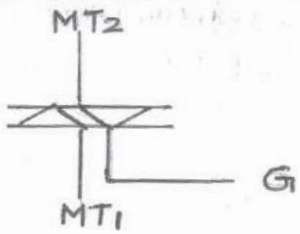
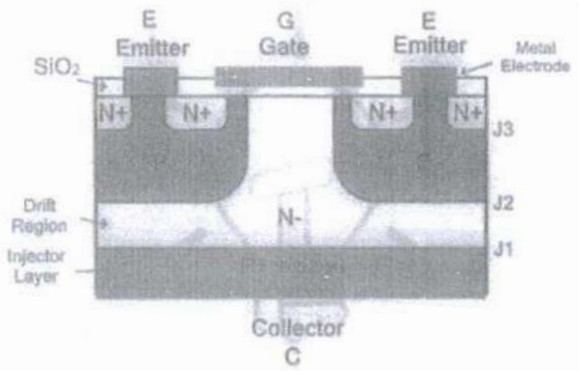
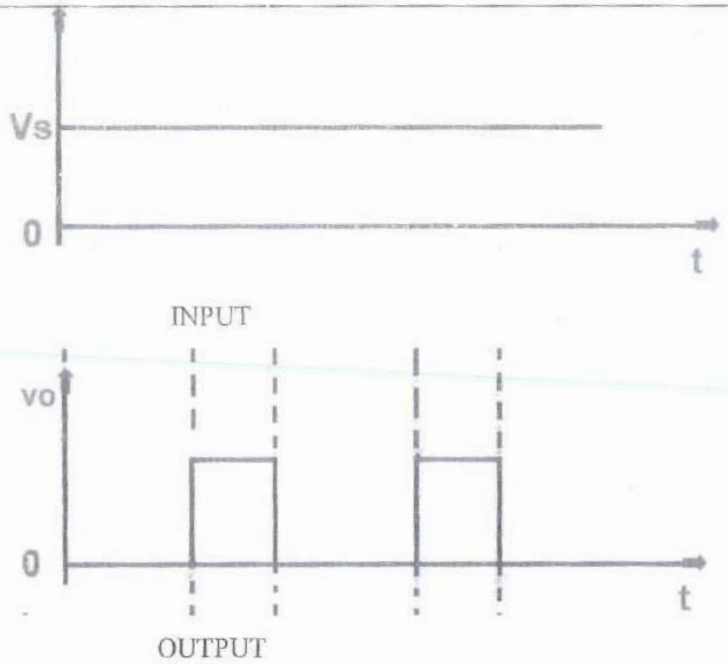
# SCHEME OF VALUATION
# SCORING INDICATORS

**REVISION: 2021**
**COURSE NAME: INDUSTRIAL AUTOMATION**
**COURSE CODE: 5042** **QID: 2109230088**

| Q.No | Scoring Indicators | Split score | Sub Total | Total score |
|---|---|---|---|---|
| | **PARTA** | | | **9** |
| I.1 | 180 degree. | 1 | 1 | |
| I.2 |  <br>Three terminals of TRIAC are Main terminal 1, Main terminal 2 and Gate. | 1 | 1 | |
| I.3 | Inverter. | 1 | 1 | |
| I.4 | Induction heating is the process of heating electrically conductive materials by electromagnetic induction. | 1 | 1 | |
| I.5 | Controlled Rectifier. | 1 | 1 | |
| I.6 | Uninterruptible Power Supply. | 1 | 1 | |
| I.7 | Programmable Logic Controller (PLC). | 1 | 1 | |
| I.8 | ADD,SUB,MUL,DIV,SQR,NEG,ABS (any two) | 2 x 0.5 | 1 | |
| I.9 | 1. Surface heating, melting and soldering, etc.<br>2. Heating of liquid conductors and gaseous conductors.<br>3. Heating of silicon.<br>4. Inductive furnaces for heating the metals to their melting point.<br>5. The induction stoves used in kitchen. (any two) | 2 x 0.5 | 1 | |
| | **PARTB** | | | **24** |
| II.1 | The process of turning OFF the SCR is called commutation.<br>The different types of forced commutation are<br>Class A Commutation<br>Class B Commutation,<br>Class C Commutation,<br>Class D Commutation | Def (1 mark) + Types- (2marks) (1+2) | 3 | |

| | | | | |
|---|---|---|---|---|
| | Class E Commutation. (any two types) | | | |
| II.2 |  | Figure<br>(3 marks) | 3 | |
| II.3 | PLCs have a variety of applications and uses, including:<br>Process Automation Plants (e.g. mining, oil &gas)Glass Industry<br>Paper Industry<br>Cement Manufacturing<br>In boilers – Thermal Power Plants (any three) | 3 x 1 | 3 | |
| II.4 |  | Input<br>(1 mark)<br>+<br>Output<br>(2 marks) | 3 | |
| II.5 | 1. PLC increases the reliability, flexibility and accuracy of the automation system.<br>2. PLC has the ability to easily communicate and connect with the computer.<br>3. PLC gives supervisory control capability.<br>4. Small size & easy for installation. | 3 x 1<br>(3 marks) | 3 | |

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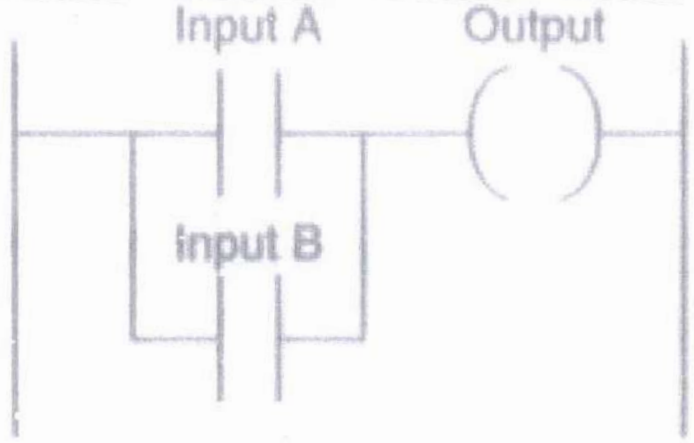
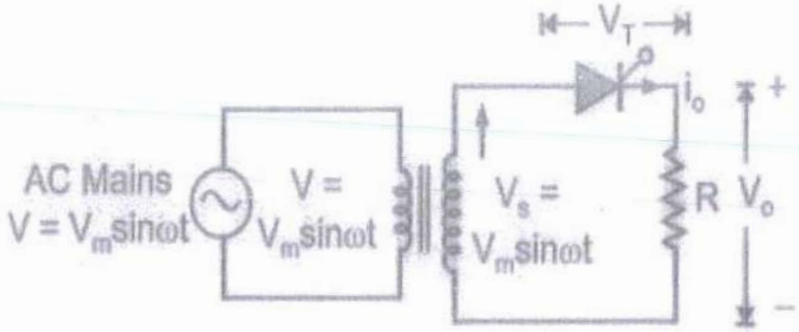
|---|---|---|---|---|
| | 5. Programming & re-programming is easy.<br>6. Trouble shooting is easy.<br>7. Less physical wiring. (Any 3) | | | |
| II.6 |  | Fig<br>(3 marks) | 3 | |
| II.7 | Resistance welding is a liquid state welding method where the metal-to-metal joint can be formed within a liquid state. It is a thermoelectric method where heat can be generated at the edge planes of welding plates because of electric resistance and a weld joint can be created by applying low-pressure to these plates. This type of welding uses electric resistance to generate heat. (Any 3 points) | 3 x 1 | 3 | |
| II.8 |  | Figure<br>(3 marks) | 3 | |
| II.9 | 1. Used to control ac output.<br>2. Speed control is done by changing the frequency.<br>3. Have both convertor and inverter.<br>4. Frequent maintenance is required.<br>5. Complex Circuit. (Any 3 points) | 3 x 1<br>(3 marks) | 3 | |

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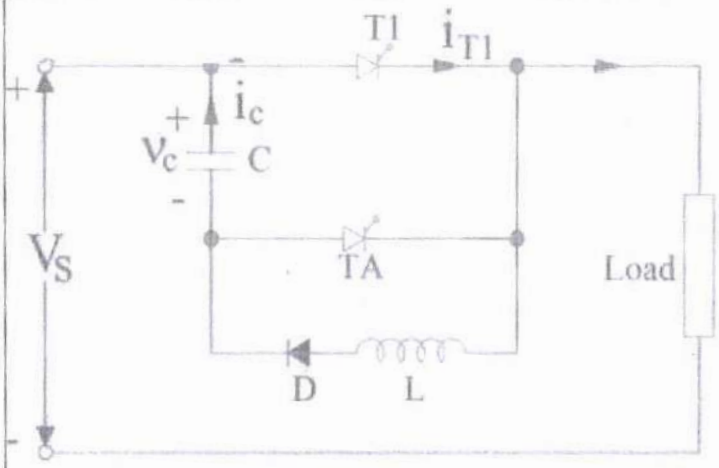
|---|---|---|---|---|
| II.10 | 1. stator voltage control<br>2 .variable voltage control<br>3. variable frequency control<br>4. rotor on-off control (Any 3 methods) | 3 x 1 (3 marks) | 3 | |
| | **PARTC** | | | 42 |
| III. |  <br><br>Class D commutation is also called Impulse Commutation. The circuit consists of two Thyristors T1 and TA and they are named as main and auxiliary respectively. The diode, inductor, and auxiliary Thyristor form the commutation circuit.<br>Initially, both the Thyristors are in OFF state and voltage across capacitor is zero. As we apply the input voltage and trigger Thyristor T1, the load current starts flowing through it, and capacitor starts charging with positive polarity for lower plate.<br>If we trigger the auxiliary Thyristor TA, the main Thyristor T1 turns OFF and the capacitor starts charging with the opposite polarity. When it gets full-charged, it causes TA to turn OFF, because capacitor does not allow the flow of current through it when it gets fully charged. Therefore, the output current will be zero because at this stage both the Thyristors are in OFF state. | Figure- (4marks) + Explanation (3 marks) | 7 | |

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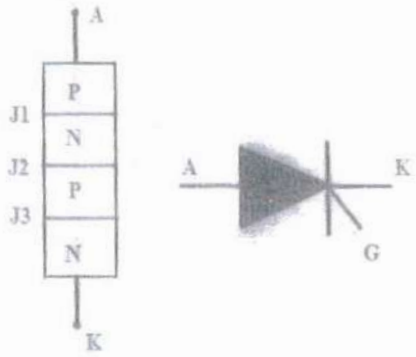
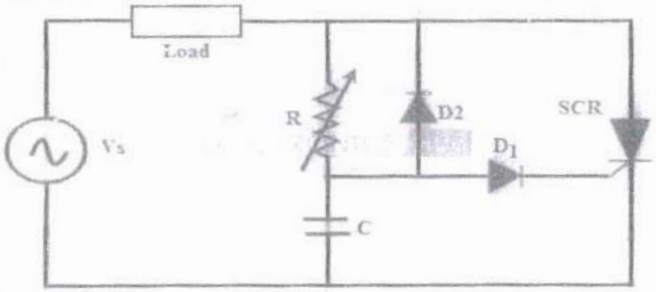
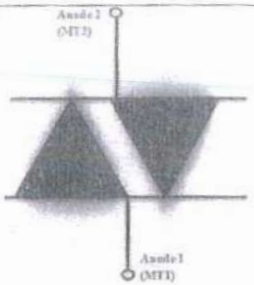
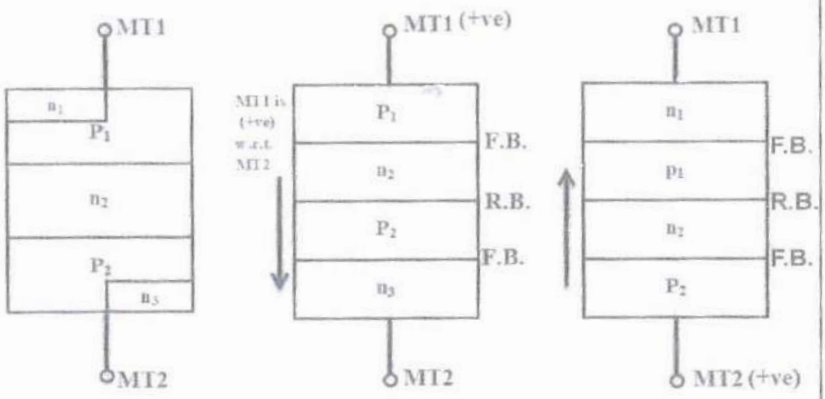
|---|---|---|---|---|
| IV |  <br>The Silicon Controlled Rectifier (SCR) is a three terminal device. Its terminals are anode, cathode and gate as shown in figure. SCR has built in feature to turn ON or OFF and its switching is controlled bybiasing conditions at gate input terminal.<br><br>**Construction:**<br>The SCR is a four layer and three terminal device. The four layers of P andN are arranged alternately such that they form three junctions J1, J2 and J3. The outer layers (P and N-layers) are heavily doped whereas middle P and N- layers are lightly doped. The gate terminal is taken at the middle P-layer, anode is from outer P- layer and cathode is from outer N- layer. Depending on the biasing given to the SCR, the operation of SCR is dividedinto three modes.<br><br>1. Forward blocking Mode: In this mode SCR does not conduct even if it is forward biased.<br>2. Forward Conduction Mode: This is the only conducting mode of SCR.<br>3. Reverse Blocking Mode: SCR in reverse blocking mode behaves as an open switch. | Figure 3 (marks) + Explanation (4 marks) | 7 | |

| | | | | |
|---|---|---|---|---|
| V |  <br>The circuit consists of two diodes with an RC network connected to turn on the SCR. By varying the variable resistance, triggering or firing angle can be controlled.<br>During the negative half cycle of the input signal, capacitor charges with lower plate positive through diode D2 up to the maximum supply voltage Vmax. This voltage remains at -Vmax across the capacitor till supply voltage attains zero crossing.<br>During the positive half cycle of the input, the SCR becomes forward biased and the capacitor starts charging through variable resistance to the triggering voltage value of the SCR. When the capacitor voltage is equal to the gate trigger voltage, SCR is turned ON. Therefore the capacitor voltage is helpful for triggering the SCR. Diode D1 prevents the negative voltage between the gate and cathode during the negative half cycle. | Figure (3marks) + Explanation (4 marks) | 7 | |
| VI |  | Figure (4marks) + Explanation (3marks) | 7 | |

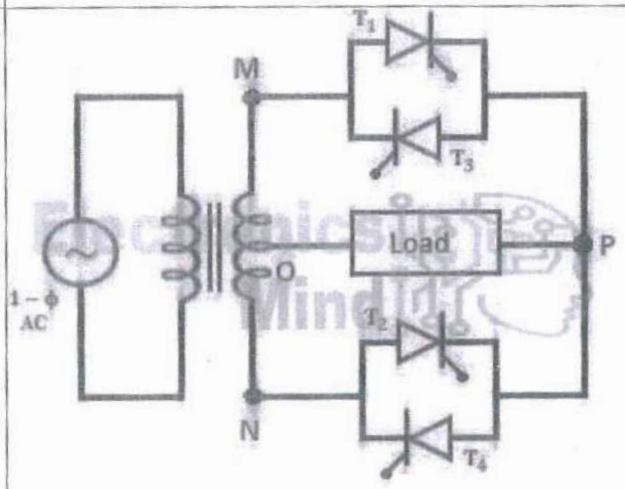



DIAC has the symbol of two diodes connected in parallel and opposite to one another and has two terminals MT1 and MT2 where MT stands for Main terminals. DIAC does not have base terminal, all three layers have the same amount of doping and it delivers symmetrical switching properties in both the polarities of the applied voltage.

Case (i) MT1 terminal is positive wrt MT2, the conduction will be taking place in the order of P1-N2- P2-N3 and current is flowing from MT1 to MT2 as the junction between P1-N2 and P2-N3 are Forward Biased and the junction between N2-P2 is reverse biased.

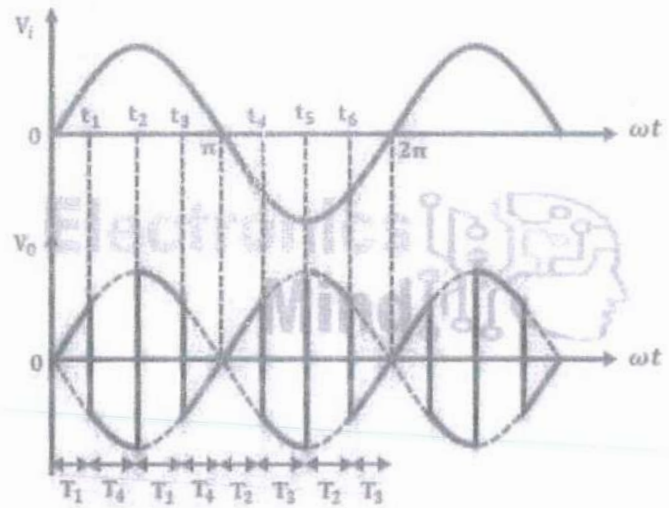
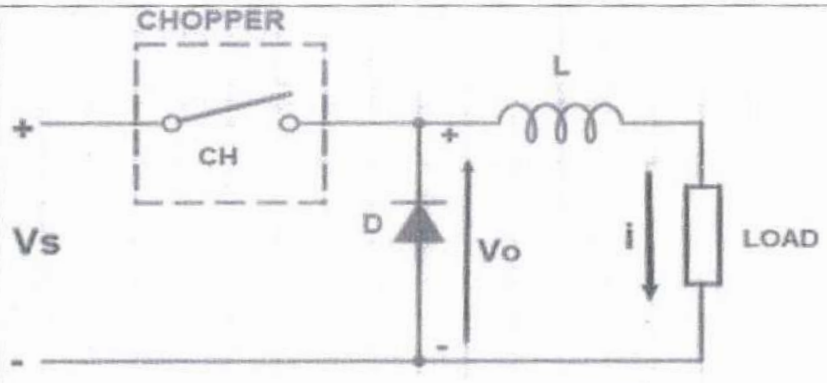
Case (ii) MT2 terminal to be positive wrt MT1, then the conduction will be taking place in the order of P2-N2- P1-N1 and current is flowing from MT2 to MT1 and the junctions betweenP2-N2 and P1-N1 are forward biased and the junction Between N2- P1 is reversebiased. Hence the conduction will be possible in both the directions.

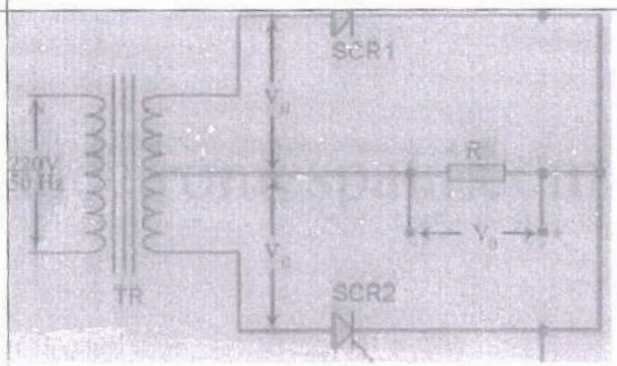
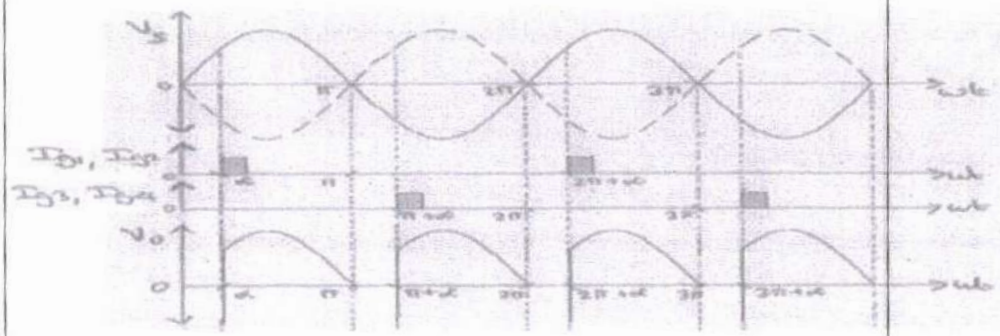
VII

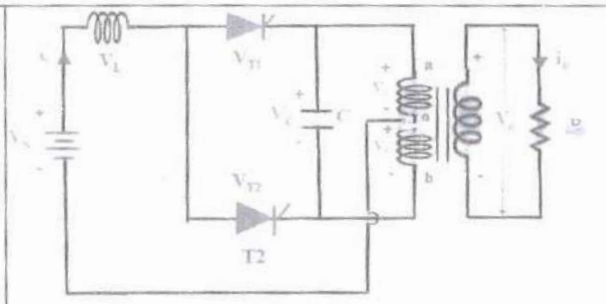


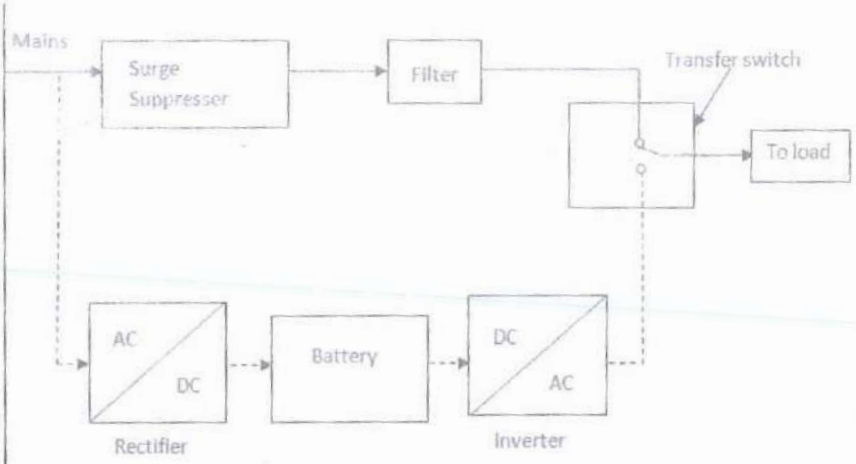

circuit (3marks) + Explanation (2marks) + Waveform (2 marks)

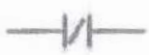
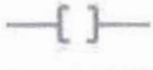
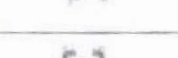
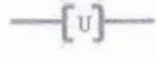
7

| | | | | |
|---|---|---|---|---|
| | A mid-point cyclo converter uses a center tapped transformer. The load is connected between points O and P. The thyristors are triggered depending upon the polarities of points M and N of the transformer. During positive half cycle, point M is positive with respect to point O.the thyristor $T_1$ is triggered from 0 to $t_1$, thus the obtained output voltage is positive. At the instant $t_1$, the thyristor $T_1$ is forced commutated and thyristor $T_4$ is turned ON so that the load voltage becomes negative as shown in the waveforms.<br>At $\pi$, $T_4$ is forced commutated and $T_2$ is turned ON, thus the output voltage is positive. At the instant $t_4$, the thyristor $T_2$ is forced commutated and $T_3$ is turned ON, and thus the output voltage is negative. In this manner the sequence continues, as a result, the output voltage frequency is higher than the supply frequency.<br>  <br> | | | |
| VIII |  <br><br>The chopper is shown within a dotted line and assumed to be a switch. The circuit consists of inductor L, a free-wheeling diode, chopper CH, | Figure- (4 marks) + Explanation (3marks) | 7 | |

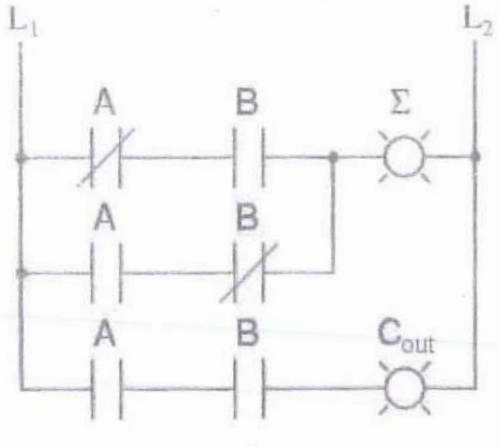
| | | | | |
|---|---|---|---|---|
| | Source and Load. Fixed DC input voltage Vs is applied and we get the variable DC output voltage. To get the variable DC voltage, we will switch ON and OFF the chopper CH at some frequency called the chopping frequency (f).<br>**Case (i)** When CH is switched ON, the source is directly connected to load and hence the output voltage Vo becomes equal to Vs.<br>**Case (ii)** When chopper is switched OFF, the load is disconnected from the source Vs and hence load voltage Vo will be ZERO during the entire period for which CH is OFF. | | | |
| IX |  <br>The circuit consist of two thyristors SCR1 and SCR2, a centre tap transformer, a voltage source Vs and a R Load. During the positive half cycle of the input voltage, the thyristor SCR1 is forward biased but it does not conduct until a gate signal is applied to it. When a gate pulse is given to the thyristor SCR1 at $\omega t = \alpha$, it gets turned ON and begins to conduct. When the thyristor SCR1 is ON, the input voltage is applied to the load.<br>During the negative half cycle, SCR2 is forward biased, the thyristor SCR1 gets reverse biased. When a gate pulse is given to the thyristor SCR2 at $\omega t = \Pi+\alpha$, it gets turned ON and begins to conduct.<br>  | circuit (3marks) + Explanation (2marks) + Waveform (2 marks) | 7 | |

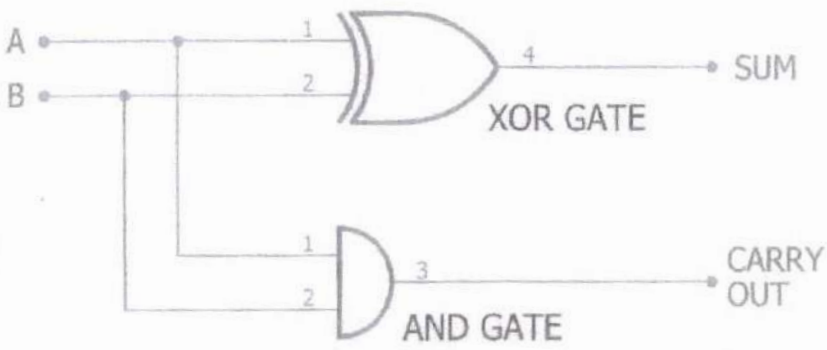
| | | | | |
|---|---|---|---|---|
| X |  <br>The parallel inverter circuit consists of two SCRs: T1 and T2, an inductor L, an output transformer, and commutating capacitor C.<br>Mode 1: SCR1 is conducting while SCR 2 is OFF. In this case current flows in the upper half of the primary winding. As a result an emf Vdc is induced across the upper as well as lower half of the primary winding. An induced voltage on the secondary is produced and supplied to the load the capacitor C charges to a voltage of 2Vdc with upper plate as positive.T2 is forward biased by the capacitor voltage 2Vdc. In this time Vo=Vdc.<br>Mode 2: When SCR 2 is turned ON by applying a trigger pulse to its gate m at this time capacitor voltage 2Vdc appears as a reverse bias across SCR 1, it is therefore turned OFF. A current Io begins to flow through SCR 2 and lower half of primary winding. The capacitor has charged (upper plate as negative) from +2Vdc to -2Vdc at time t=t1. Load voltage also changes from to –Vdc. | Figure (3 marks) + Explanation (4 marks) | 7 | 7 |
| XI | The methods of Resistance welding are as follows<br>Spot Welding, Projection Welding, Butt Welding and Seam Welding<br>**Spot Welding:** Spot Welding bonds together two or more metal sheets which are held in an overlapping position between a pair of welding electrodes, one fixed and one mobile. Spot welding is employed in the manufacture of automobiles, aircraft, and steel household furniture. Spot welding is faster that other types of welding.<br>**Projection Welding:** Projection welding is mainly used in electrical, automotive and construction fields. The advantage of this method is its flexibility as the welder can weld more than one spot at a time. This method can't be used on metals.<br>**Butt Welding:** In butt welding the adjoining of two surfaces takes place | Listing (1mark) + Explaining Any 3 (3 x 2) | 7 | |

| | | | | |
|---|---|---|---|---|
| | simultaneously over the entirety of the affected work piece surfaces instead of in small spots. In a basic butt weld, the two pieces to be welded are first brought together under pressure and then current is applied.<br>**Seam Welding:** seam welding is a modification of spot welding wherein the electrodes are replaced by rotating wheels. It can produce a continuous joint that is liquid and gas tight. | | | |
| XII | Offline UPS is also called as Standby UPS system which can give only the basic features. The primary source is the filtered AC mains. When the power breakage occurs, the transfer switch will select the backup source. Thus the stand by system will start working only when there is any failure in mains.<br>In this system, the AC voltage is first rectified and stored in the storage battery connected to the rectifier. When power breakage occurs, this DC voltage is converted to AC voltage by means of a power inverter, and is transferred to the load connected to it.<br>  <br> | Figure (4 marks) + Explanation (3 marks) | 7 | |
| XIII | The Bit instructions of PLC are Normally Open, Normally Closed, Output coil, Latch, Unlatch. | Listing (1mark) + Explaining any four (4 x 1.5) | 7 | |

| Instruction | Symbol | Description |
|---|---|---|
| Examine ON (Normally Open) |  | An input condition that is open when de-energized |
| Examine OFF (Normally Closed) |  | An input condition that is close when de-energized |
| Output coil |  | An output instruction that is true when the input conditions become true |
| Negated Output |  | An output instruction that is true all the time except when all input conditions true |
| Latch Output Coil |  | To hold an output ON |
| Unlatch |  | To unlatch the latched ON output |

XIV




Ladder (4 marks) + Explanation /Truth Table (3 marks)

7

| Input | | Output | |
|---|---|---|---|
| A | B | Sum | Carry |
| 0 | 0 | 0 | 0 |
| 0 | 1 | 1 | 0 |
| 1 | 0 | 1 | 0 |
| 1 | 1 | 0 | 1 |