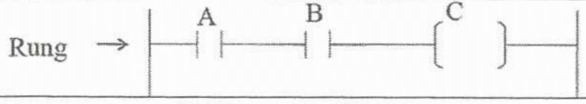
(132)

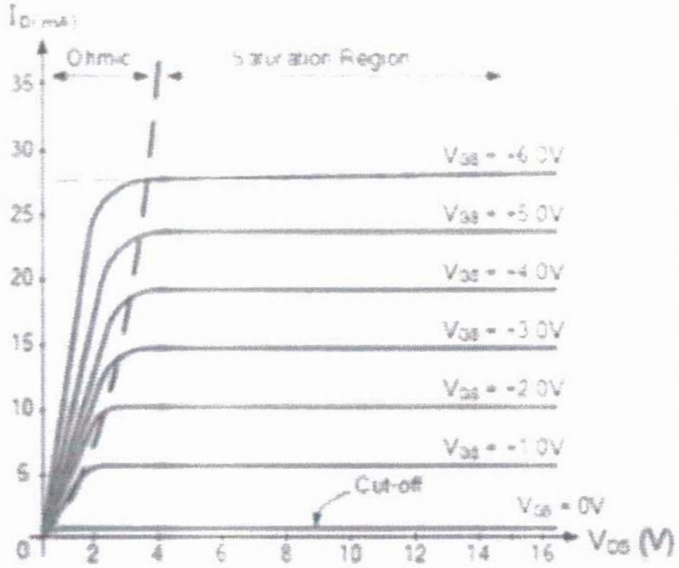
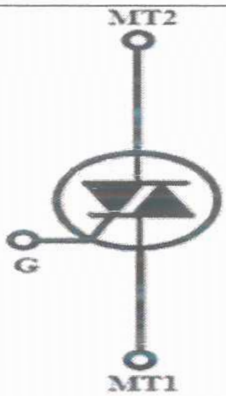
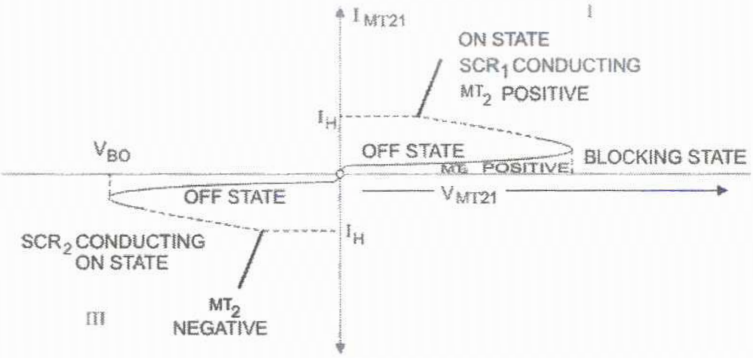
(13)

Scoring Indicators

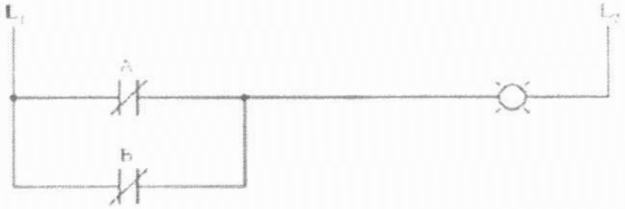
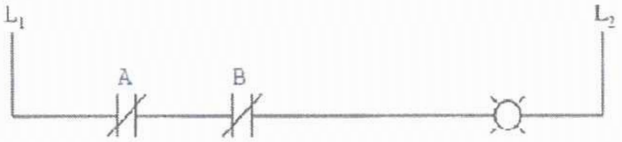
COURSE NAME : INDUSTRIAL AUTOMATION

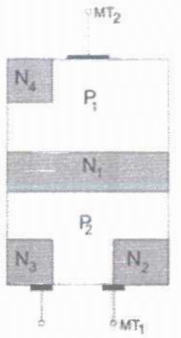
COURSE CODE : 5042 (21) **QID :2109230090**

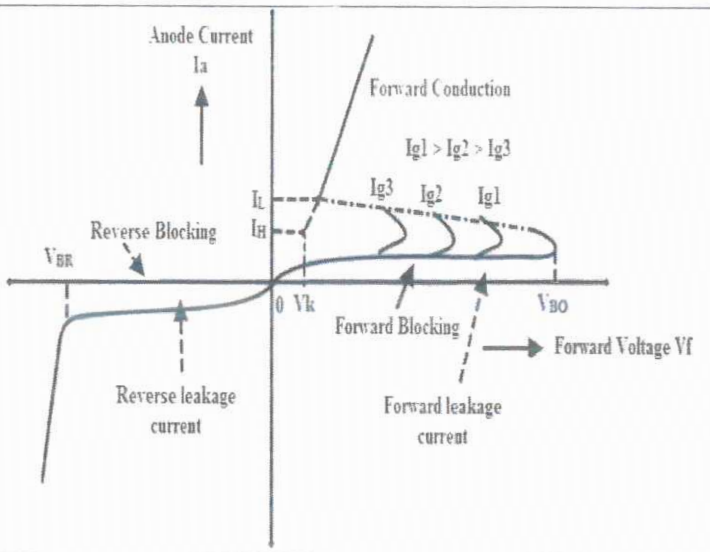
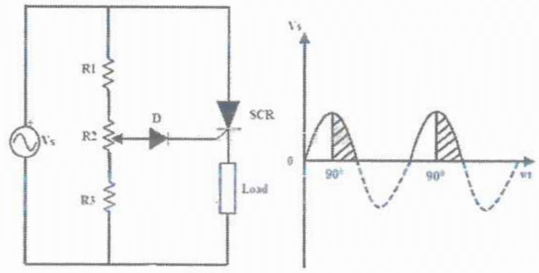
Q No	Scoring Indicators	Split score	Sub Total	Total score
	PART A			**9**
I. 1	○ MOSFET is used for switching and amplifying electronics signals in the electronic devices. ○ It is used as an inverter. ○ It can be used in digital circuit. ○ MOSFET can be used as a high frequency amplifier. ○ It can be used as a passive element e.g. resistor, capacitor and inductor. ○ It can be used in brushless DC motor drive. ○ It can be used in electronic DC relay.	Any two ½ mark each	1	
I. 2	The process of turning off the SCR is called commutation		1	
I. 3	A controlled rectifier is a type of AC to DC converter that provides adjustable DC output voltage from the given AC input supply.		1	
I. 4	Step down cyclo-converters		1	
I. 5	Chopper		1	
I. 6	Spot resistance welding, projection resistance welding, seam resistance welding, flash resistance welding	Any two points (1\2 mark each	1	
I. 7	Uninterruptible Power Supply (UPS)		1	
I. 8	JSR, SBR, RET, JMP, LBL	Any two	1	
I. 9	**AND** 		1	
	PART B			24

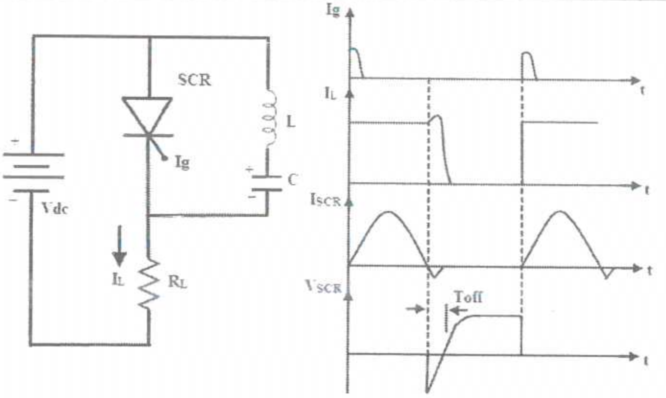
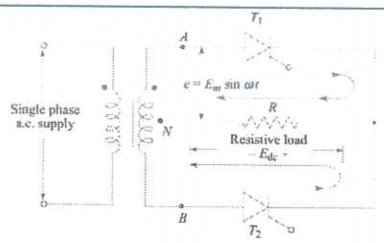
II. 1		VI chara 2 marks + Region of operation 1 mark	3	
II. 2	  V-I Characteristic of a Triac	Circuit symbol 1.5 marks + VI chara 1.5 marks	3	
II. 3	Gate triggering is the method in which positive gate current is flown in forward biased SCR to make it ON. Gate triggering method is mostly used in a Silicon-Controlled Rectifier (SCR).		3	

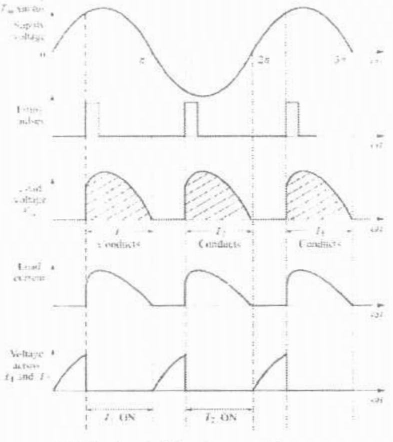
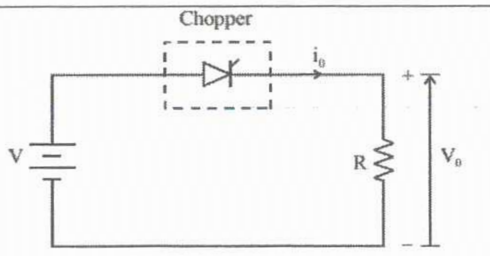
	Gate triggering is, in fact, the most reliable, simple and efficient way to turn on SCR			
II. 4	DC power is connected to a transformer through the center tap of the primary winding. A relay switch is rapidly switched back and forth to allow current to flow back to the DC source following two alternate paths through one end of the primary winding and then the other.		3	
II. 5	• Rolling mills • Ship propulsion drivers • Water pumps • Washing machines • Mine winders • Industries	Any three points 1 mark each	3	
II. 6	A drive is an electrical or electronic device used to control the speed and motion of electrical machines such as motors and robots etc. AC (alternating current drive) converts the AC supply to the DC using converter circuits based on rectifier and invert it back to the AC from DC using inverter to control the speed of electric motors especially three phase motors. A DC drive (direct current drive) is a DC motor speed control system which convert the input AC supply to the DC using converter circuit based on rectifier (diodes and thyristors) to control the speed of DC motors.	AC drive 1.5 marks + DC drives 1.5 marks	3	
II. 7	The principle of operation of a dielectric heating is such that a non-conducting material is present between two electrodes and an external electric field is applied across these two electrodes. The dielectric material which is present between the two electrodes can be anything such as wood, plastic, glass, etc. So, whenever these materials are provided with a high voltage alternating supply then even minute motion of charged particles		3	

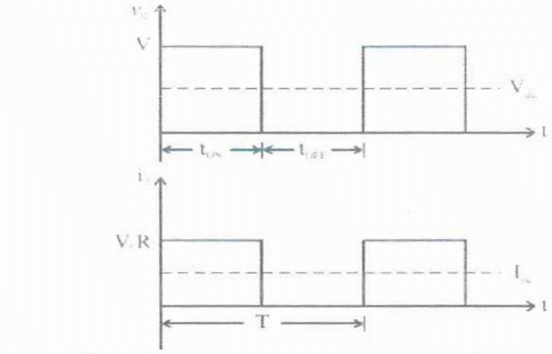
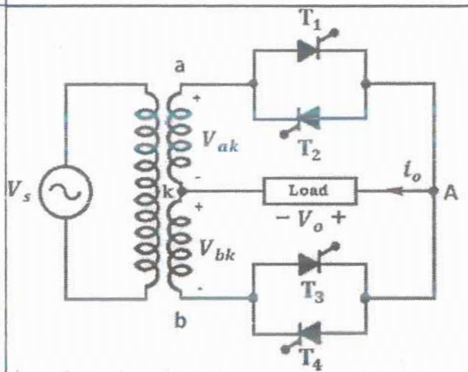
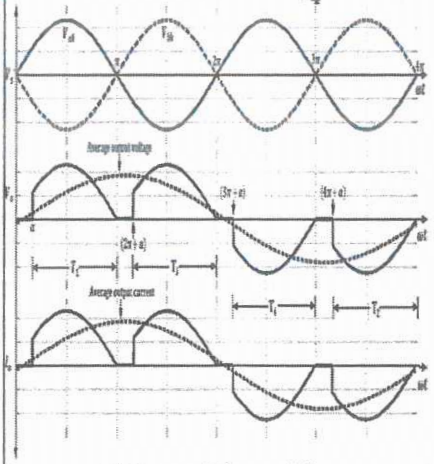
	results in the flow of current which leads to dielectric losses. This resultantly produces heat within the material.			
II. 8	NAND gate  NOR gate 	1.5 marks + 1.5 marks	3	
II.9	Increased reliability More flexibility Lower cost Faster response time Easier to troubleshoot Reusable	Any three point (1 mark each)	3	
II.10	Dual Converters, which can convert AC to DC and DC to AC at the same time. Dual Converter has two converters, one converter works a rectifier (Converts AC to DC) and other converter works as an inverter (converts DC into AC). This converter works as a rectifier when the value of α is less than 90°. When the value of α is greater than 90°, this converter works as an inverter		3	
	PART C			42
III	Triac is switching electronics device has three terminal. it conducts in both the directions, whether the applied gate signal is positive or negative. The three terminal of triac is level by Main Terminal 1 (MT1), Main Terminal 2 (MT2) and Gate (G). 1. **When $MT_2$and Gate terminal are positive with Respect to MT_1** when this happen, the current flow through the path P_1-	Figure (3 marks) + Explain	7	7

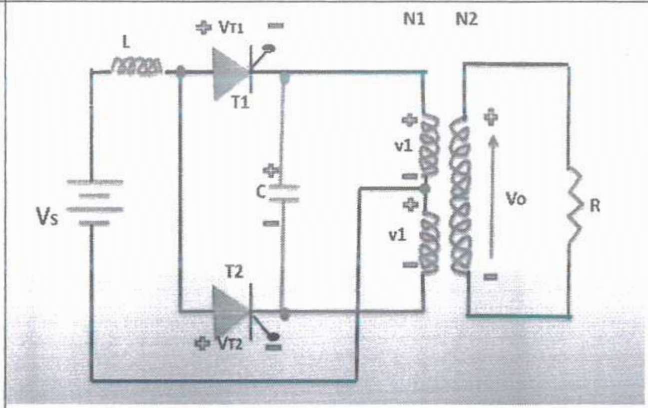
	N_1-P_2-N_2. Where P_1-N_1 and P_2-N_2 are forward biased but N_1-P_2 is reverse biased, and it is said the operated in positively biased region. 2. **When MT$_2$positive and gate is negative with respect to MT$_1$** The path for current flow through the P1-N1-P2-N2. The path P2-N3 is forward the current is injected into P2 on the triac. 3. **3. When MT2and gate both are negative voltage with respect to MT$_1$** The path for current is P2-N1-P1-N4. The P2-N1 and P1-N4 are forward biased but N1- P1 is reverse biased. The triac is called negatively biased. 	4 marks		
IV	**Forward Blocking Mode** In this mode of operation, the Silicon Controlled Rectifier is connected such that the anode terminal is made positive with respect to cathode while the gate terminal kept open. **Forward Conduction Mode** In this mode, SCR or thyristor comes into the conduction mode from blocking mode. It can be done in two ways as either by applying positive pulse to gate terminal or by increasing the forward voltage (or voltage across the anode and cathode) beyond the break over voltage of the SCR **Reverse Blocking Mode** In this mode of operation, cathode is made positive with respect to anode. Then the junctions J1 and J3 are reverse biased and J2 is forward biased. This reverse voltage drives the SCR into reverse blocking region results to flow a small leakage current through it .	Figure 3 marks + Explain 4 marks	7	7

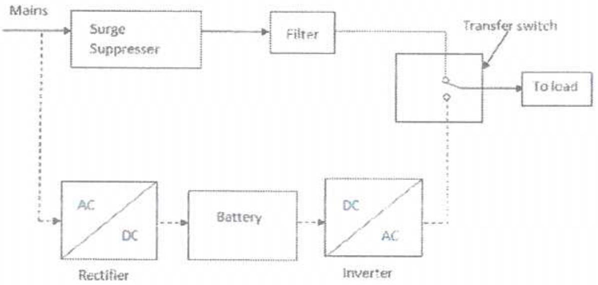
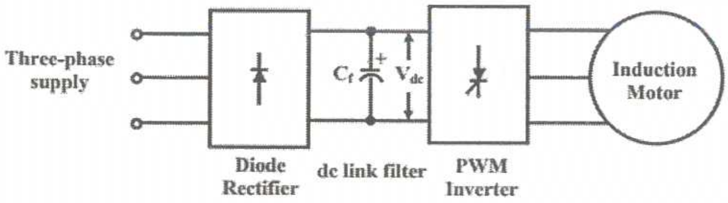
				
V	 Here the Resistance and diode combination circuit acts as a gate control circuitry to switch the SCR in the desired condition. . As the positive voltage applied, the SCR is forward biased and doesn't conduct until its gate current is more than minimum gate current of the SCR. When the gate current is applied by varying the resistance R2 such that the gate current should be more than the minimum value of gate current, the SCR is turned ON and hence the load current starts flowing through the SCR. The SCR remains ON until the anode current is equal to the holding current of the SCR and it will switch OFF when the voltage applied is zero. In this, the triggering angle is limited to 90 degrees only. Because the applied voltage is maximum at 90 degrees so the gate current has to reach minimum gate current value somewhere between zero to 90 degrees.	Figure 2 marks + Explain 5 marks	7	7

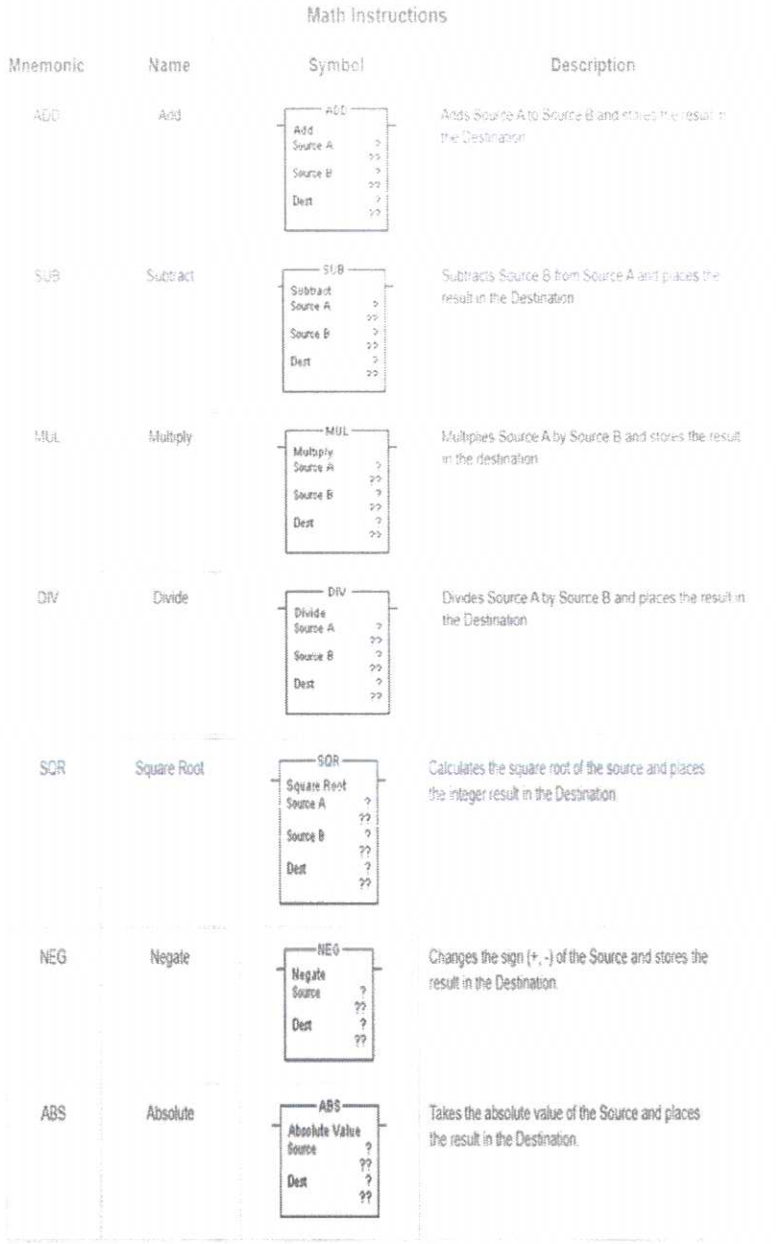
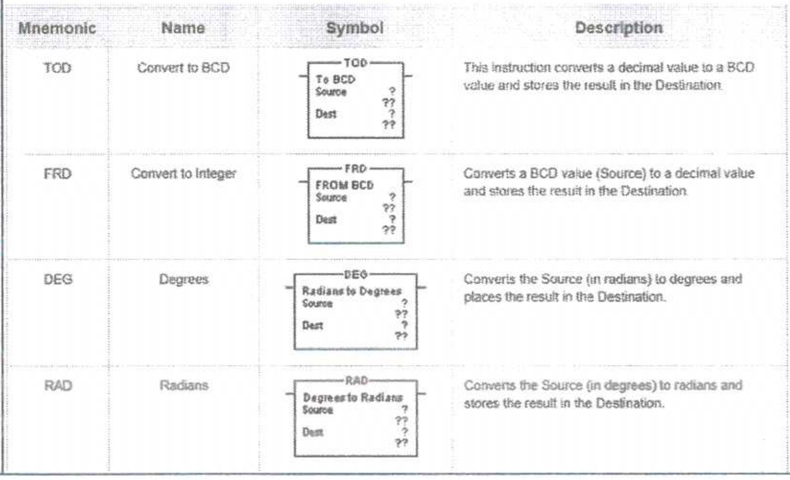
VI	 This is also a self commutation circuit in which commutation of SCR is achieved by a resonating LC. In Class B Commutation , the LC resonant circuit is connected across the SCR but not in series with the load When a DC supply is applied to the circuit, the capacitor charges up to V_{dc}, with an upper plate positive and lower plate negative. When the SCR is triggered, the current flows in two directions: one is through $V_{dc+} – SCR – R – V_{dc–}$ and the another one is the commutating current (I_C) through L and C components. When the SCR is turned ON, the capacitor starts discharging in the path $C_+ – L – SCR – C_–$. When the capacitor is fully discharged, it starts charging with a reverse polarity. As a result of the reverse voltage, a commutating current I_C, will flow in the opposite direction of the load current I_L. When the commutating current I_C becomes higher than the load current, the SCR will automatically turn OFF and the capacitor charges with its original polarity	Figure 3 marks + Explain 3 marks + Waveform 1 mark	7	7
VII	 Fig.1 *Full-wave mid-point circuit with resistive load*	Figure 3 marks + Waveform 1 mark + Explain 3 marks	7	7

	 Fig.2 Waveforms for M-2 configuration with resistive load During the positive half-cycle of the a.c. supply, i.e. when terminal *A* of the transformer is positive with respect to terminal B,, or the secondary-winding terminal *A* is positive with respect to N. Here SCR1(T1) is forward-biased and SCR2(T2) is reverse-biased. Since no triggering pulses are given to the gates of the SCRs, initially they are in off-state. When SCR1 is triggered at a firing-angle α, current would flow from terminal *A* through SCR1, the resistive load *R* and back to the centre-tap of the transformer T. This current continuous to flow up to angle ππ when the line voltage reverses its polarity and SCR1 is turned-off. During the negative half-cycle of the a.c. supply, the terminal *B* of the transformer is positive with respect to N. Here SCR2 is forward-biased When SCR2is triggered at an angle (π+α),current would flow from terminal B, through SCR2, the resistive load and back to centre-tap of the transformer. This current continues till angle 2π, then SCR2 is turned off.			
VIII	 Fig. 2.1: Step-down Chopper with Resistive Load	Figure 3 marks + Waveform 1 marks + Explain 3 marks	7	7

	 Fig. 2.2: Step-down choppers — output voltage and current waveforms In step-down choppers, the output voltage will be less than the input voltage whereas in step-up choppers output voltage will be more than the input voltage. When thyristor is ON, supply voltage appears across the load and when thyristor is OFF, the voltage across the load will be zero.			
IX	  When "a" is positive with respect to "k" in figure 1 during positive half cycle of supply voltage, forward biased thyristor T_1 is triggered at $\omega t = \alpha$. With this, load current i_o starts flowing in the positive direction from "A" to "k". Load current i_o is shown in figure 2. Thyristor T_1 remains on till $\omega t = \pi$. At $\omega t = \pi$ the load current is zero as supply voltage falls to zero and hence T_1 is commutated at π. After π, negative cycle of supply starts hence "b" is positive	Figure 3 marks + Waveform 1 marks + Explain 3 marks	7	7

	with respect to "k" thereby forward biasing thyristor T_3. T_3 is triggered at $\omega t = \pi + \alpha$. Load voltage now follows V_{bk} as shown in figure 2. At $\omega t = 2\pi$ thyristor T_3 is commutated. After such two positive half cycles of load voltage and load current, thyristor T_4 is gated at $(2\pi + \alpha)$ when "k" is positive with respect to "b". As T_4 is forward biased, it starts conducting but load direction is reversed, i.e. it is now from "k" to "A". At $\omega t = 3\pi$, thyristor T_4 is naturally commutated and load current goes to zero as shown in figure 2. In a sequence at $\omega t = 3\pi + \alpha$, T_2 is triggered as "k" is positive with respect to "a" and then thyristor T_2 starts conducting and load voltage and current will be negative as shown in figure 2 In this manner, two negative half cycles of load voltage and current, equal to the two positive half cycle, are generated as shown in figure 2.			
X	 **Mode 1** The mode 1 begins when the SCR T1 is turned on and a current flow through the inductor and SCR T1 and the upper half of the primary winding as shown in the figure. When the SCR T1 is turned on, the DC voltage Vs appears across the upper half oh the primary winding. This current establishes magnetic flux and it links with both the half of the primary winding. Then the total voltage in primary is 2Vs and the capacitor in charged with the polarity of upper plate as positive . **Mode 2** This mode begins when the SCR T2 is turned on. When T2 is turned on , the capacitor applies a reverse voltage to the SCR T1. When this reverse voltage is applied for a sufficient time across T1, it will be turned off. Then the SCR T2 will now conduct and a voltage of 2Vs will appear across the transformer primary winding and the	Figure 3 marks + Explain 4 marks	7	7

	capacitor. Now the capacitor will again charges from +2Vs to – 2Vs with upper plate negative. **Mode 3** During this mode , the SCR T1 is again turned on. When the SCR T1 is turned on, the capacitor applies a reverse voltage to SCR T2 . when this reverse voltage is applied for a sufficient time across SCR T2, it will be turned off. Thus if the two SCR' s T1 and T2 are turned on and turned off alternatively , an AC voltage will be obtained across the output terminals			
XI	 Figure 1 - This UPS is also called as Standby UPS system - Here, the primary source is the filtered AC mains (shown in solid path in figure). When the power breakage occurs, the transfer switch will select the backup source (shown in dashed path in figure). - 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	Figure 4 marks + Explain 3 marks	7	7
XII	 The variable voltage variable frequency supply for an induction motor drive consists of a uncontrolled or controlled rectifier (fixed voltage fixed frequency ac to variable/fixed voltage dc) and an inverter (dc to variable voltage/variable frequency ac). If rectification is uncontrolled, as in diode rectifiers, the voltage and frequency can both be controlled in a pulse-width-modulated (PWM) inverter	Figure 4 marks + Explain 3 marks	7	7

XIII	 	Any 7 (1 mark each)	7	7

Math Instructions

Mnemonic	Name	Symbol	Description
ADD	Add	ADD Add Source A ? ?? Source B ? ?? Dest ? ??	Adds Source A to Source B and stores the result in the Destination
SUB	Subtract	SUB Subtract Source A ? ?? Source B ? ?? Dest ? ??	Subtracts Source B from Source A and places the result in the Destination
MUL	Multiply	MUL Multiply Source A ? ?? Source B ? ?? Dest ? ??	Multiplies Source A by Source B and stores the result in the destination
DIV	Divide	DIV Divide Source A ? ?? Source B ? ?? Dest ? ??	Divides Source A by Source B and places the result in the Destination
SQR	Square Root	SQR Square Root Source A ? ?? Source B ? ?? Dest ? ??	Calculates the square root of the source and places the integer result in the Destination
NEG	Negate	NEG Negate Source ? ?? Dest ? ??	Changes the sign (+, -) of the Source and stores the result in the Destination
ABS	Absolute	ABS Absolute Value Source ? ?? Dest ? ??	Takes the absolute value of the Source and places the result in the Destination

Mnemonic	Name	Symbol	Description
TOD	Convert to BCD	TOD To BCD Source ? ?? Dest ? ??	This instruction converts a decimal value to a BCD value and stores the result in the Destination.
FRD	Convert to Integer	FRD FROM BCD Source ? ?? Dest ? ??	Converts a BCD value (Source) to a decimal value and stores the result in the Destination.
DEG	Degrees	DEG Radians to Degrees Source ? ?? Dest ? ??	Converts the Source (in radians) to degrees and places the result in the Destination.
RAD	Radians	RAD Degrees to Radians Source ? ?? Dest ? ??	Converts the Source (in degrees) to radians and stores the result in the Destination.

XIV	**Large Quantities of Contacts** – The PLC has a large number of contacts for each coil available in its programming . **Lower Cost** – Increased technology makes it possible to condense more functions into smaller and less expensive packages **Pilot Running** – A PLC programmed circuit can be evaluated in the lab. The program can be typed in, tested, observed, and modified if needed, saving valuable factory time. **Reliability and Maintainability** – Solid-state devices are more reliable, in general, than mechanical systems or relays and timers. **Visual Observation** – A PLC circuit's operation can be seen during operation directly on a CRT screen. **Easy expandability.** For adding functionality to a PLC one can just add it to the programme and set up the constraints, where a relay system needs the new physical component added and the necessary wiring to make it work. **Smaller size**. The space required for a PLC system vs the cabinet needed for a relay logic circuitry is much smaller. – The operation or mis-operation of a circuit can be observed as it happens. – PLCs are programmable – Many control relays can be replaced by software, which means less hardware failure, – It is easier to make changes in software than in hardware. – Special functions such as time delay actions, counters are easy to produce in software.	Any 7 Points (1 mark each)	7	7