Reason (R): It requires voltage greater than forward breakover voltage.

- a) Both Assertion (A) and Reason (R) are true, and R is the correct explanation of A
- b) Both A and R are true, but R is not the correct explanation of A
- c) A is true, but R is false
- d) A is false, but R is true

Answer: d

24. The circuit shown in figure represents which type of SCR commutation?



- a) Class A – Load commutation
- b) Class B – Resonant pulse commutation
- c) Class C – Complementary commutation
- d) Class D – Auxiliary commutation

Answer: c

25.

Device	Carrier Type	Input Impedance
SCR	Bipolar	Low

Power BJT	A?	Low
Power MOSFET	Unipolar	B?
IGBT	Hybrid	High
GTO	Bipolar	Low

From the table, determine the correct values of **A** and **B**.

- a) A = Bipolar, B = High
- b) A = Unipolar, B = Low
- c) A = Hybrid, B = Moderate
- d) A = Bipolar, B = Low

Answer: a

26.

Device	Fully Controlled	High Frequency	High Input Impedance
P	No	No	No
Q	Yes	No	No
R	Yes	Yes	Yes

P, Q and R respectively represent

- a) SCR, GTO, MOSFET
- b) GTO, SCR, MOSFET
- c) SCR, MOSFET, GTO
- d) BJT, GTO, SCR

Answer:a

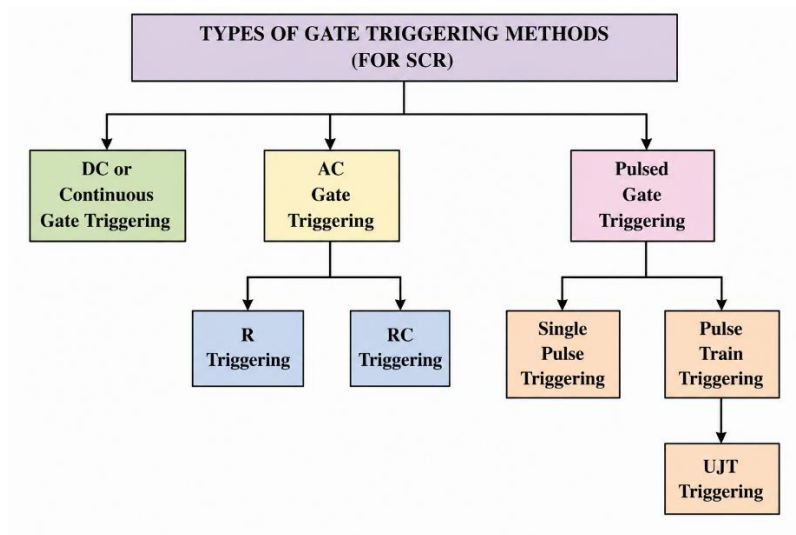
27. Arrange devices in increasing order of switching speed.

- 1. Power MOSFET
- 2. SCR
- 3. IGBT
- 4. Power BJT

- a) 2 → 4 → 3 → 1
- b) 1 → 3 → 4 → 2
- c) 2 → 3 → 4 → 1
- d) 4 → 2 → 3 → 1

Answer:a

28. Study the chart of SCR gate triggering methods shown in the figure and identify the incorrect classification.



- a) DC or Continuous Gate Triggering under gate triggering methods
- b) Single Pulse Triggering under Pulsed Gate Triggering
- c) RC Triggering under AC Gate Triggering
- d) UJT Triggering under Pulse Train Triggering

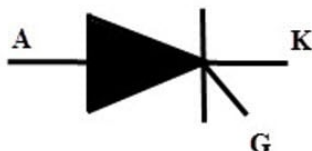
Answer: D

29. A power electronic engineer needs a device for:

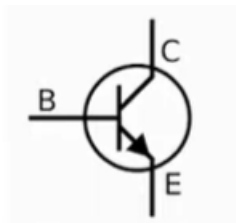
- Very high switching speed
- Low switching loss
- High input impedance

Identify the most suitable device.

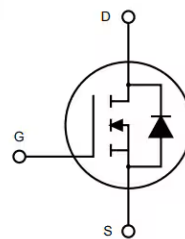
a)



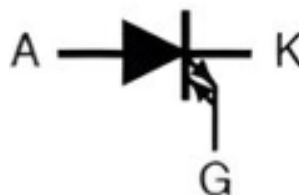
b)



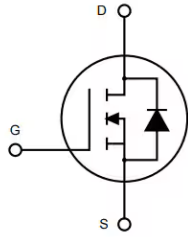
c)



d)



Answer: C)



30. **Assertion (A):** GTO requires simpler gate drive circuit than SCR.

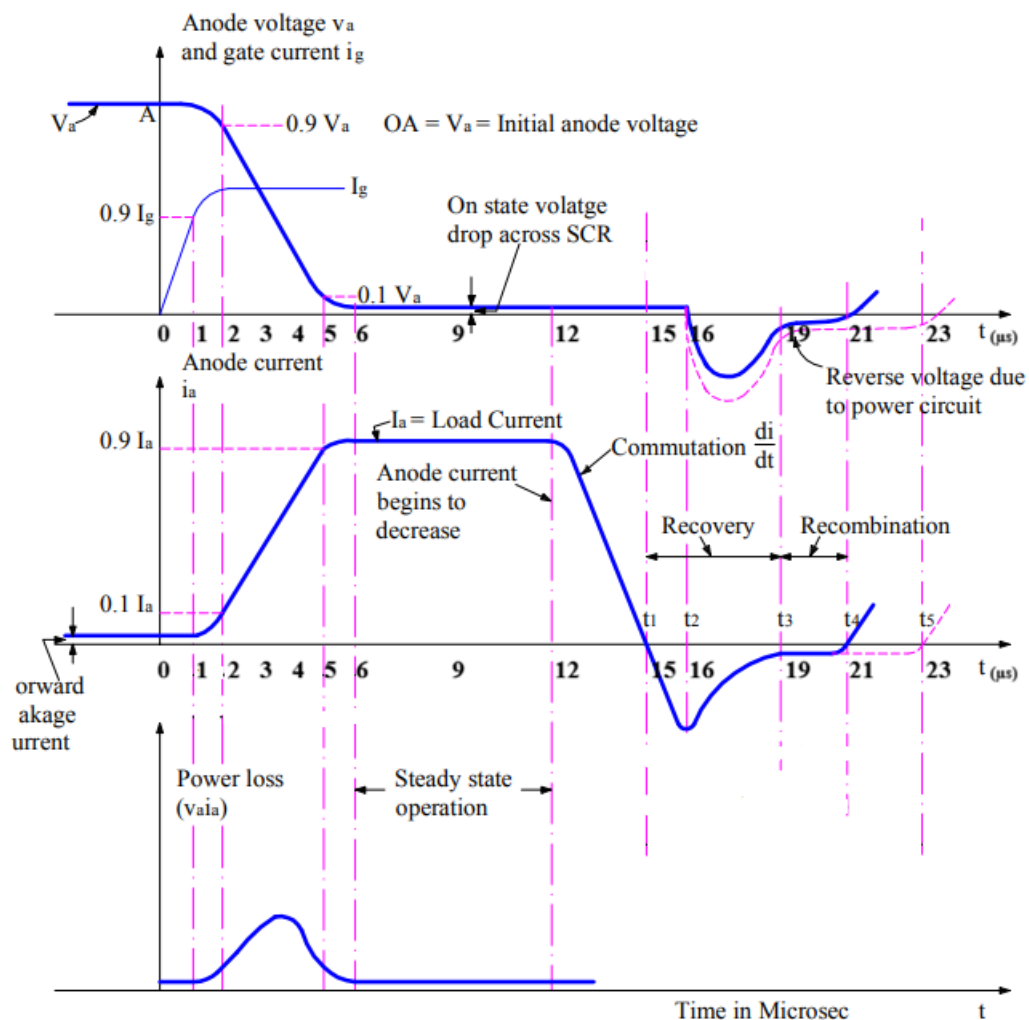
Reason (R): GTO requires large negative gate current during turn OFF.

- a) Both A and R are true, and R is the correct explanation of A
- b) Both A and R are true, but R is not the correct explanation of A
- c) A is true, but R is false
- d) A is false, but R is true

Answer: d

UNIT 1: DESCRIPTIVE QUESTIONS:

1. Discuss the various turn ON methods of SCR with neat diagrams. Highlight the significance of gate triggering methods
2. Describe the commutation methods used for turning OFF SCR
3. Illustrate the construction and operation of GTO with suitable diagrams.
4. Explain the construction and working of IGBT with neat diagrams. Summarize its advantages, disadvantages and applications.
5. The figure shows the switching characteristics of an SCR during turn ON and turn OFF conditions. Analyze the waveform and answer the following:



- Identify and calculate the delay time (t_d), rise time (t_r) and spread time (t_s). (3 Marks)
- Calculate the total turn ON time of SCR. (2 Marks)
- Identify and calculate the reverse recovery time (t_{rr}) and gate recovery time (t_{gr}). (2 Marks)
- Calculate the total turn OFF time of SCR. (1 Mark)
- Explain the significance of recovery and recombination periods during SCR turn OFF. (2 Marks)

Answer

(a) Identify and calculate the delay time (t_d), rise time (t_r) and spread time (t_s).

From waveform:

- Delay time, $t_d = 2 - 1 = 1 \mu s$
- Rise time, $t_r = 5 - 2 = 3 \mu s$
- Spread time, $t_s = 6 - 5 = 1 \mu s$

Answer:

- $t_d = 1 \mu s$
- $t_r = 3 \mu s$

- $t_s = 1 \mu s$

(b) Calculate the total turn ON time of SCR.

Formula:

$$t_{on} = t_d + t_r + t_s$$

Substituting values:

$$t_{on} = 1 + 3 + 1 = 5 \mu s$$

Answer: Total turn ON time = $5 \mu s$

(c) Identify and calculate the reverse recovery time (t_{rr}) and gate recovery time (t_{gr}).

From waveform:

- Reverse recovery time, $t_{rr} = 19 - 15 = 4 \mu s$
- Gate recovery time, $t_{gr} = 21 - 19 = 2 \mu s$

Answer:

- $t_{rr} = 4 \mu s$
- $t_{gr} = 2 \mu s$

(d) Calculate the total turn OFF time of SCR.

Formula:

$$t_{off} = t_{rr} + t_{gr}$$

Substituting values:

$$t_{off} = 4 + 2 = 6 \mu s$$

Answer: Total turn OFF time = $6 \mu s$

(e) Explain the significance of recovery and recombination periods during SCR turn OFF.

Recovery Period:

During this period, excess charge carriers near junctions are removed and reverse current flows through SCR.

Recombination Period:

During this period, remaining charge carriers recombine and SCR regains its forward blocking capability.

UNIT – II : CONVERTERS AND CHOPPERS

1. Increasing the firing angle (α) in a single-phase semi-controlled converter results in

- a) Increase in average output voltage
- b) Decrease in average output voltage
- c) No change in output voltage
- d) Output voltage becomes independent of α

Answer: b

2. The single-phase semi-controlled bridge converter consists of

- a) Four SCRs
- b) Two SCRs and two diodes
- c) Four power diodes
- d) One SCR and three diodes

Answer: b

3. In a semi-controlled bridge converter with RL load, the inductor primarily

- a) Increases firing angle
- b) Prevents diode conduction
- c) Reduces source voltage
- d) Maintains current continuity

Answer: d

4. Which statement regarding the freewheeling diode is correct?

- a) It increases inversion operation.
- b) It is connected in series with the load.
- c) It transfers load current away from the main rectifier during freewheeling.
- d) It conducts only during the positive half cycle.

Answer: c

5. Which one of the following expressions represents the average output voltage of a single-phase semi-controlled bridge converter operating with continuous load current?

a) $V_{dc} = \frac{2v_m}{\pi} (1 + \cos \alpha)$

b) $V_{dc} = \frac{v_m}{\pi} (1 - \cos \alpha)$

c) $V_{dc} = \frac{v_m}{\pi} (1 + \cos \alpha)$

d) $V_{dc} = \frac{2v_m}{\pi} (1 - \cos \alpha)$

Answer: c

6. A single-phase fully controlled bridge converter consists of

- a) Four SCRs
- b) Two SCRs and two diodes
- c) Two SCRs and one diode bridge
- d) Four power diodes

Answer:a

7. Compared to a semi-controlled converter, a fully controlled bridge converter

- a) Uses fewer SCRs
- b) Can operate in both rectification and inversion modes
- c) Requires no gate triggering
- d) Cannot control output voltage

Answer: b

8. A firing angle greater than 90° enables a fully controlled bridge converter to

- a) Operate only as a rectifier
- b) Eliminate the need for SCR commutation
- c) Operate in inversion mode when the load supports power reversal
- d) Produce maximum positive average output voltage

Answer:c

9. If the firing angle is increased from 30° to 75° , the converter output voltage

- a) Increases
- b) Becomes alternating
- c) Remains unchanged
- d) Decreases

Answer:d

10. A DC chopper is also known as a

- a) AC voltage controller
- b) DC-to-DC converter
- c) DC-to-AC converter
- d) AC-to-DC converter

Answer: b

11The primary energy storage element responsible for voltage boosting in a step-up chopper is

- a) Capacitor
- b) Resistor
- c) Transformer
- d) Inductor

Answer:d

12. Which control technique varies the output voltage by changing only the ON time while keeping the switching frequency constant?

- a) Constant frequency control (PWM)
- b) Variable frequency control
- c) Phase angle control
- d) Integral cycle control

Answer:a

13.Regenerative braking of a DC motor commonly employs

- a) Step-up chopper
- b) Step-down chopper
- c) AC chopper
- d) Cycloconverter

Answer:a

14. Which statement correctly differentiates a step-up chopper from a step-down chopper?

- a) A step-up chopper stores energy in the capacitor during ON time.
- b) A step-up chopper transfers stored inductive energy to the load during OFF time.
- c) A step-down chopper always produces an output voltage greater than the source voltage.
- d) Both operate only with resistive loads.

Answer: b

15. Which chopper is commonly used for regenerative braking of DC motors?

- a) Class A
- b) Class B
- c) Class C
- d) Class D

Answer: b

16. Which chopper can operate in both first and second quadrants?

- a) Class A
- b) Class B
- c) Class C
- d) Class D

Answer: c

17. The distinguishing feature of a Class E chopper compared to Class A–D choppers is that it

- a) Uses only one switching device.
- b) Requires no diode.
- c) Produces only positive output voltage.
- d) Operates in all four quadrants of the V–I plane.

Answer: d

18. The auxiliary thyristors in an AC chopper are mainly used for

- a) Rectification
- b) Voltage amplification
- c) Commutation of the main thyristors
- d) Frequency conversion

Answer: c

19. In Mode II operation of an AC chopper, the main thyristor is turned OFF by

- a) Natural commutation
- b) Reverse gate current
- c) Discharge current of the commutating capacitor through the auxiliary thyristor
- d) Reducing the supply voltage to zero

Answer: c

20. The output frequency of an AC chopper is mainly determined by

- a) Switching rate of the thyristors
- b) Supply frequency
- c) Capacitance value only
- d) Load resistance only

Answer: a

21. A Class D chopper is capable of operating in

- a) First and Fourth quadrants

- b) First and Second quadrants
 c) Second and Third quadrants
 d) Third and Fourth quadrants

Answer: a

UNIT 2: ANALYTICAL

22. Match the following waveforms with their corresponding devices and unique features. Select the correct answer from the options given below.

WAVEFORMS	DEVICE	Characteristics
A)	1. AC chopper	i. Average output polarity depends on firing angle
B)	2. Semi-controlled Converter	ii. Output voltage always lower than source
C)	3. Fully Controlled Converter	iii. No negative average output voltage
D)	4. Step-down Chopper	iv. Only the RMS value is controlled; supply frequency remains unchanged

a) A-3-i, B-2-iii, C-4-ii, D-1-iv

b) A-2-iii, B-3-i, C-4-ii, D-1-iv

c) A-2-i, B-3-iii, C-1-ii, D-4-iv

d) A-1-iv, B-4-ii, C-2-iii, D-3-i

Answer: b

23. Assertion (A): A fully controlled bridge converter can operate as both a rectifier and an inverter.

Reason (R): The average output voltage depends on the firing angle and becomes negative when $\alpha > 90^\circ$ under suitable load conditions.

a) Both Assertion (A) and Reason (R) are true, and **R is the correct explanation** of A.

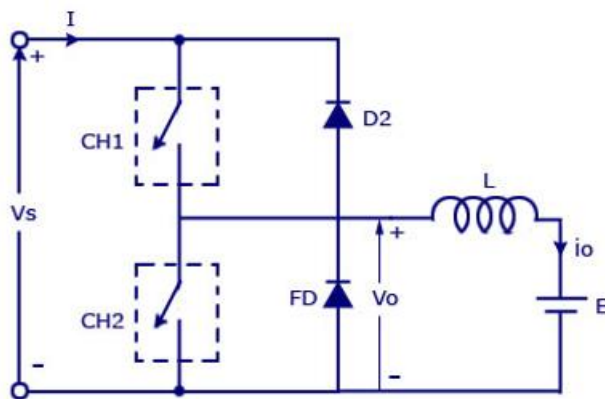
b) Both A and R are true, but **R is not the correct explanation** of A.

c) A is true, but R is false.

d) A is false, but R is true

Answer: a

24. Study the given circuit. Which combination of components operates as a Class A chopper?



a) CH1, FD and Load

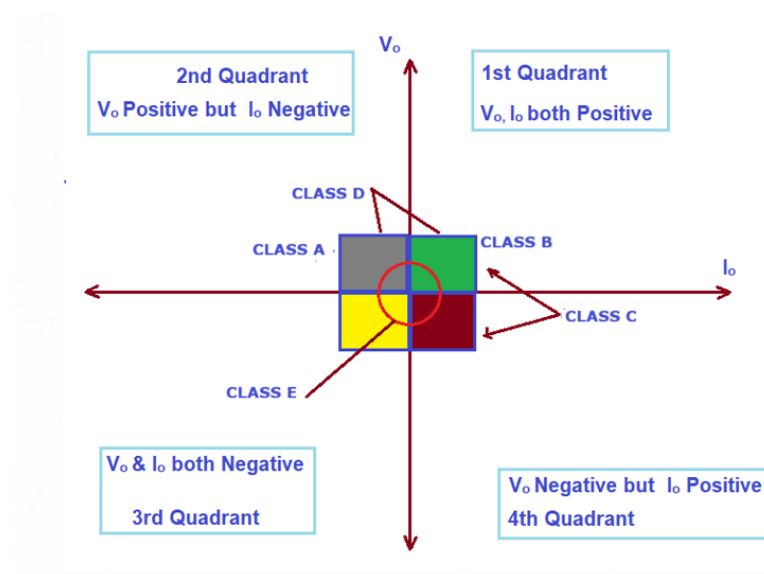
b) CH2, D2 and Load

c) CH1, D2 and Load

d) CH2, FD and Load

Answer: a

25.



Study the four-quadrant representation of chopper classes shown in the figure. Which one of the following chopper classes is correctly represented with respect to its operating quadrant(s)?

- a) Class A
- b) Class B
- c) Class C
- d) Class E

Answer: d) Class E

26.

Device	Statement
Semi-controlled Converter	Inversion possible
Fully Controlled Converter	Four SCRs
Step-down Chopper	$(V_o < V_s)$
AC Chopper	Controls RMS voltage

Identify the incorrect entry in the table.

- a) Semi-controlled Converter
- b) Fully Controlled Converter
- c) Step-down Chopper
- d) AC Chopper

Answer: a

27. Arrange the following events in the correct sequence during AC chopper operation.

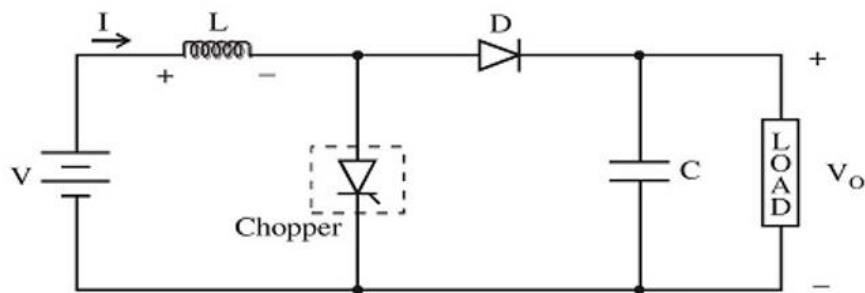
1. Load voltage becomes zero until the next triggering pulse.
2. Main SCR starts supplying power to the load.
3. Commutating capacitor is charged to the required polarity.
4. Auxiliary SCR is triggered.
5. Capacitor discharges and turns OFF the main SCR.

- a) $3 \rightarrow 2 \rightarrow 4 \rightarrow 5 \rightarrow 1$
- b) $2 \rightarrow 3 \rightarrow 4 \rightarrow 5 \rightarrow 1$
- c) $3 \rightarrow 4 \rightarrow 2 \rightarrow 5 \rightarrow 1$
- d) $2 \rightarrow 4 \rightarrow 3 \rightarrow 5 \rightarrow 1$

Answer:a

28. Study the given circuit. Which combination of component functions is correct?

Component	Function
P	Stores energy
Q	Prevents reverse current
R	Smoothens output voltage



- a) P–Inductor, Q–Capacitor, R–Diode
- b) P–Capacitor, Q–Inductor, R–Diode
- c) P–Diode, Q–Capacitor, R–Inductor
- d) P–Inductor, Q–Diode, R–Capacitor

Answer: D

29. A single-phase fully controlled bridge converter with **R load** is supplied from a **230 V (rms)** source. If the firing angle is **60°**, the average output voltage is

- a) 103.5 V
- b) 155.3 V
- c) 230 V
- d) 0 V

Answer:a

(Given:

- Supply voltage, $V_s=230\text{ V}$
- Firing angle, $\alpha=60^\circ$

For a **single-phase fully controlled bridge converter (R load)**,

$$V_{dc} = \frac{2v_m}{\pi} (\cos \alpha)$$

$$v_m = \sqrt{2} v_s$$

$$V_m = 1.414 \times 230 = 325.22\text{V}$$

$$V_o = 103.52\text{V}$$

30. Assertion (A): Auxiliary SCRs are used in an AC chopper to increase the supply frequency.

Reason (R): Auxiliary SCRs assist in the commutation of the main SCRs.

- a) Both A and R are true, and R is the correct explanation of A
- b) Both A and R are true, but R is not the correct explanation of A
- c) A is true, but R is false
- d) A is false, but R is true

Answer: d

UNIT 2: DESCRIPTIVE QUESTIONS:

1. Illustrate the circuit of a single-phase semi-controlled bridge converter with RL load and freewheeling diode, and discuss its operation with relevant waveforms.

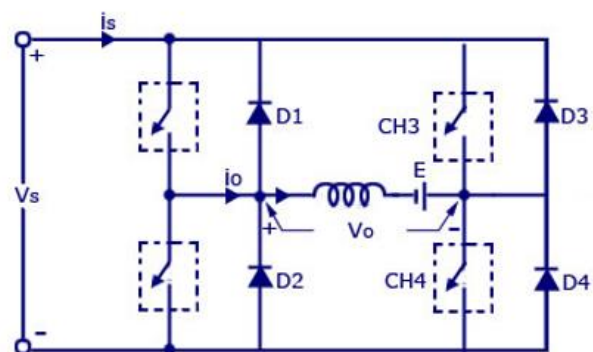
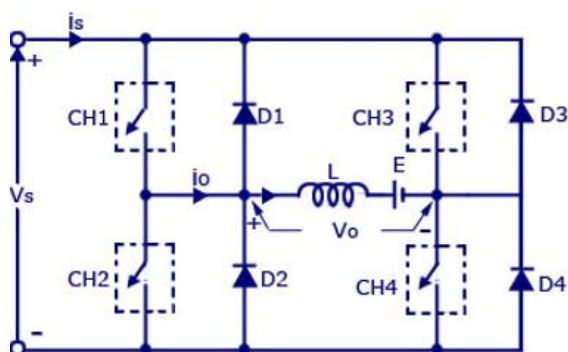
2. Analyze the operation of a single-phase fully controlled bridge converter feeding an RL load with the aid of neat circuit diagrams and waveforms.

3. Discuss the working of an AC chopper during different modes of operation with suitable circuit diagrams and waveforms.

4. Compare and contrast the construction and operation of step-up and step-down choppers with neat circuit diagrams, waveforms and suitable applications.

UNIT 2: ANALYTICAL DESCRIPTIVE:

5. Study the given chopper circuit and answer the following questions. (5 × 2 = 10 Marks)



a) Identify the **class of chopper** represented by the given circuit. Justify your answer based on its quadrant of operation.

b) During **first quadrant operation**, identify the chopper switches that conduct. State whether the circuit operates as a **step-up** or **step-down** chopper.

c) During **second quadrant operation**, identify the conduction path after **CH2 is turned OFF**. State the direction of power flow.

d) During **third quadrant operation**, identify the conducting chopper switch and state the polarity of the output voltage and output current.

e) During **fourth quadrant operation**, explain why the circuit behaves as a **step-up chopper**.

ANSWER:

a) Identify the **class of chopper** represented by the given circuit. Justify your answer based on its quadrant of operation.

Answer:

- **Class E chopper**
- Supports operation in all four quadrants (both $V_o V_o$ and $I_o I_o$ can be positive or negative).

b) During **first quadrant operation**, identify the chopper switches that conduct. State whether the circuit operates as a **step-up** or **step-down** chopper.

Answer:

- CH1 and CH4 conduct.
- Operates as a **step-down chopper**.

c) During **second quadrant operation**, identify the conduction path after **CH2 is turned OFF**. State the direction of power flow.

Answer:

- Current flows through **D1 and D4**.
- Power flows **from load to source** (regenerative operation).

d) During **third quadrant operation**, identify the conducting chopper switch and state the polarity of the output voltage and output current.

Answer:

- CH3 is operated (with CH2 ON).
- V_{oV_o} is negative and I_{oI_o} is negative.

e) During fourth quadrant operation, explain why the circuit behaves as a step-up chopper.

Answer:

- When CH4 is switched OFF, the energy stored in the inductor is fed back to the source through **D2 and D3**.
- Hence, the circuit operates as a **step-up chopper** during regenerative operation.

UNIT – III : Inverters and Power Supplies

1.Which statement best describes the operation of a single-phase full bridge inverter?

- A) It converts AC into pulsating DC.
- B) It converts DC into AC by alternately switching diagonal pairs of semiconductor devices.
- C) It regulates AC voltage using SCR firing angle.
- D) It converts fixed AC into variable DC.

Answer: B

2.In a single-phase full bridge inverter, simultaneous conduction of switches in the same inverter leg results in

- A) Improved output voltage
- B) Better voltage regulation
- C) Reduced harmonic distortion
- D) Shoot-through fault across the DC source

Answer: D

3.Compared to a half-bridge inverter, the full-bridge inverter produces

- A) Half the output voltage
- B) The same output voltage
- C) Twice the output voltage
- D) Zero output voltage

Answer: C

4.A major drawback of a half-bridge inverter is that it requires

- A) Four SCRs
- B) Two transformers
- C) A three-wire DC supply
- D) Two inductors

Answer: C

5.The McMurray inverter is also known as

- A) Line commutated inverter
- B) Auxiliary commutated inverter
- C) Resonant inverter
- D) Current source inverter

Answer: B

6.The primary purpose of the commutation circuit in a McMurray inverter is to

- A) Increase inverter frequency
- B) Reduce output voltage ripple
- C) Turn OFF the conducting SCR by applying reverse voltage
- D) Synchronize inverter with the AC mains

Answer: C

7.In a McMurray inverter, the impulse required to turn OFF the conducting SCR is obtained from

- A) RC triggering circuit
- B) Pulse transformer
- C) Battery bank
- D) LC resonant circuit

Answer: D

8.The energy trapped in the commutating capacitor of the McMurray inverter is removed through

- A) Transformer winding
- B) Feedback diodes
- C) Load resistor
- D) Battery bank

Answer: B

9.Which voltage control technique in an inverter provides better output voltage regulation without changing the DC input?

- A) Transformer tap changing
- B) Pulse Width Modulation
- C) Rectifier control
- D) Battery charging

Answer: B

10.Which statement regarding inverter output waveform is correct?

- A) A pure square-wave inverter produces the least harmonic distortion.
- B) PWM techniques help produce an output waveform closer to a sine wave.
- C) Harmonics are completely eliminated in square-wave inverters.
- D) Voltage control is impossible in PWM inverters.

Answer: B

11.In the sine-wave synthesis method, the quasi-square wave is obtained by

- A) Connecting outputs of identical inverters through transformers with a phase difference
- B) Connecting SCRs in parallel
- C) Using a high-frequency chopper
- D) Increasing the DC input voltage

Answer: A

12.In comparison with a linear regulated power supply, an SMPS achieves higher efficiency mainly because

- A) The switching device operates either in saturation or cutoff
- B) It uses larger transformers
- C) It dissipates more power in resistive elements
- D) It uses only AC output

Answer: A

13.The transformer used in an SMPS is generally much smaller than that of a linear power supply because the SMPS operates at

- A) Low frequency (50 Hz)
- B) Variable DC
- C) High switching frequency
- D) Zero frequency

Answer: C

14. During normal operation of an SMPS, output voltage regulation is mainly achieved by

- A) Varying transformer turns ratio
- B) Changing PWM duty cycle
- C) Increasing mains frequency
- D) Increasing filter capacitance

Answer: B

15. The error amplifier in an SMPS compares

- A) Reference voltage and output voltage
- B) Input voltage and output current
- C) Input current and output current
- D) Frequency and duty cycle

Answer: A

16. The primary purpose of a UPS is to

- A) Increase AC frequency
- B) Convert DC into DC
- C) Provide uninterrupted power during mains failure
- D) Improve power factor

Answer: C

17. Which feature distinguishes an online UPS from an offline UPS during normal operating conditions?

- A) Battery supplies the load directly.
- B) Utility power directly feeds the load without conversion.
- C) The inverter continuously supplies power to the load.
- D) Output is available only during power failure.

Answer: C

18. In an Online UPS, the load receives power under normal operating conditions through the

- A) Static switch only
- B) Battery directly
- C) Inverter
- D) AC voltage controller

Answer: C

19. Which UPS is also known as a Standby UPS?

- A) Online UPS
- B) Offline UPS
- C) Rotary UPS
- D) Double Conversion UPS

Answer: B

20. The transfer time from inverter to mains supply in an Online UPS using a static switch is approximately

- A) 40–50 ms
- B) 20–30 ms

- C) 4–5 ms
- D) 100 ms

Answer: C

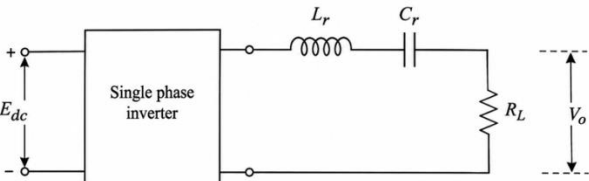
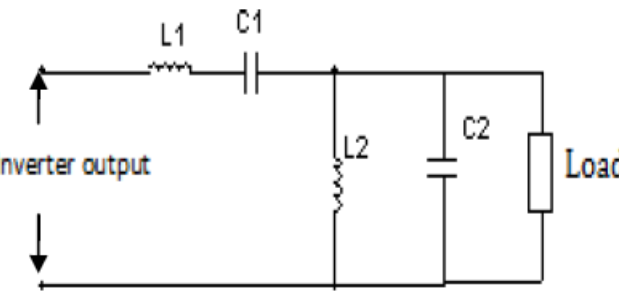
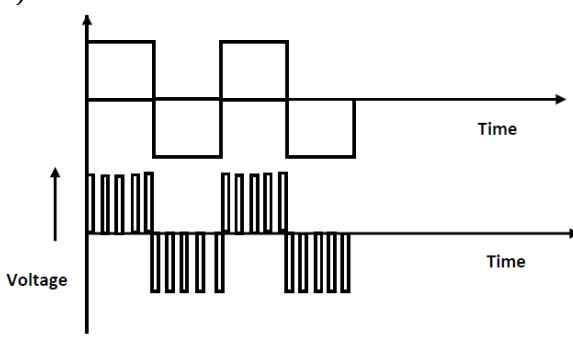
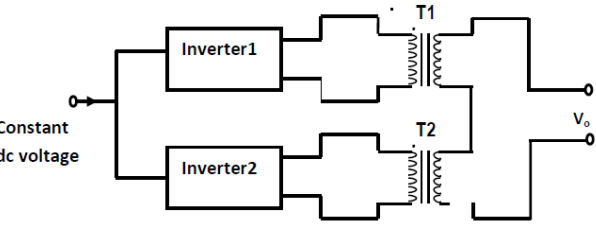
21. Which of the following applications most critically requires an online UPS?

- A) Domestic ceiling fan
- B) Decorative lighting
- C) Electric iron
- D) Hospital intensive care equipment

Answer: D

UNIT 3: ANALYTICAL MCQ

22. Match the harmonic-reduction method in Column I with its operating principle in Column II and the corresponding effect/limitation in Column III..

METHOD	Operating Principle	Effect / Limitation
P) 	1. Multiple pulses are generated during each half cycle	a. High Q-factor is required for effective harmonic reduction
Q) 	2. Load is made resonant at the output frequency	b. Harmonics are eliminated using suitable LC sections
R) 	3. Two inverter outputs are combined through transformers with phase difference	c. Harmonic content decreases as the number of pulses increases, but switching losses limit the pulse number
S) 	4. Suitable LC network is connected to suppress harmonic components	d. Harmonics are further reduced when quasi-square signals are added with phase difference

- A) P-2-b, Q-4-a, R-3-c, S-1-d
 B) P-4-b, Q-2-a, R-1-d, S-3-c
 C) P-2-a, Q-4-b, R-1-c, S-3-d
 D) P-3-d, Q-4-b, R-2-c, S-1-a

Answer: C

23. Assertion (A): The McMurray inverter uses an LC circuit and an auxiliary thyristor for commutation.

Reason (R): The resonating LC circuit produces an impulse that is applied to turn OFF the conducting thyristor.

- A) Both A and R are true, and R is the correct explanation of A.
- B) Both A and R are true, but R is not the correct explanation of A.
- C) A is true, but R is false.
- D) A is false, but R is true.

Answer: A

24. Consider the following statements for full bridge inverter:

- 1. Diagonal pairs of switches are operated alternately.
- 2. The polarity of load voltage changes when the conducting diagonal pair changes.
- 3. Both switches in the same leg should be turned ON simultaneously.
- 4. The inverter converts DC power into AC power.

Which statements are correct?

- A) 1 and 2 only
- B) 1, 2 and 4 only
- C) 2 and 3 only
- D) 1, 3 and 4 only

Answer: B

25. A student studies the following operating conditions of an SMPS. Which combination correctly identifies their effects?

Condition	Observation
P	Switching frequency is increased
Q	PWM duty cycle is increased
R	Switching device operates mainly in ON/OFF states
S	Output voltage falls below the reference value

- A) P–larger transformer, Q–increased output voltage, R–lower losses, S–duty cycle unchanged
- B) P–larger transformer, Q–decreased output voltage, R–lower efficiency, S–duty cycle decreased
- C) P–smaller transformer, Q–no change in output voltage, R–higher losses, S–switching frequency decreased
- D) P–smaller transformer, Q–increased output voltage, R–higher efficiency, S–duty cycle increased

Answer: D

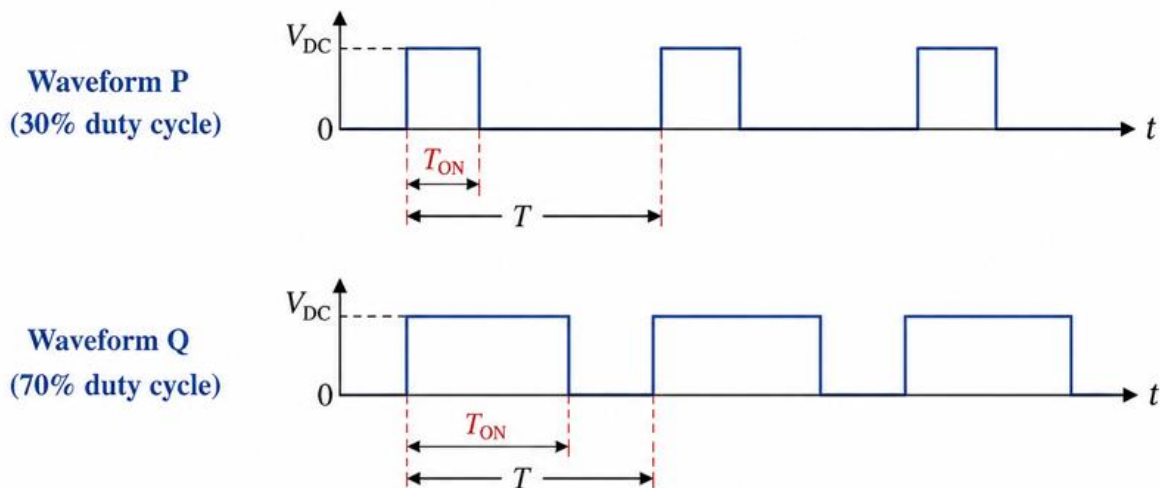
26. A fixed DC source is connected to an inverter. The required AC load voltage is lower than the present output, while the DC source cannot be changed. Which sequence represents the appropriate control action?

1. Reduce the effective ON duration of the switching pulses.
2. Maintain the DC input voltage constant.
3. Reduce the effective output voltage of the inverter.
4. Supply the required lower AC voltage to the load.

- A) 2 → 3 → 1 → 4
 B) 1 → 3 → 2 → 4
 C) 2 → 1 → 3 → 4
 D) 3 → 1 → 2 → 4

Answer: C

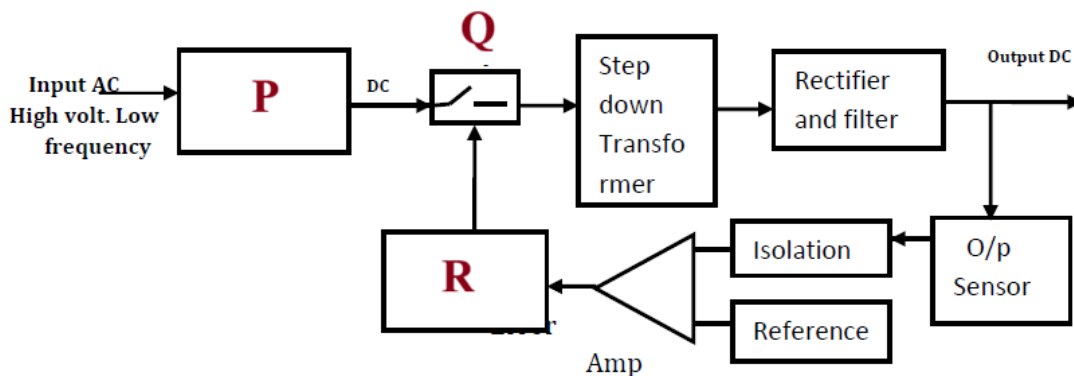
27. Study the PWM waveforms P and Q shown in the figure. If the DC input voltage remains constant, which waveform produces the higher effective output voltage?



- A) Waveform P
 B) Waveform Q
 C) Both waveforms produce the same effective output voltage
 D) The effective output voltage cannot be determined

Answer: B

28. Study the SMPS block diagram shown below. The blocks marked P, Q and R are to be identified. Which option correctly identifies them?

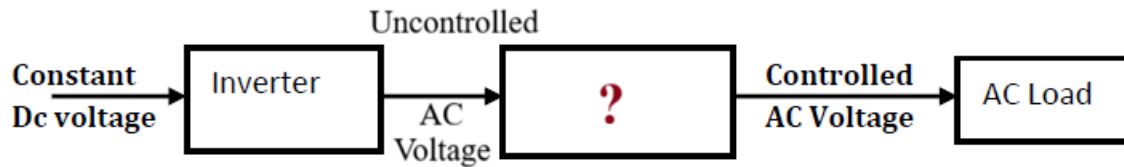


- A) P – Rectifier, Q – Switching circuit, R – PWM control circuit
 B) P – Filter, Q – Rectifier, R – Transformer
 C) P – Transformer, Q – Rectifier, R – Filter

D) P – Inverter, Q – Filter, R – Rectifier

Answer: A

29. Study the block diagram shown. A constant DC voltage is applied to an inverter, whose output is an uncontrolled AC voltage. The intermediate block is used to obtain a controlled AC voltage. Which of the following is the most appropriate block for the missing stage?



- A) AC voltage controller using phase-angle control
- B) Uncontrolled bridge rectifier
- C) DC chopper
- D) LC commutation circuit

Answer: A

30. Assertion (A): An SMPS can provide regulated output voltage even when the input or load conditions change.

Reason (R): The output voltage of an SMPS is regulated by varying the transformer turns ratio during normal operation.

- A) Both A and R are true, and R is the correct explanation of A.
- B) Both A and R are true, but R is not the correct explanation of A.
- C) A is true, but R is false.
- D) A is false, but R is true.

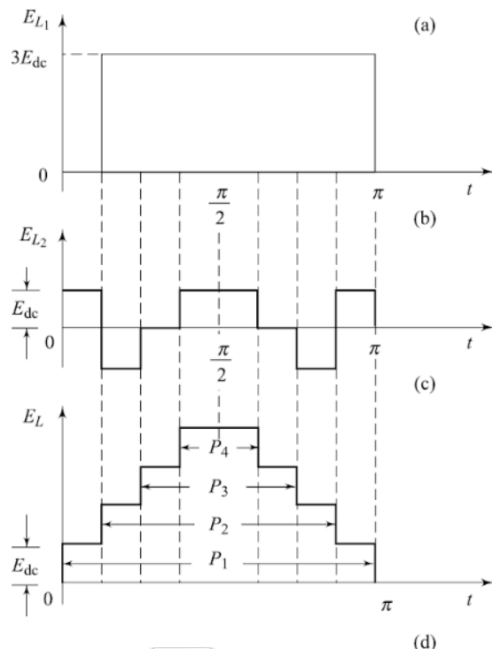
Answer: C

UNIT 3: DESCRIPTIVE QUESTIONS:

1. Explain the working of a single-phase full-bridge inverter with a neat circuit diagram and output waveform.
2. Explain the construction and working of a McMurray inverter with a neat circuit diagram, including the commutation process.
3. Describe the operation of a Switched Mode Power Supply (SMPS) with a neat block diagram and the function of its main blocks.
4. Compare the operation, features, advantages, disadvantages and applications of online UPS and offline UPS.

UNIT 3: ANALYTICAL DESCRIPTIVE QUESTIONS

5. The output waveforms of an inverter are shown in the given figure. Analyse the waveforms and answer the following:



a) Identify the **output voltage control / waveform synthesis method** represented by the given waveforms. (2 Marks)

b) Draw the **corresponding inverter control circuit** for the identified method. (3 Marks)

c) Identify the type of output waveform obtained: **stepped wave, quasi-square wave or sine wave**. Give the reason for your choice. (2 Marks)

d) Describe how the individual inverter outputs are combined to produce the required output waveform. (2 Marks)

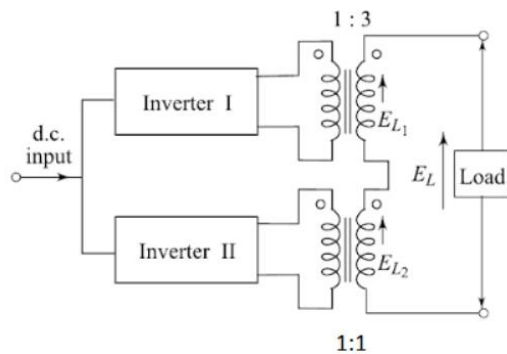
e) State one advantage of the identified method in terms of **harmonic reduction**. (1 Mark)

ANSWER:

a) **Identify the output voltage control / waveform synthesis method.** (2 Marks)

The method represented is sine-wave synthesis using multiple inverter outputs, also called a stepped-wave inverter method.

b) **Draw the corresponding inverter control circuit.** (3 Marks)



c) **Identify the type of output waveform obtained. Give the reason.** (2 Marks)

Answer: Stepped waveform.

The final load voltage EL consists of successive voltage levels P1,P2,P3 and P4. Therefore, the output is not a simple square wave or a pure sine wave; it is a **stepped approximation of a sine wave**.

d) Describe how the individual inverter outputs are combined to produce the required output waveform. (2 Marks)

The two inverter outputs produce different voltage contributions:

- EL1 provides a voltage of approximately **3Edc**.
- EL2 provides stepped positive, zero and negative voltage levels of approximately **Edc**.
- These voltages are combined through the transformer secondary windings.
- Their combination produces the successive output levels **P1,P2,P3 and P4**, forming the stepped load voltage EL.

Thus, the individual inverter outputs are **combined in suitable magnitude and phase** to synthesize the stepped waveform.

e) State one advantage of the identified method in terms of harmonic reduction. (1 Mark)

The stepped waveform provides a **closer approximation to a sinusoidal waveform**, thereby **reducing harmonic content** compared with a simple square-wave inverter output.

UNIT – IV : PLC AND ROBOTICS

1. Which unit of a PLC interprets the input signals and performs control actions according to the stored program?

- A) Processor unit
- B) Power supply unit
- C) Programming device
- D) Output interface

Answer: A

2. In a PLC, the primary function of the memory unit is to

- A) Convert AC into DC
- B) Detect physical quantities
- C) Drive the output motor directly
- D) Store the control program and process data

Answer: D

3. Ladder Logic is primarily based on

- A) Magnetic amplifier circuits
- B) Relay logic circuit diagrams
- C) Transformer equivalent circuits
- D) Digital communication protocols

Answer: B

4. In a PLC ladder diagram, two normally open contacts connected in series represent which logic operation?

- A) OR
- B) NOT

C) AND
D) NAND
Answer: C

5. For a NAND logic implemented using ladder programming, the output becomes OFF when

- A) Both input conditions are OFF
- B) Only the first input is ON
- C) Only the second input is ON
- D) Both input conditions are ON

Answer: D

6. In a timer-delay-on operation, the timer starts when

- A) The input condition becomes TRUE
- B) The output becomes FALSE
- C) The PLC is switched OFF
- D) The preset value becomes zero

Answer: A

7. In a timer-delay-on operation, the output turns ON when

- A) The input becomes FALSE
- B) The preset time is reached while the input remains TRUE
- C) The PLC memory is cleared
- D) The timer is disconnected from the output

Answer: B

8. In the conveyor-control system, which device detects the box at the end of the conveyor?

- A) Emergency-stop push button
- B) Proximity switch
- C) Overload relay
- D) Motor starter

Answer: B

9. When the START push button is actuated in the conveyor-control sequence, the first control action is to

- A) Energize the motor-control relay
- B) Stop the motor
- C) Switch OFF the green lamp
- D) Activate the red lamp

Answer: A

10. What is the main purpose of the emergency-stop push button in the conveyor-control system?

- A) Increase conveyor speed
- B) Detect the position of the box
- C) Stop the motor at any time when required
- D) Start the conveyor automatically

Answer: C

11. Which robot component provides support and stability to the entire robot?

- A) Base
- B) Wrist

- C) End-effector
- D) Controller

Answer: A

12.The primary function of the wrist in a robot is to provide

- A) Electrical power to the controller
- B) Orientation and positioning of the end-effector
- C) Feedback from the proximity sensor
- D) Programming instructions

Answer: B

13.Which component of a robot generates motion using electrical, hydraulic or pneumatic power?

- A) Controller
- B) Sensor
- C) Drive/Actuator
- D) End-effector

Answer: C

14.An end-effector is attached to the

- A) Base of the robot
- B) Controller
- C) Wrist of the manipulator
- D) Drive unit

Answer: C

15.The primary function of a gripper-type end-effector is to

- A) Control the robot program
- B) Supply power to the robot
- C) Hold and manipulate a workpiece
- D) Measure the robot speed

Answer: C

16.Selection of an appropriate end-effector mainly depends on the

- A) Colour of the robot
- B) Nature of the task and workpiece
- C) Size of the controller memory
- D) PLC scan time

Answer: B

17.In ladder logic, an output coil is energized when its preceding logic condition is

- A) FALSE
- B) TRUE
- C) Undefined
- D) Always OFF

Answer: B

18. The preset value of a PLC timer determines the

- A) Input voltage
- B) PLC memory size
- C) Motor speed directly
- D) Required delay duration

Answer: D

19.The links and joints of a robot primarily provide

- A) Program storage
- B) Electrical isolation
- C) Mechanical movement of the robotic arm
- D) Sensor amplification

Answer: C

20.A robotic system used in automatic lighting control requires measurement of light intensity. Which sensor is appropriate?

- A) LDR
- B) MQ-2
- C) Vibration sensor
- D) GPS module

Answer: A

21.Which sensor can be selected for detecting the presence of gas or smoke in an industrial environment?

- A) BMP280
- B) MQ-2
- C) MPU6050
- D) LDR

Answer: B

UNIT 4: ANALYTICAL MCQ

22. Study the sensor images given in Column I and match each sensor with its correct name in Column II and its corresponding application in Column III. Select the correct combination.

SensorImage	Sensor	Main Application
P. 	1. DHT11	a. Detects flame
Q. 	2. HC-SR04 Ultrasonic sensor	b. Measures temperature and humidity
R. 	3. LDR	c. Detects/measures light intensity
S. 	4. Flame sensor	d. Measures distance / detects obstacles

- A) P-1-b, Q-2-d, R-4-a, S-3-c
B) P-2-d, Q-3-c, R-1-b, S-4-a
C) P-4-a, Q-1-b, R-2-d, S-3-c
D) P-2-d, Q-1-b, R-4-a, S-3-c

Answer: D

23. Assertion (A): In an OFF-delay timer, the output remains energized for the preset delay period when the input condition changes from ON to OFF.

Reason (R): The preset value of an OFF-delay timer represents the number of PLC scan cycles required to execute the ladder program.

- A) Both A and R are true, and R is the correct explanation of A.
- B) Both A and R are true, but R is not the correct explanation of A.
- C) A is true, but R is false.
- D) A is false, but R is true.

Answer: C

24. Consider the following statements regarding PLC ladder programming:

1. Two normally open contacts connected in series can represent AND logic.
2. Two normally open contacts connected in parallel can represent OR logic.
3. An output coil is energized regardless of the preceding contact conditions.
4. A normally closed contact remains logically TRUE when its associated input is ON.

Which of the following is correct?

- A) 1 and 2 only
- B) 1 and 3 only
- C) 2 and 4 only
- D) 3 and 4 only

Answer: A

25. A PLC timer exhibits the operating conditions given in the table. Based on the input transition, timer status and output response, which type of timer is represented?

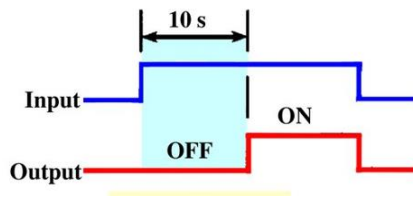
Condition	Input	Timer status	Output
P	ON	Not timing	ON
Q	OFF	Timing	ON
R	OFF	Preset time completed	OFF
S	ON again during timing	Timer reset	ON

- A) ON-delay timer
- B) Pulse timer
- C) Counter
- D) OFF-delay timer

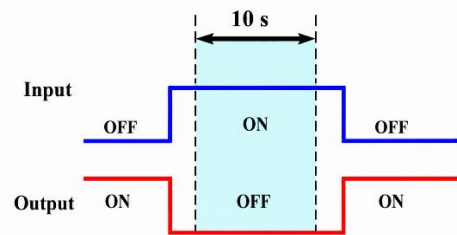
Answer: D

26. The waveform corresponding to an ON-delay timer is shown in one of the following options. Select the waveform that correctly represents the operation of an ON-delay timer.

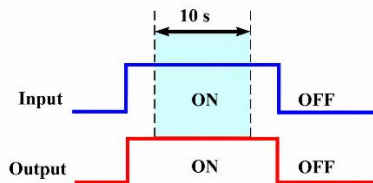
A)



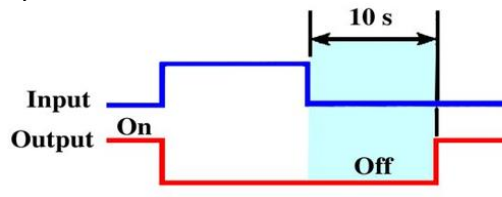
C)



B)

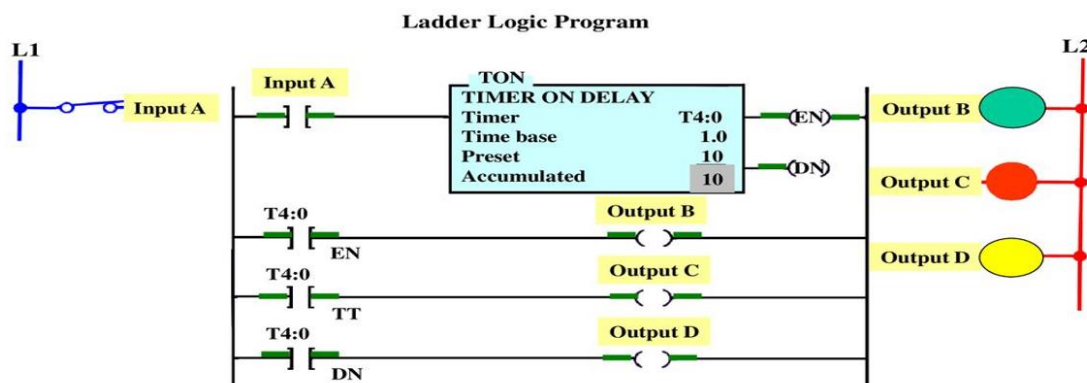


D)



Answer: A

27. Input A is switched ON at 0 s and remains continuously ON. The three outputs are connected to Green (B), Red (C) and Yellow (D) indicator lamps. Consider 0 s, 7 s and 11 s after Input A is switched ON. Which combination correctly indicates the lamps that glow at these three instants?



A) 0 s – Green + Red; 7 s – Green + Red; 11 s – Green + Yellow

B) 0 s – Red; 7 s – Green + Yellow; 11 s – Yellow

C) 0 s – Green + Yellow; 7 s – Green + Red; 11 s – Green

D) 0 s – Green; 7 s – Red; 11 s – Green + Yellow

Answer: A

28. consider the following application statements:

1. A **parallel gripper** is suitable for grasping and holding objects from two sides.
2. A **vacuum gripper** is suitable for picking and holding objects using suction.

3. A **magnetic gripper** is suitable for lifting ferrous objects.
4. A **spray gun** is suitable for holding and transferring heavy metallic objects by magnetic attraction.

Which of the following statements is correct?

- A) 1, 2 and 3 only
- B) 1 and 3 only
- C) 2 and 4 only
- D) 1, 2, 3 and 4

Answer: A

29. Which of the following statements correctly describes the functional relationship between the major elements of an industrial robot?

- A) The controller converts electrical signals directly into mechanical motion, while the actuator stores the task instructions.
- B) The sensor determines the required mechanical movement and directly drives the robot joints.
- C) The actuator converts the control command into mechanical motion, enabling the manipulator to perform the required movement.
- D) The end-effector processes the robot program and generates the control signals required for joint movement.

Answer: C

30. Assertion (A): The selection of an end-effector depends on the task to be performed by the robot.

Reason (R): The wrist of a robot provides orientation and positioning of the end-effector.

- A) Both A and R are true, and R is the correct explanation of A.
- B) Both A and R are true, but R is not the correct explanation of A.
- C) A is true, but R is false.
- D) A is false, but R is true.

Answer: B

UNIT 4: DESCRIPTIVE QUESTIONS:

1. a) Illustrate the application of PLC timers in any suitable industrial or automation application and describe how the timer is used to control the sequence of operation. (5 Marks)

b) Construct ladder programs to realize the following three basic logic gates using PLC contacts and coils:

- AND gate
 - OR gate
 - NAND gate
- (5 Marks)**

2.Design a PLC-based conveyor control system for automatic movement and positioning of a workpiece. Develop the ladder program and describe the sequence of operation using suitable input, output and proximity-sensor conditions.

3. Describe the major building blocks of an industrial robot and illustrate the function of each block in the overall operation of the robot..

4.Classify the different types of robot end-effectors and describe their functions with suitable industrial applications.

UNIT 4: ANALYTICAL DESCRIPTIVE QUESTIONS:

5. Observe the given automated conveyor sorting system and answer the following:



a)Identify the different sensors shown in the system and **state the function** of each sensor. (2 Marks)

b)Represent the PLC control structure used in the system by drawing the functional blocks from **input sensing to output control**.(2 Marks)

c)Identify the output devices/actuators shown in the system and **state the function** of each. (2 Marks)

d)Trace the sequence of operation of the system from **workpiece detection to sorting**, indicating the interaction between the sensors, PLC and output devices. (2 Marks)

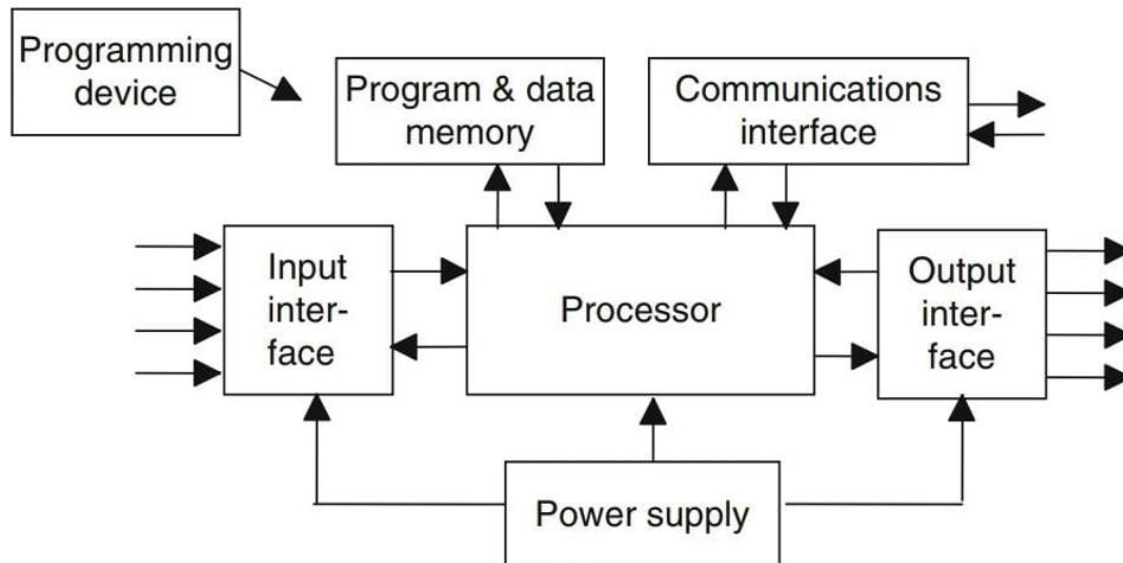
e)Identify the **industrial application** represented by the given system and **state its purpose**. (2 Marks)

ANSWER:

a) Identify the four sensors and their functions. (2 Marks)

1. **Inductive proximity sensor** – detects the presence/position of the workpiece, particularly metallic objects.
2. **Photoelectric sensor** – detects the presence of an object by interruption/reflection of light.
3. **Color sensor** – identifies the colour of the workpiece for sorting.
4. **Ultrasonic sensor** – detects/measures the distance of the workpiece from the sensor.

b) PLC system block diagram. (2 Marks)



c) Identify the output devices/actuators and their functions. (2 Marks)

1. **Conveyor motor** – drives the conveyor belt.
2. **Pneumatic cylinder** – pushes/diverts the workpiece towards the appropriate sorting path.
3. **Robotic arm** – picks and places the workpiece.
4. **Indicator/stack light** – indicates the operating/status condition of the system.

d) Sequence of Operation – 2 Marks

When a workpiece enters the **conveyor**, the sensors detect its **presence and characteristics such as colour/position**. The sensor signals are sent to the **PLC**, which processes them and activates the appropriate **pneumatic diverter or robotic arm** to sort the workpiece into the required collection bin.

e) Industrial application — 2 Marks

The system represents an **automated conveyor-based material sorting and handling system**.

Purpose: To automatically **detect, identify, sort and transfer workpieces** with minimum manual intervention, improving productivity, accuracy and repeatability in industrial material-handling operations.

UNIT – IV: MEDICAL ELECTRONICS

1.The bioelectric potential developed across the membrane of an excitable cell is primarily associated with the movement of

- A) Electrons
- B) Ions
- C) Photons
- D) Neutrons

Answer: B

2.A cell having a membrane potential of approximately -70 mV, with the inside negative relative to the outside, is said to be in the

- A) Depolarized state
- B) Repolarized state
- C) Polarized or resting state
- D) Refractory state

Answer: C

3.During depolarization, which event primarily causes the membrane potential to become positive?

- A) Rapid entry of Na^+ into the cell
- B) Rapid entry of K^+ into the cell
- C) Exit of Na^+ from the cell
- D) Entry of Cl^- into the cell

Answer: A

4.Which electrode is most appropriate for measuring the bioelectric potential from within a single cell?

- A) Suction cup electrode
- B) Metal plate electrode
- C) Microelectrode
- D) Floating electrode

Answer: C

5.Surface electrodes with a relatively larger contact area are particularly suitable for

- A) Intracellular potential measurement
- B) ECG measurement
- C) Single-cell recording
- D) Measuring action potential inside a neuron

Answer: B

6.In an ECG recorder, the signals obtained from the patient electrodes are first directed to the

- A) Power amplifier
- B) Lead selector
- C) Oscillator
- D) Defibrillator

Answer: B

7.EMG is primarily used for recording the electrical activity associated with

- A) Brain activity
- B) Heart activity
- C) Muscle activity
- D) Kidney function

Answer: C

8.For recording localized electrical activity from a muscle, which electrode arrangement would be most appropriate?

- A) Large-area surface electrode only
- B) Needle/depth electrode
- C) Suction cup used for ECG
- D) Defibrillator paddle

Answer: B

9. Which combination correctly represents the basic components of an implanted pacemaker?

- A) Battery, pulse generator and electrodes
- B) Transformer, capacitor and oscillator
- C) Sensor, defibrillator and filter
- D) Amplifier, recorder and transducer

Answer: A

10. A pacemaker having leads connected to both the right atrium and right ventricle is classified as a

- A) Single-chamber pacemaker
- B) Dual-chamber pacemaker
- C) Biventricular pacemaker
- D) External pacemaker

Answer: B

11.The primary purpose of defibrillation is to

- A) Measure blood pressure
- B) Record brain activity
- C) Resynchronize abnormal cardiac activity using an electrical shock
- D) Increase blood oxygen concentration

Answer: C

12. In peritoneal dialysis, the peritoneal cavity acts as a

- A) Heat exchanger
- B) Semipermeable membrane
- C) Blood pump
- D) Pressure sensor

Answer: B

13.During an open-heart surgical procedure, the patient's heart is stopped while continuous circulation and oxygenation of blood must be maintained. Which system is

most appropriate?

- A) Pacemaker
- B) Defibrillator
- C) Heart-lung machine
- D) EMG recorder

Answer: C

14. In the ECG recorder, the use of a differential preamplifier with negative current feedback mainly contributes to

- A) increasing the chart speed
- B) stabilizing the amplification of the weak ECG signal
- C) producing the 1 mV calibration signal
- D) mechanically deflecting the writing arm

Answer: B

15. If the feedback signal corresponding to the pen position is not properly supplied to the power amplifier, which part of the ECG recorder's operation is most directly affected?

- A) Electrode selection
- B) Pen-position control and damping
- C) Patient signal generation
- D) Lead identification

Answer: B

16. A pacemaker is required to coordinate contraction of the right and left ventricles. Which type is most appropriate?

- A) Single-chamber pacemaker
- B) Dual-chamber pacemaker
- C) Biventricular pacemaker
- D) External pacemaker

Answer: C

17. In a DC defibrillator, after the high-voltage capacitor has been charged, the high-voltage switch changes from position A to B. What is the immediate consequence?

- A) The transformer starts charging the capacitor again
- B) The capacitor discharges through the electrodes
- C) The rectifier blocks the capacitor
- D) The inductor removes the stored charge

Answer: B

18. In the DC defibrillator, an inductor is included in the electrode circuit primarily to

- A) increase the charging voltage of the capacitor
- B) produce the high-voltage supply
- C) slow the capacitor discharge by producing a counter voltage
- D) rectify the transformer output

Answer: C

19. During peritoneal dialysis, the effectiveness of waste removal depends primarily on the exchange of substances between

- A) blood and dialysate across the peritoneal membrane
- B) blood and air through the lungs
- C) dialysate and atmospheric air
- D) blood and heating fluid

Answer: A

20. Which pair correctly matches the stored energy/control principle with the medical equipment?

- A) ECG recorder – capacitor discharge
- B) DC defibrillator – capacitor discharge through electrodes
- C) Pacemaker – transformer-based defibrillation
- D) Heart-lung machine – differential amplification

Answer: B

21. The operation time of a heart-lung machine at normal body temperature is limited to:

- A) 5 minutes
- B) 10 minutes
- C) 20 minutes
- D) 30 minutes

Answer: B

UNIT 5: ANALYTICAL MCQ

22. Match the medical equipment shown in Column I with its corresponding equipment name and main application in Columns II and III.

Equipment Image	Medical Equipment	Main Application
A. 	P. Pacemaker	1. Maintains blood circulation and oxygenation
B. 	Q. Heart-Lung Machine	2. Records electrical activity of heart
C. 	R. ECG Recorder	3. Provides electrical impulses to heart
D. 	S. DC Defibrillator	4. Discharges stored electrical energy to heart

- A) A-P-3, B-Q-1, C-R-2, D-S-4
 B) A-R-2, B-P-3, C-S-4, D-Q-1
 C) A-R-3, B-P-1, C-S-2, D-Q-4
 D) A-S-4, B-R-2, C-P-3, D-Q-1

Answer: B

23. Assertion (A): Microelectrodes can be used to measure the potential within a single biological cell.

Reason (R): The tip diameter of a microelectrode is very small, typically in the range of 0.5–5 μm , allowing it to be inserted into the cell with minimal damage.

- A) Both A and R are true, and R is the correct explanation of A.
- B) Both A and R are true, but R is not the correct explanation of A.
- C) A is true, but R is false.
- D) A is false, but R is true.

Answer: A

24.

Measurement requirement	Electrode type
Potential within a single cell	P
Highly localized extracellular potential	Q
Potential from the skin surface	R

Which inference correctly identifies P, Q and R?

- A) P–Surface, Q–Micro, R–Depth
- B) P–Micro, Q–Depth/Needle, R–Surface
- C) P–Depth, Q–Surface, R–Micro
- D) P–Micro, Q–Surface, R–Depth

Answer: B

25. Which of the following statements regarding the heart-lung machine is/are correct?

1. It temporarily supports blood circulation during open-heart surgery.
2. It is primarily used to record the electrical activity of the heart.
3. It provides oxygenation of blood while the normal function of the lungs is bypassed.
4. At normal body temperature, the operation time is limited to about 10 minutes.

- A) 1 and 2 only
- B) 1, 3 and 4 only
- C) 2 and 4 only
- D) 1, 2, 3 and 4

Answer: B

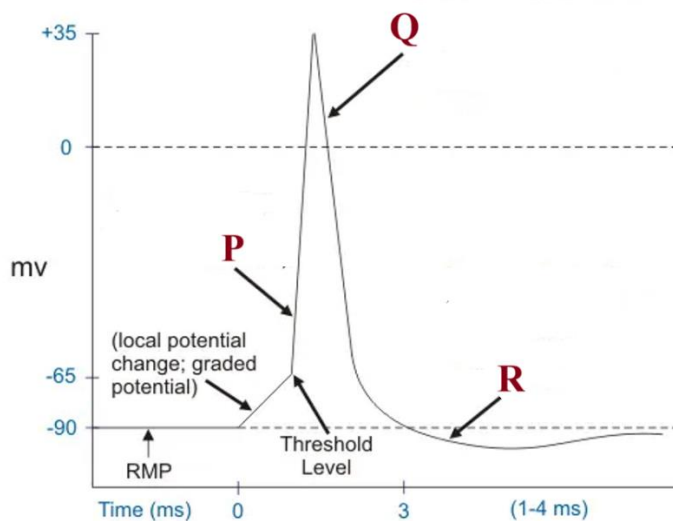
26. Assertion (A): A dual-chamber pacemaker is used when electrical signals are blocked between the atrium and ventricle.

Reason (R): A single-chamber pacemaker uses two leads to stimulate both the right atrium and right ventricle.

- A) Both A and R are true, and R is the correct explanation of A.
- B) Both A and R are true, but R is not the correct explanation of A.
- C) A is true, but R is false.
- D) A is false, but R is true.

Answer: C

27. Study the given graph representing the resting and action potential of a cell. Identify the physiological events represented by P, Q and R.



- A) P–Depolarization; Q–Repolarization; R–Hyperpolarization
- B) P–Repolarization; Q–Depolarization; R–Resting potential
- C) P–Resting potential; Q–Depolarization; R–Repolarization
- D) P–Hyperpolarization; Q–Resting potential; R–Depolarization

Answer: A

28. Which of the following correctly identifies the electrical events represented by the portions of the ECG?

1. P represents atrial depolarization.
2. Q–R–S represents ventricular depolarization.
3. T represents ventricular repolarization.
4. S–T interval is associated with ventricular contraction.

- A) 1 and 2 only
- B) 1, 2 and 3 only
- C) 2 and 4 only
- D) 1, 2, 3 and 4

Answer: D

29. Arrange the following steps in the correct sequence for recording EMG activity:

- P. Record muscle activity during voluntary contraction
- Q. Clean the electrode application site
- R. Record muscle activity at rest
- S. Insert the needle/place surface electrodes at the muscle

- A) Q → S → R → P
- B) S → Q → P → R
- C) R → Q → S → P
- D) Q → R → P → S

Answer: A

30. Assertion (A): EMG is used to record the electrical activity associated with muscle activity.

Reason (R): Surface electrodes are used to record ECG, EMG and EEG signals.

- A) Both A and R are true, and R is the correct explanation of A.
- B) Both A and R are true, but R is not the correct explanation of A.**
- C) A is true, but R is false.
- D) A is false, but R is true.

Answer: B

UNIT 5: DESCRIPTIVE QUESTIONS:

1.Explain the different types of biomedical electrodes used for measurement of biopotentials.

2.Illustrate the block diagram of an ECG recorder and explain the function of each block in the signal acquisition and recording process.

3. Describe the working of a DC defibrillator with a suitable block diagram and explain how electrical energy is stored and discharged through the patient during defibrillation.

4.Explain the construction and working of a heart-lung machine with a neat block diagram.

UNIT 5: ANALYTICAL DESCRIPTIVE QUESTIONS:

5. A patient exhibits different abnormalities in cardiac conduction as described below. Determine the appropriate pacemaker type for each condition and justify your selection.

Condition	Requirement
Slow rhythm originating from sinus node	?
Block between atrium and ventricle	?
Need for synchronized ventricular contraction	?

a) Identify the suitable pacemaker for each condition – 3 marks

b) List and explain the function of the major components used in a pacemaker. (3 Marks)

c) Explain how the selected pacemaker helps to correct or improve the cardiac rhythm in each condition. (2 Marks)

d) Justify why different pacemaker types are required for different cardiac conditions. (2 Marks)

ANSWER:

a) Suitable pacemaker – 3 Marks

- Sinus-node-origin slow rhythm → **Single chamber**
- AV block → **Dual chamber**
- Need for ventricular synchronization → **Biventricular/CRT**

b) Major components of a pacemaker – 3 Marks

The major components are:

1. **Battery** – supplies electrical energy to the pacemaker.
2. **Pulse generator** – generates the required electrical pulses.
3. **Electrodes/Leads** – carry the electrical impulses from the pulse generator to the heart.

c) How the pacemaker improves cardiac rhythm – 2 Marks

The pacemaker delivers **controlled electrical impulses** to the heart when the natural electrical activity is inadequate or blocked. This helps initiate or coordinate cardiac contractions according to the patient's requirement.

d) Why different types are required – 2 Marks

Different cardiac conditions affect different parts of the heart. Therefore:

- **Single chamber** → stimulation of one chamber.
- **Dual chamber** → coordination between atrium and ventricle.
- **Biventricular/CRT** → synchronization of the right and left ventricles.