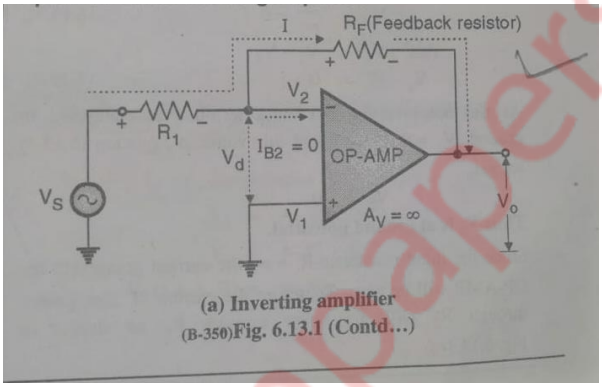
INDUSRIAL ELECTRONICS SOLUTION

SEM 4(CBCGS –MAY 2018)

BRANCH – MECHANICAL ENGINEERING

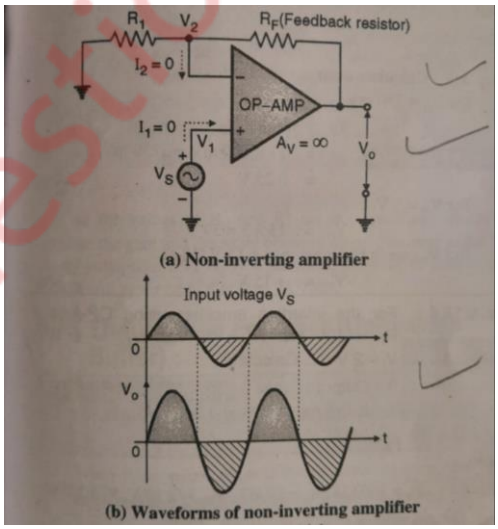
Q1] A) Draw an inverting and non-inverting amplifier. Write their gain equations. (5)



(a) Inverting amplifier

(B-350)Fig. 6.13.1 (Contd...)

$A_{VF} = -(IR_F / IR_1) = -(R_F / R_1)$



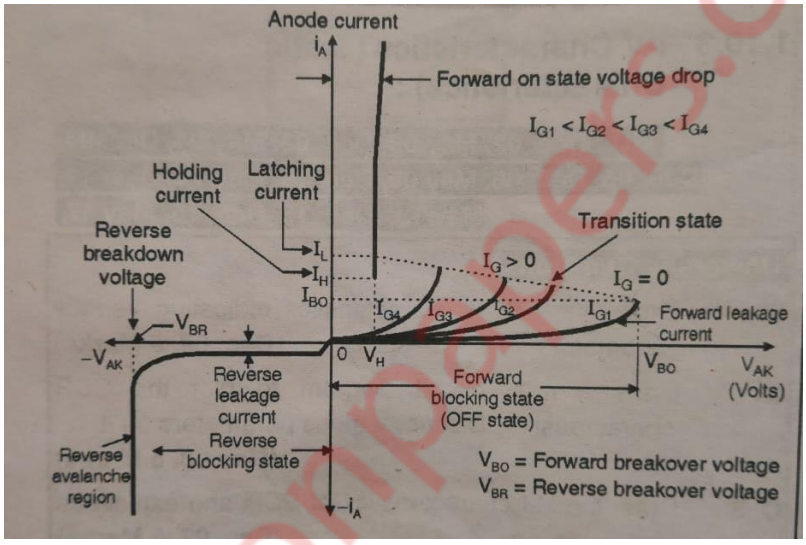
(a) Non-inverting amplifier

(b) Waveforms of non-inverting amplifier

$A_{VF} = (V_O/V_S) = (R_1+R_F) / (R_1) = 1+ (R_F/R_1)$

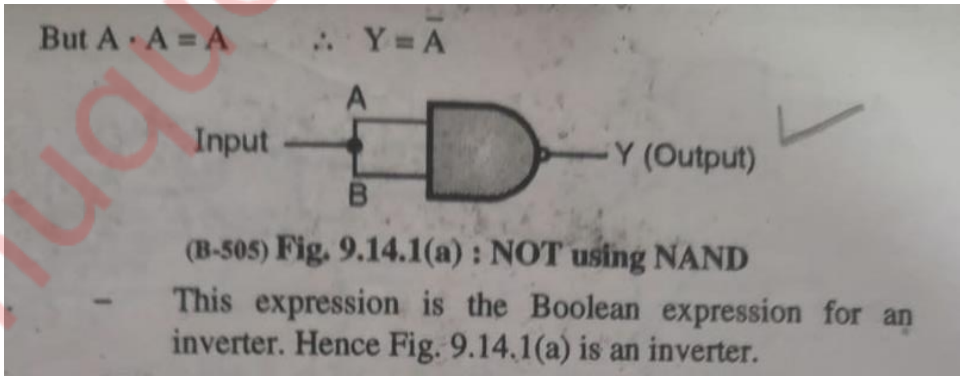
Q1] B) Draw V-I characteristics of SCR and define the terms latching current and holding current. (5)

- Holding current represents the minimum current that flow through a SCR and still hold it in the ON state.
- Latching current is the minimum anode current that must flow through SCR to latch it into on state
- The latching current is always higher than holding current.
- The latching current is important when the SCR is being turned ON.

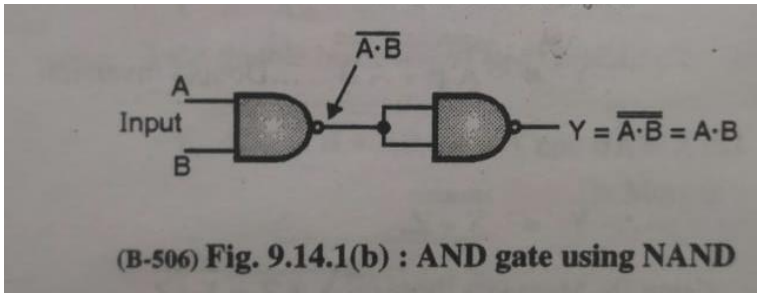


Q1] C) Implement basic gates using NAND gate. (5)

[1] NOT GATE

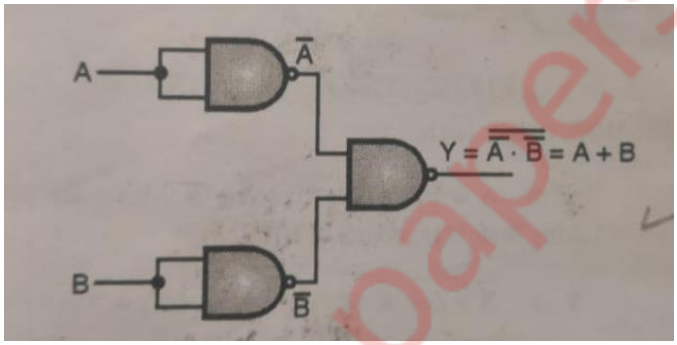


[2] AND GATE



(B-506) Fig. 9.14.1(b) : AND gate using NAND

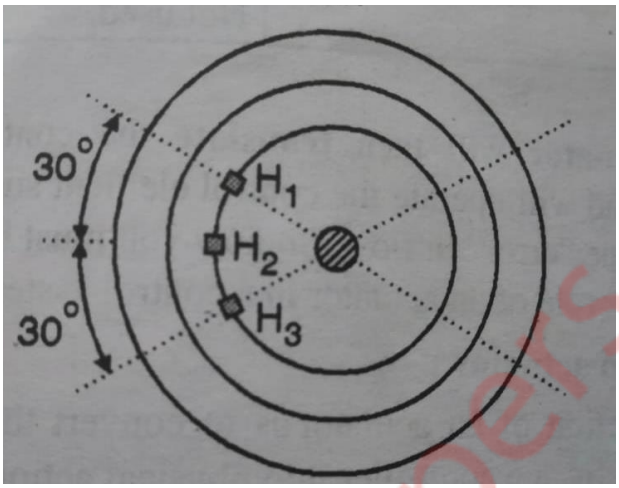
[3] OR GATE

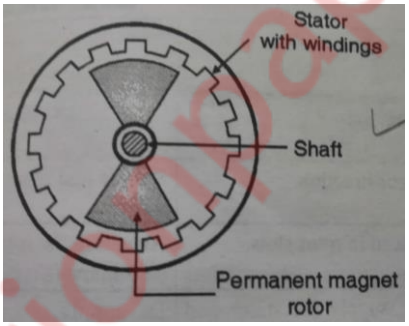


Q1] D) What is BLDC motor? List its applications. (5)

- The term brushless DC motor is applicable to many configurations of AC synchronous motors in which semiconductor control is used for controlling the stator current in such a way that maximum torque is obtained at a given speed.
- The construction of a BLDC motor which shows that its construction is similar to that of a permanent magnet synchronous motor.
- The stator has a three phase winding while rotor is in the form of permanent magnets.
- The BLDC motor also consists of rotor position sensors which produce electrical signal that indicate the current position of the rotor.
- The BLDC motor stator winding is driven from an electronic drive which is basically a transistorised three phase inverter.
- The base driving signal of transistors connected in the three phase inverter obtained from the rotor position sensors.

- Speed of the BLDC motor can be controlled by controlling in its stator voltage which can be achieved by controlling the DC input voltage of the inverter.
- The field produced by stator and rotor remains stationary with respect to each other.
- The torque speed characteristic is similar to that of DC motor.





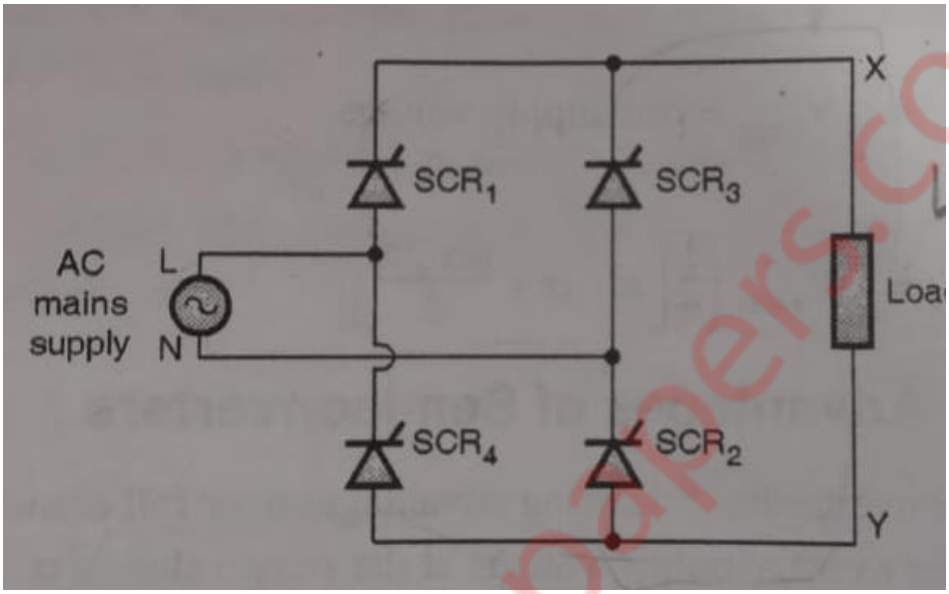
APPLICATIONS:

[1] Computer peripheral equipments.
[2] Spindle drivers in hard disk drives in computer.
[3] Turn table drive ine record player.
[4] Instrumentation and control systems.
[5] Electric power steering.
[6] Air conditioners.
[7] Biomedical instruments.
[8] In the field of aerospace.

Q1] E) Compare Microprocessor and Microcontroller. (5)

SR. NO.	Microprocessor	Microcontroller
1	Microprocessor is a general purpose device which is called a CPU.	A microcontroller is a dedicated chip which is also called a single chip computer.
2	Microprossre do not contains I/O terminals, timers, memories, etc.	A microcontroller includes RAM, ROM, serial and parallel interface, timers, interrupt circuitry in a single chip.
3	Microprocessor are most commonly used as the CPU in microcontroller system.	Microcontrollers are used in small, minimum component designs performing control-oriented applications.
4	Microprocessor instruction sets are mainly intended for catering to large volumes of data.	Microcontroller instructions are both bit addressable as well as byte addressable.
5	This design is complex and expensive.	Microcontrollers have instruction sets catering to the coontrols of input and output.
6	The instruction set of microprocessor is complex with large number of instructions.	Microconttroler based system design is rather simple and cost effective.
7	A microprocessor has zero status flag.	A microcontroller has non zero flag.

Q2] A) **Draw and explain single phase full wave fully controlled rectifier with the help of waveforms for R load.** **(7)**

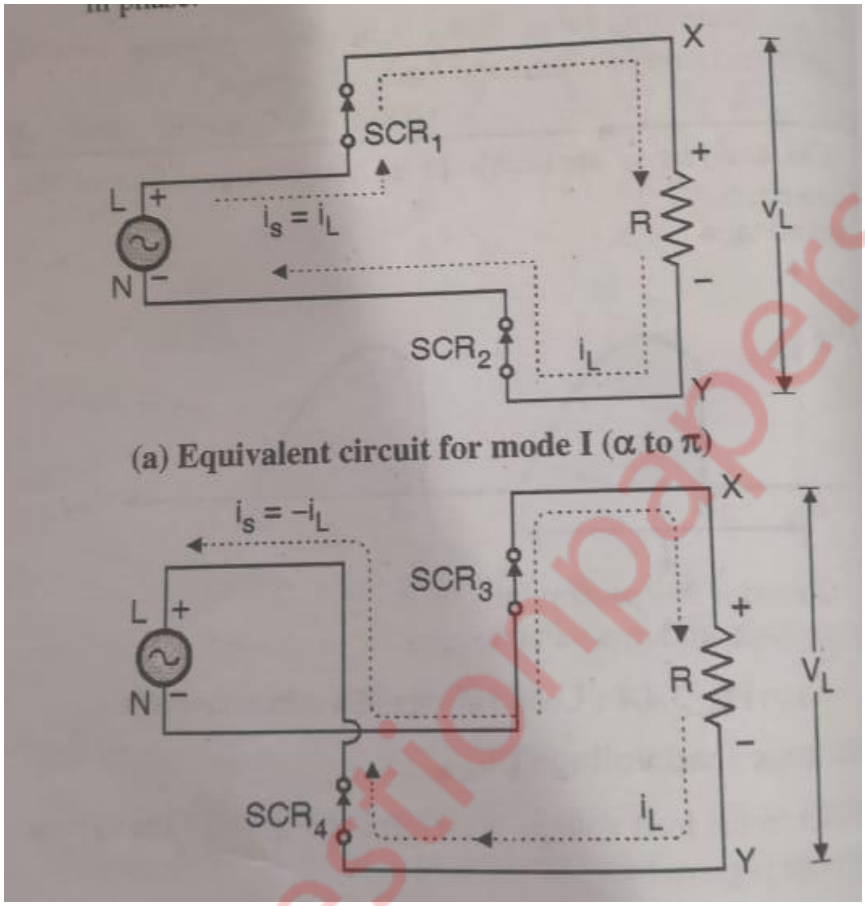


- If the two diodes in the semi converter circuit are replaced by two SCR then we obtain the full bridge converter configuration.
- The full converter configuration consists of 4 SCRs.
- At any given instance two SCRs conduct simultaneously to connect the load across the input AC supply.
- This configuration is also called as B2 configuration.

Mode 1:

- In the positive half cycle of the input AC mains voltage the thyristors SCR 1 and SCR to are forward biased and hence can be turned on a desired value of firing angle α.
- The current flow from L through SCR1, load R, SCR2 back to N as shown

- The load current is positive and has the same shape as that of AC main input voltage
- The load voltage and load current are in phase
- At instance π the supply voltage goes to zero. The load current also becomes zero and the conducting SCR, SCR1 and SCR2 turn off due to natural commutation.



(a) Equivalent circuit for mode I (α to π)

Mode2:

All the SCRs remains off during the period. The load voltage and the current load are zero during this mode of operation.

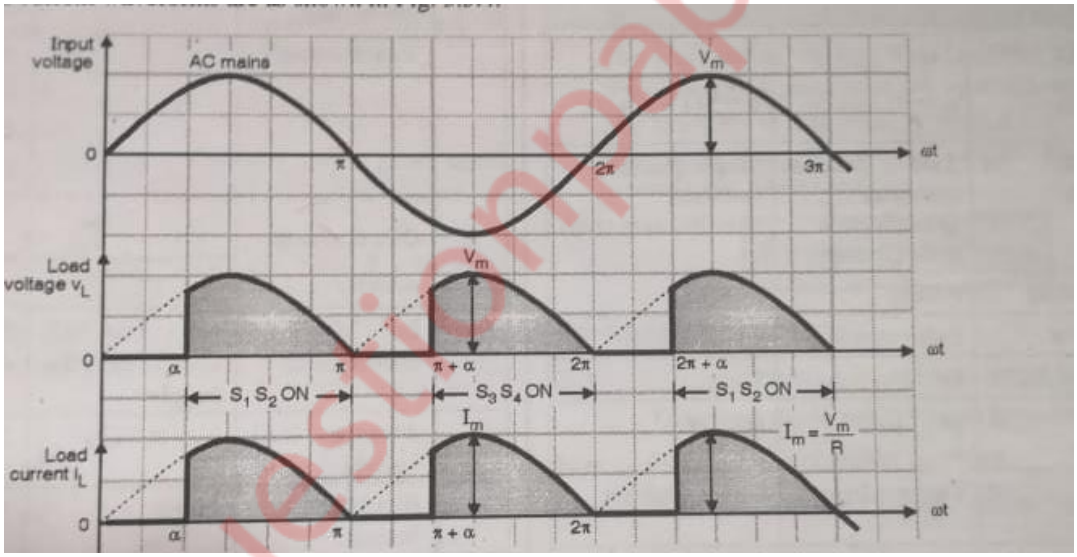
Mode 3:

- The AC input voltage becomes negative after π.

- This makes SCR 3 and SCR 4 forward biased. This SCR are turned on at π + α in the negative half cycle of AC mains voltage.
- The current flows from N through SCR3, load R, SCR IV back to L as shown in the figure
- The load still remains positive and equal to instantaneous supply voltage. The load current is positive but the supply current changes its direction and becomes negative.
- During this interval all the SCR remain off. The load voltage and load current are zero during this mode of operation during this mode of operation.

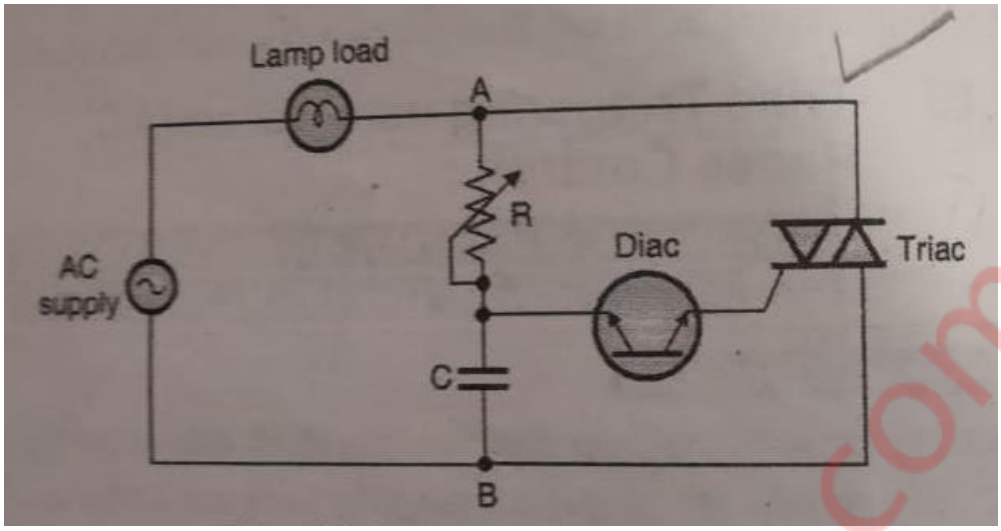
Mode 4:

During this stage all the SCRs remain OFF.

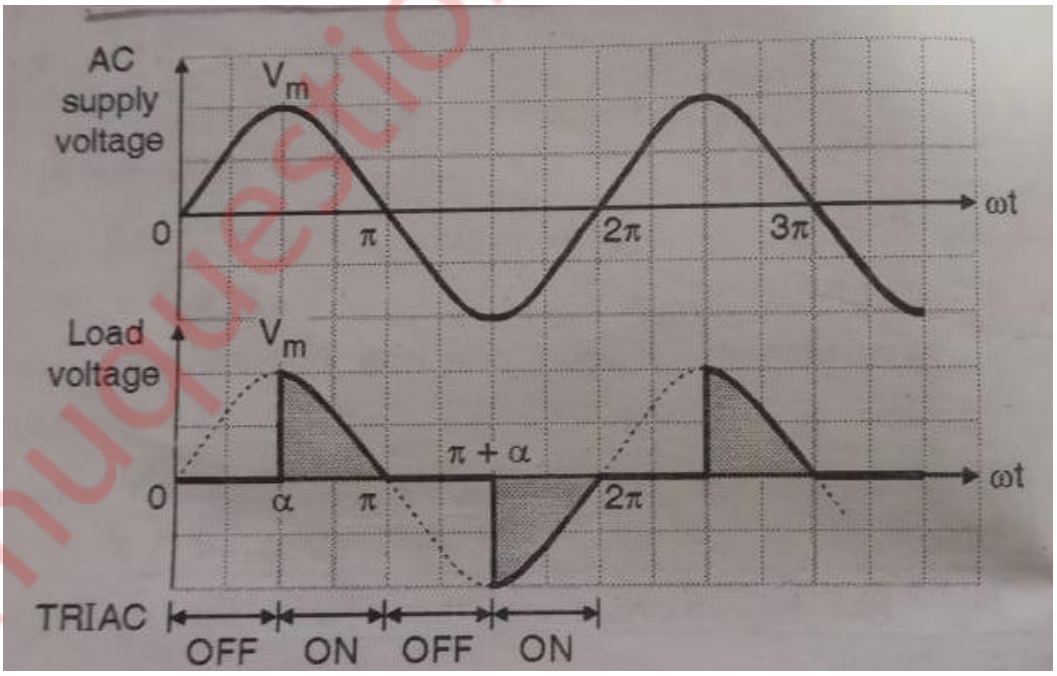


Q2] B) Illustrate how a DIAC-TRIAC pair can be used for controlling the illumination of bulb. (7)

- The light incident intensity can be changed by changing the firing angle Alpha. As Alpha increases, the light intensity will decrease. Therefore "R" acts as an intensity control.



- In the positive half cycle of the input AC supply voltage the live point L
- is positive with respect to the neutral point N. The charging current for the capacitor C_1 flows through R_1 as shown.
-
- As soon as the voltage across C_1 reaches the break over voltage of the DIAC, it is turned ON supplies gate current for the triac to turned ON.



- The conducting track is equivalent to a closed switch. Show the R_1C_1 and DIAC circuit is short circuited.

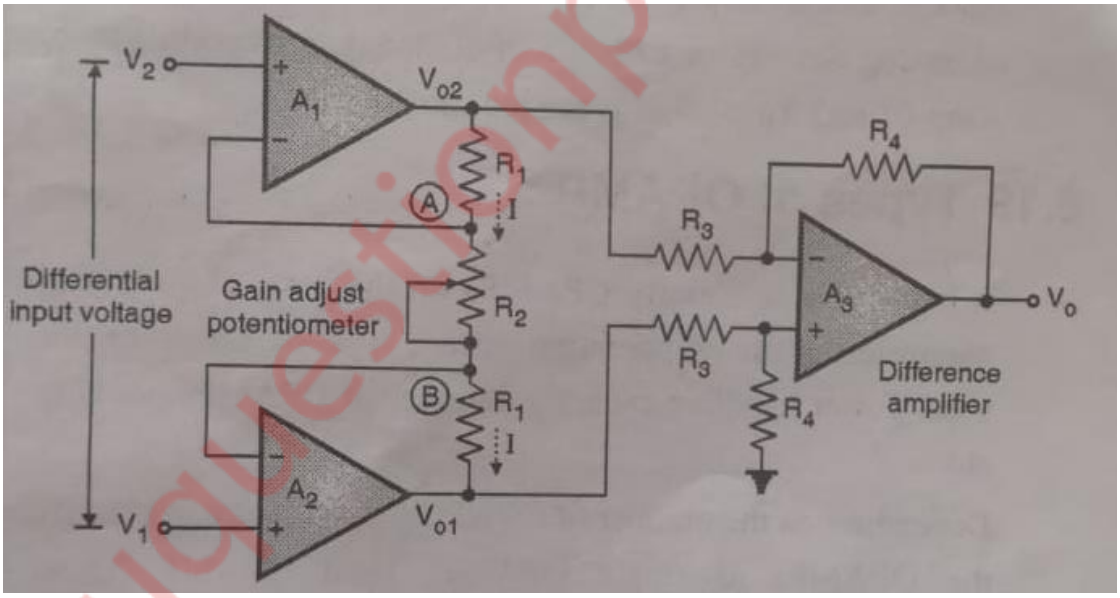
- The load voltage is equal to instantaneous supply voltage.
- Similar is for the negative half cycle of AC supply
- Thus DIAC being a bi-directional device can turn ON the TRIAC in both half cycle of input AC supply.
- The capacitor C1 must be non-polarized capacitor, being capable of charging to positive as well as negative voltages.

Q2] C) Compare AC and DC motors. (6)

AC MOTORS	DC MOTORS
Ac motors are powered from AC current.	DC motors are powered from DC current.
Conversion of current is not required.	Conversion of current from dc to ac is required.
AC motors are used where power performance is sought for extended period of time.	DC motors are used were motor speed required to be controlled externally.
It can be used with single or three phase.	All dc motors are single phase.
In ac motors armature remains stationary whereas magnetic field continuously rotates.	In DC motors armature rotates while magnetic field dose not rotates.
Maintenance and repairing if AC motors is not costly.	Maintenance and repairing of dc motors is costly.
AC motors do not use brushes.	DC motors uses brush.
It has long life span.	It has a shorter life span.
It is controlled by varying speed of current.	Speed can be varied by varying armature winding current.
It requires a starting device.	It don't any external starting device.

Q3] A) Explain instrumentation amplifier. List its applications. (7)

- In many Industrial and consumer application the measurement and control of quantities such as pressure, humidity, temprature etc. are required.
- A transducer is used to convert this quantities into a proportional electrical signal first.
- Output of the transducer is then applied to an amplifier called ''instrumentation amplifier''.
- This amplifier amplifies the low level output signal of the transducer to such a level that it can drive the indicator for display.
- The transducer is generally connected in a bridge circuit
- Its output is amplified using a low noise amplifier and through shielded cables it is applied to an instrumentation amplifier.
- Output of the instrumentation amplifier is amplified version of its input.



- The high impedance in instrumentation amplifier using cross coupled difference amplifier is shown in the figure
- A_1 and A_2 are basically non inverting amplifier with their inverting terminal (-ve) has been connected to R2 instead of connecting it to ground.

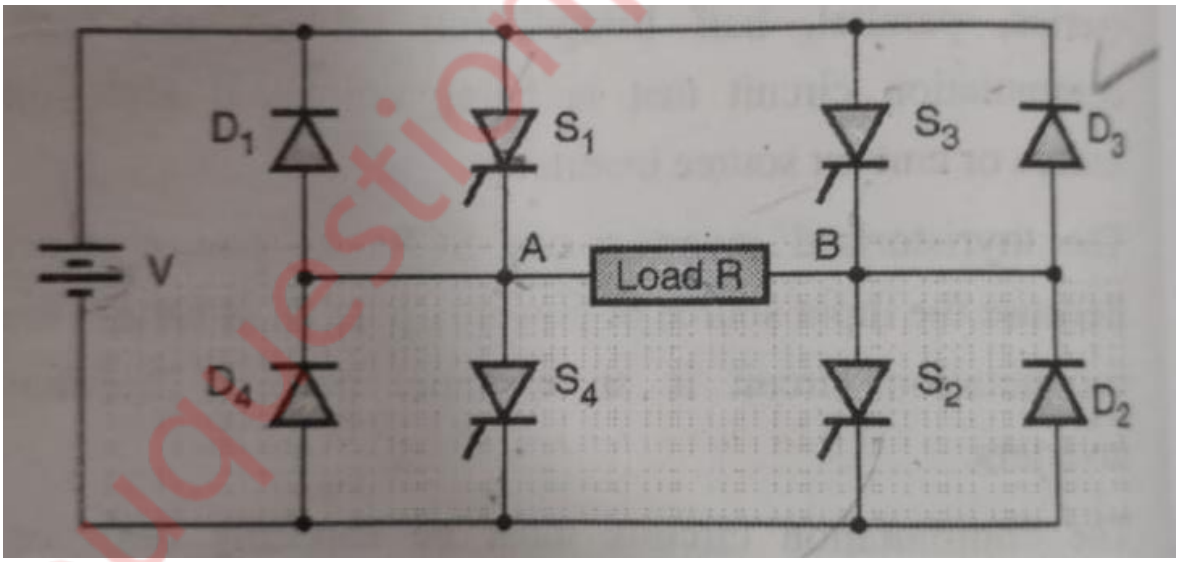
- The input impedance of all opens are used is assumed to be infinity, their input current are zero.
- The second stage OP-AMP is a difference amplifier. It amplifies the difference voltage ($V_{01} – V_{02}$)

APPLICATIONS:

Instrumentation amplifier can be used for other applications such as electronic weighing scale, light intensity metre, pressure monitor and control.

Q3] B) with neat Circuit diagram and waveform, explain the working principle of single phase bridge inverter circuit. (7)

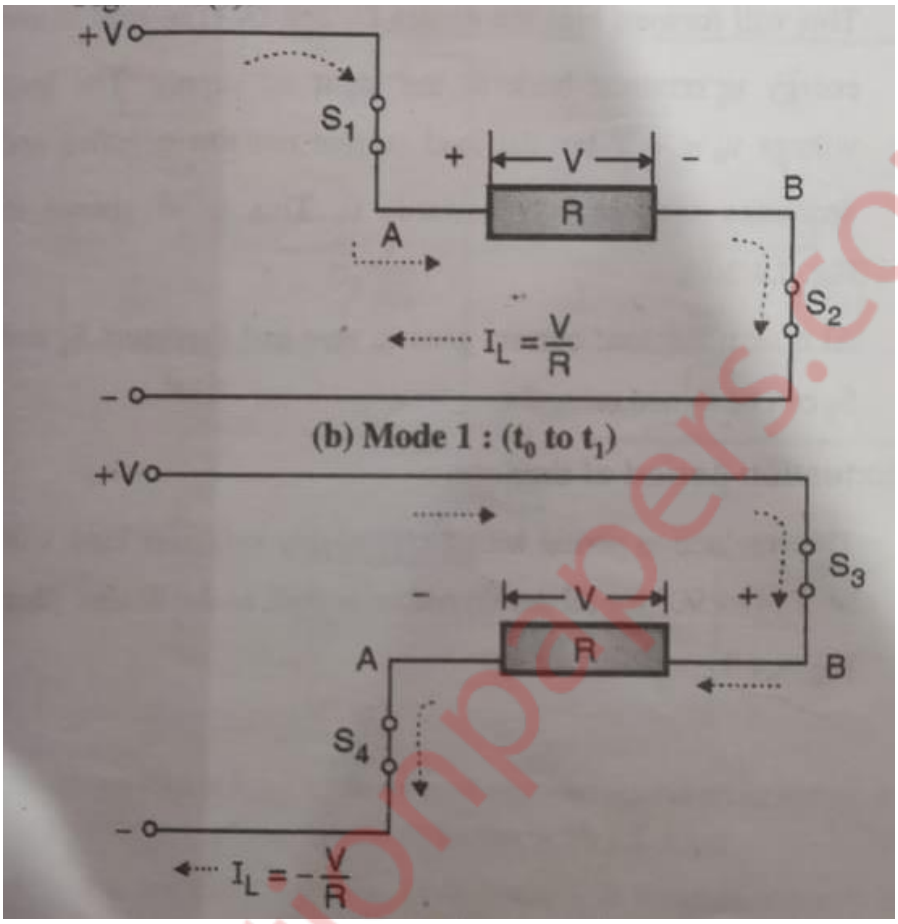
- The basic circuit of the single phase bridge without the communication components is shown in the figure
- The SCRs are turned on in pairs first S_2 and S_1 conduct simultaneously and then S_3 and S_4 conduct simultaneously.



Mode 1

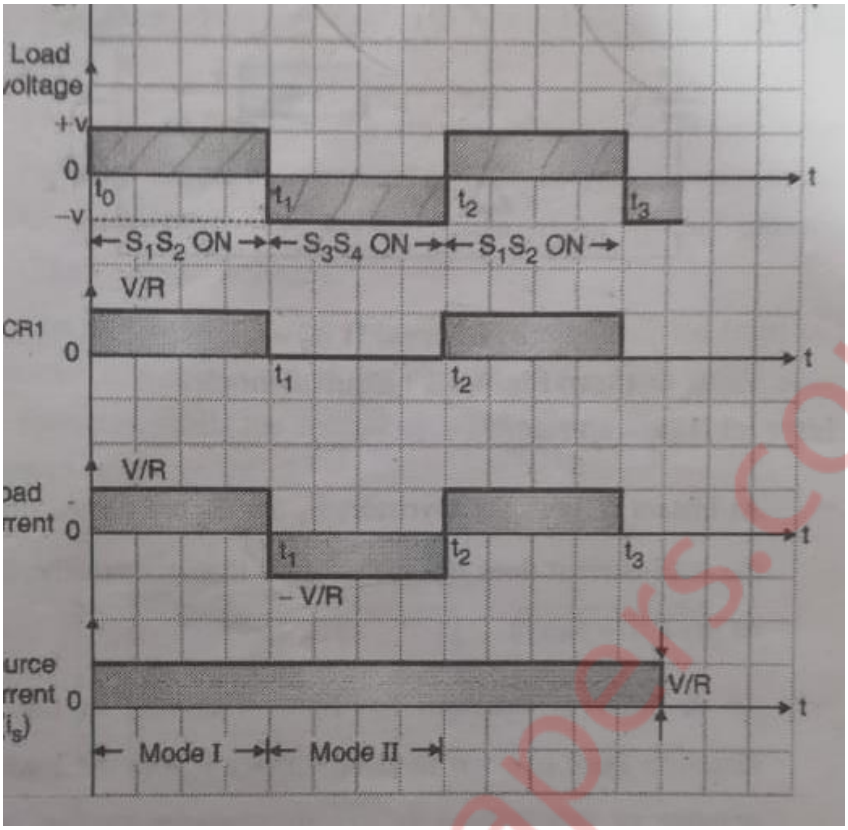
- With resistive load SCR 1 and 2 are turn on at instance t = t0
- This will connect point A of the load to positive end of the DC source voltage V and B to negative end of the source.

- The load voltage $V_{A\,B}$ =V. The load current flow from A to B and its amplitude is constant equals to $I_L = V_{A\,B} / R$. where R is the load resistance.



Mode2

- In order to reverse the voltage polarities and load current directions, SCR_1 and SCR_2 are turned off and SCR_3 and SCR_4 are turned ON. At the instant $t = t_1$.
- This will make $V_A = -V$
- This load current now flows from B to A.



Q3] C) Select motors for medium power pump and conveyor applications. **(6)**

[1]Medium pressure pump

- single phase induction motor
- three phase induction motor
- DC shunt motor are used

[2]Conveyor applications

- Perfect constant speed application the AC motors and gear motors are well suited.
- For applications with speed control higher speeds are maximum torque in small area needed AC motors and brushless DC motor are used full stop
- For precious position in the stepper for servo motors are ideal.

Q4] A) List the different applications of a microcontroller. Explain any one in detail. (7)

APPLICATIONS

- Toys, cameras, video recorders
- CD players
- TVs
- Microwave ovens
- Washing Machine
- Vacuum cleaners
- Garage Door Opener
- Home security system

Temperature measurement

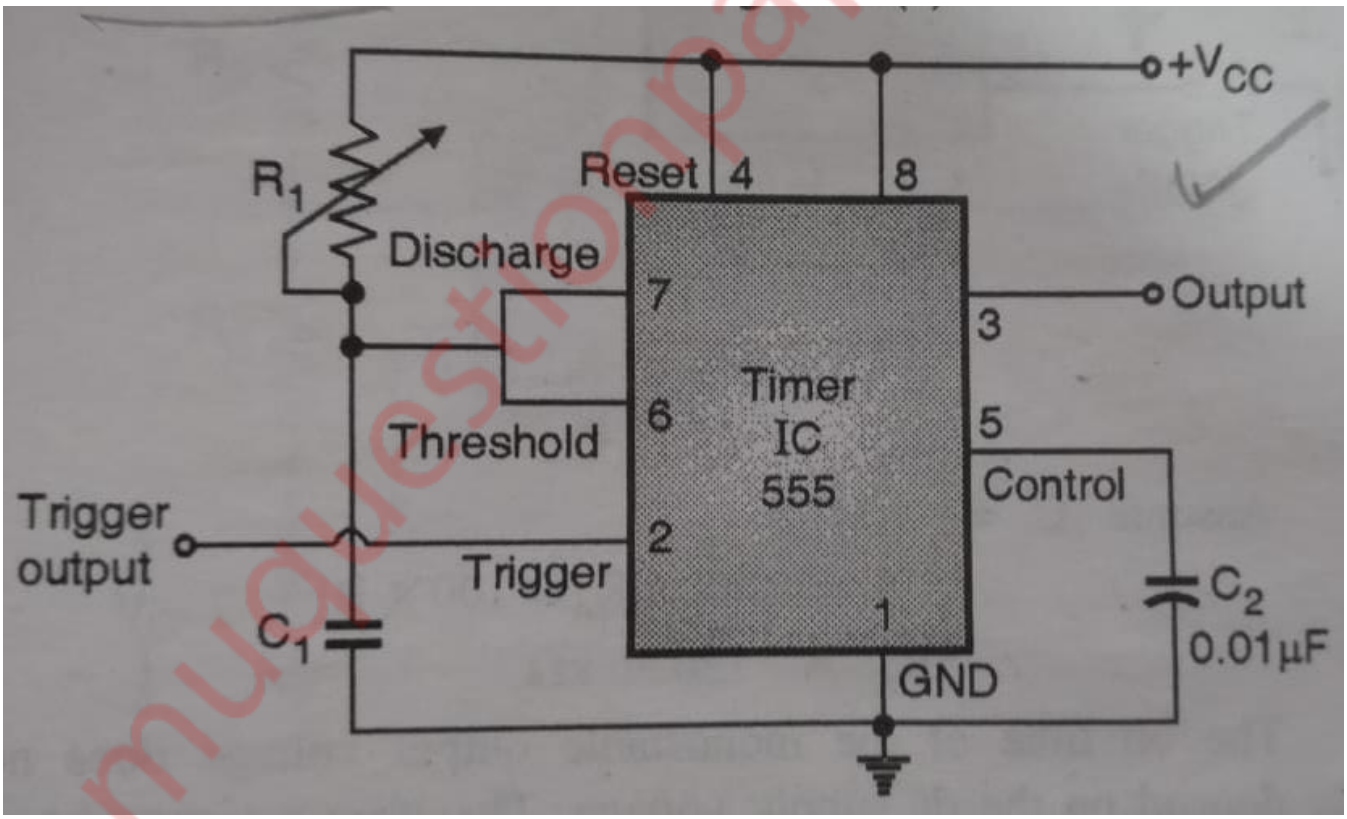
- Temperature is the most measured process variable in the industrial automation. Most commonly, a temperature sensor is used to convert temperature value to an electrical value of temperature sensors are the key to read a temperature correctly and to control temperature in industrial applications.
- The LM 34 are precision integrated circuit temperature sensor, whose output voltage is linearly proportional to the fahrenheit temperature.
- The LN 35 are precision integrated circuit temperature sensors, whose output voltage is nearly proportional to the Celsius temperature.
- LN 34 / 35 has an advantage over linear temperature sensor calibrated in degree Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Fahrenheit scale.
- the LN35 does not require any external calibration or trimming to provide typical accuracy of plus or minus 1/4degree Celsius at room

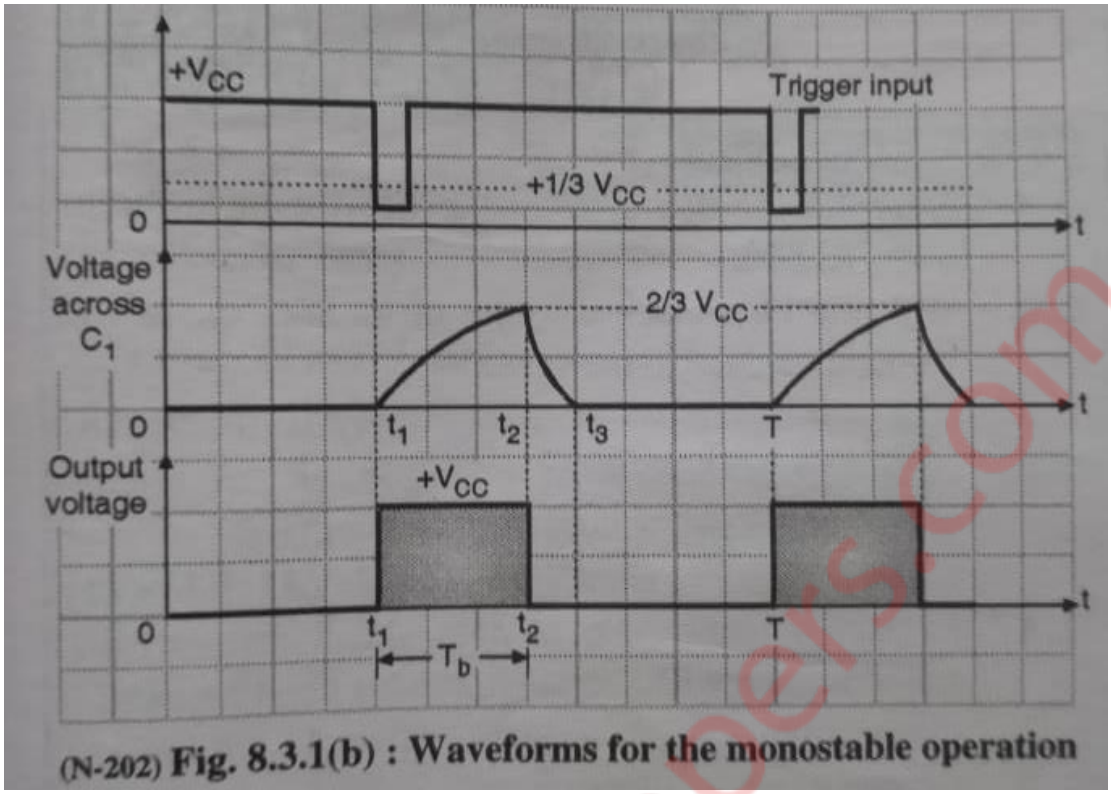
temperature and plus or minus 3/4 degree Celsius over full -55 to + 150 degree Celsius temperature range.

- LM35 is rated to operate over -55 degree Celsius to + 150 degree Celsius temperature range.

Q4] B) Explain with block diagram IC 555 timer as monostable multivibrator. (7)

- The circuit configuration for a monostable multivibrator using IC 555 is shown in the figure
- This is known as a monostable circuit because it has only one stable state.
- R1 and C1 are the externally connected components which decide the ON time of the output.
- This circuit can be actually used as timer.





(N-202) **Fig. 8.3.1(b) : Waveforms for the monostable operation**

-Interval (1 to t1)

This interval the trigger input is held high to and voltage of plus VCC. Therefore the internal transistor T1 is ON, hence the capacitor c cannot charge. The discharge threshold and output terminals will be at low level.

-Interval (t1 to t2)

A negative going pulse is applied to the trigger input terminal at the instant t = t1. As soon as a trigger input voltage goes below 1/3 VCC, the trigger comparator output becomes high.

It set the SR flip-flop inside the IC 555 to make the output high. At the same time transistor t1 is turned off and the capacitor start charging through a resistance R_A. The charging of the capacitor C is exponential as shown in the figure. The output voltage will remain high during this interval (t1-t2)

- Interval t2 to t3

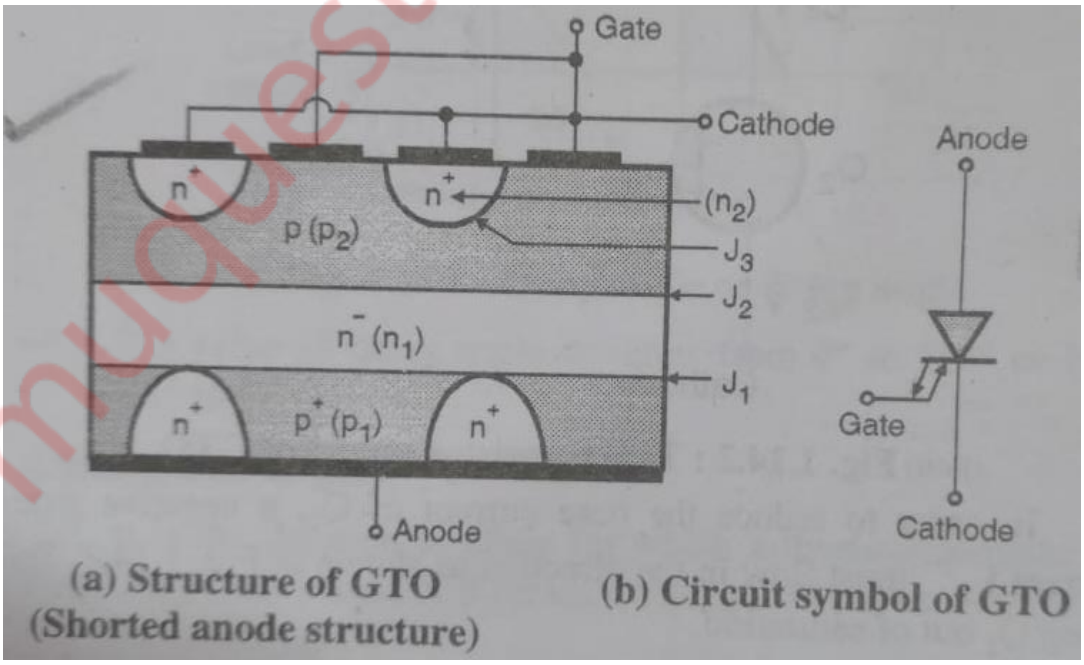
At instant t2, voltage on the capacitor is equal to 2 / 3 VCC. As soon as voltage tries to go beyond this level, the upper comparator output goes high. This will reset the SR flip flop and turn on the transistor T1. Therefore the output voltage at pin number 3 will go to zero at instant t2 and the capacitor C discharges transistor T1 exponentially. At t = t3 the capacitor is completely discharged and voltage across it is zero volt.

- Interval t3 to T

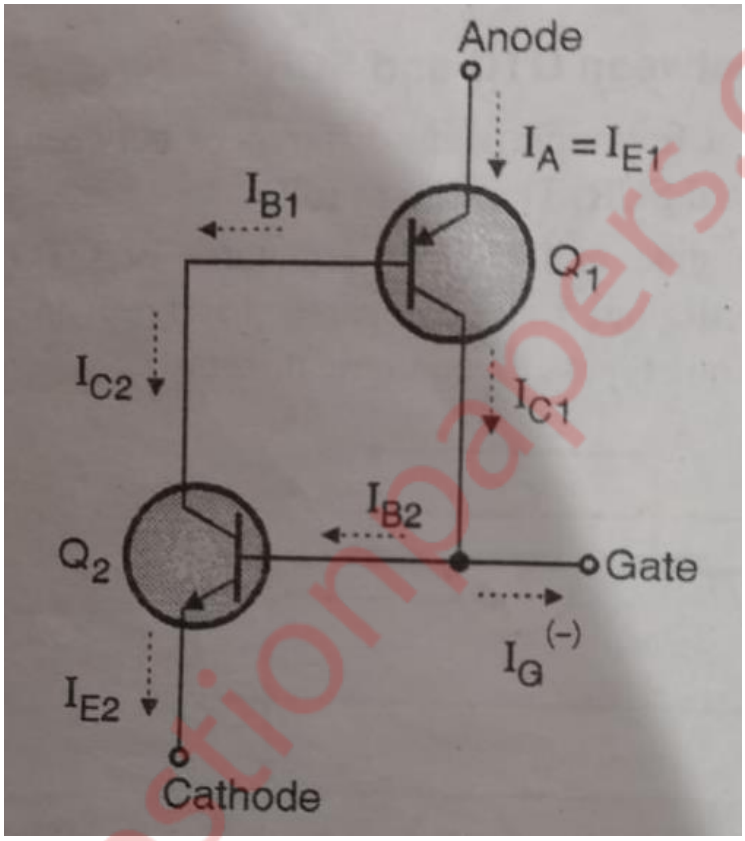
During this interval the trigger input remains high, the output voltage remains Low, transistor T1 is on and voltage on C is zero. At t = T the next trigger pulse is applied on pin number 2 and the operation repeat itself.

Q4] C) Explain GTO. How does it differ from an SCR . (6)

- GTO is a four layer structure similar to conventional SCR. GTO is developed which can be turned off by using negative get current pulse.



- SCR have the largest current carrying capacity they can block very high voltages but the major disadvantage of them is that once they are turned on, the gate will not have any control on their operations. SCR once start conducting can be turned off by using external turn off circuits known as commutation circuits.
- GTO is a three terminal device gate is control terminal.



Difference between GTO and SCR

- The gate cathode structure of GTO are highly interdigitated as compared to those in SCR with various types of geometrical form.
- The cathode area are usually formed by etching away the silicon surrounding the cathode so that appear as Islands. At the time of packing the cathode islands are directly connected to the metal heat sink the cathode connection to the outside world is made with metal heat sink directly.

- Third major difference corresponding to the anode reaction of GTO. in the p type anode layer the positive n region penetrate at regular intervals. this positive n regions make contact with the negative n regions that is the base layer and one this result in the so called "short anode structure" of GTO.

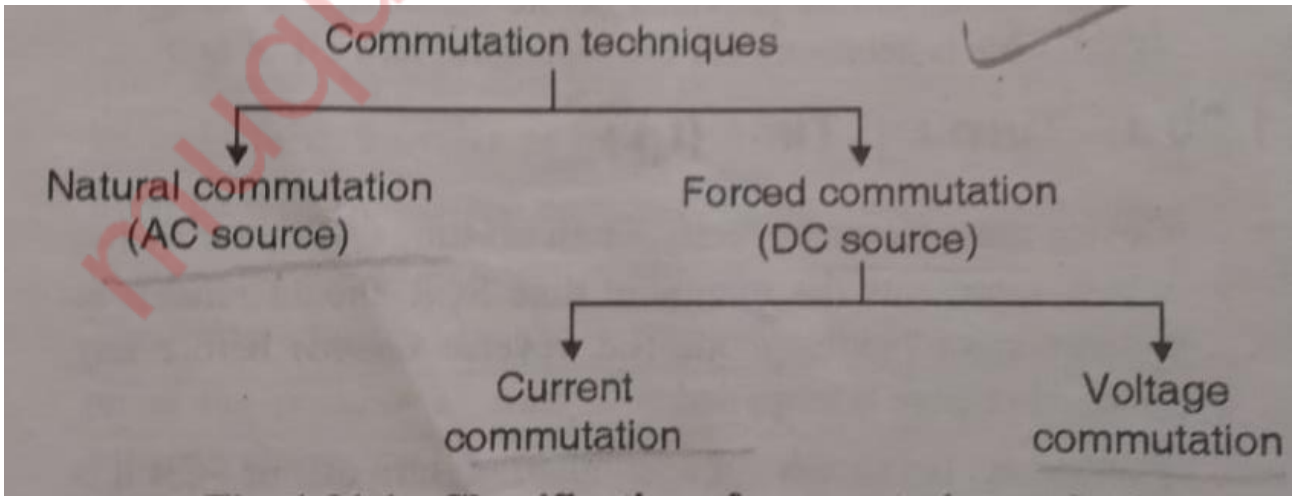
Q5] A) Classify the commutation methods of SCR. explain any one in detail. (7)

The computation techniques are broadly classified into two categories namely the natural commutation and forced commutation depending on whether the source voltage is AC or DC.

The forced communication circuits are further classified into two categories namely current computation and voltage commutation. This are the two ways of turning of a conducting SCR.

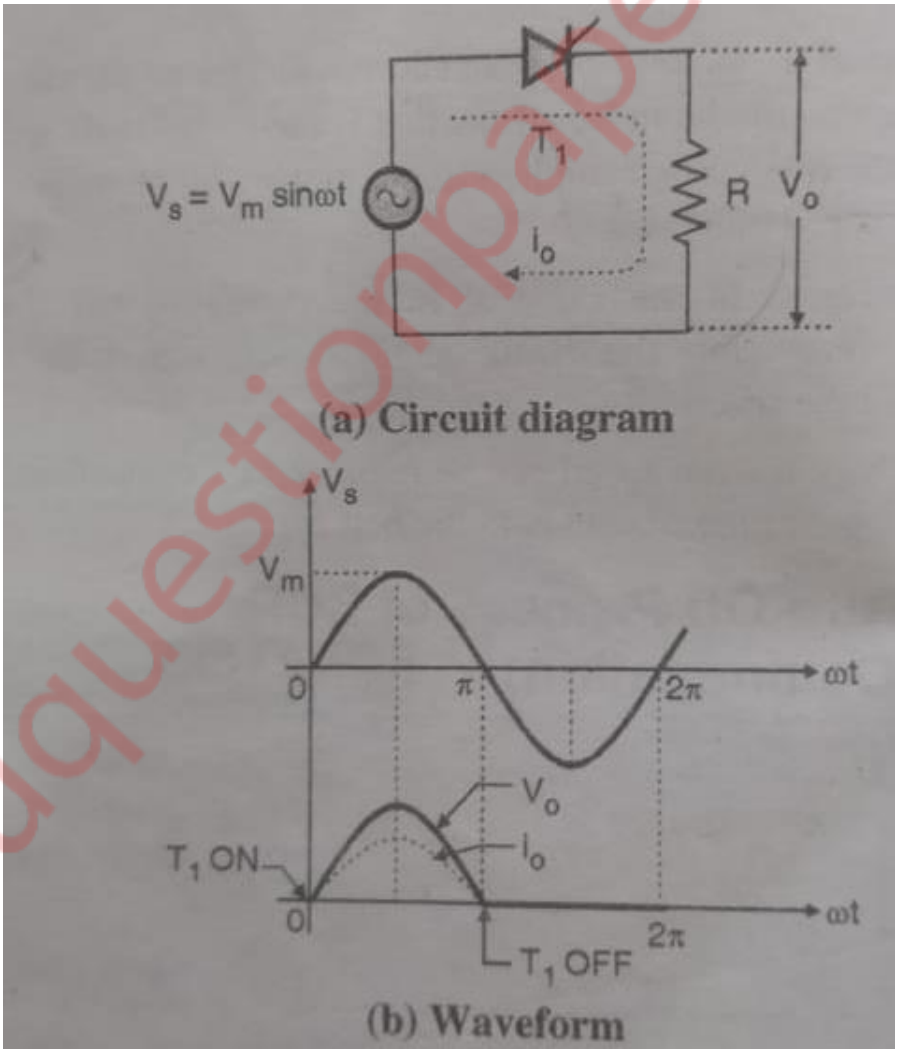
Current commutation: SCR is turned off reducing the anode current below the holding current value, then the communication is called as current communication

Voltage commutation: if the conducting SCR is turned off by applying a large reverse voltage across it then the commutation is called as voltage commutation.

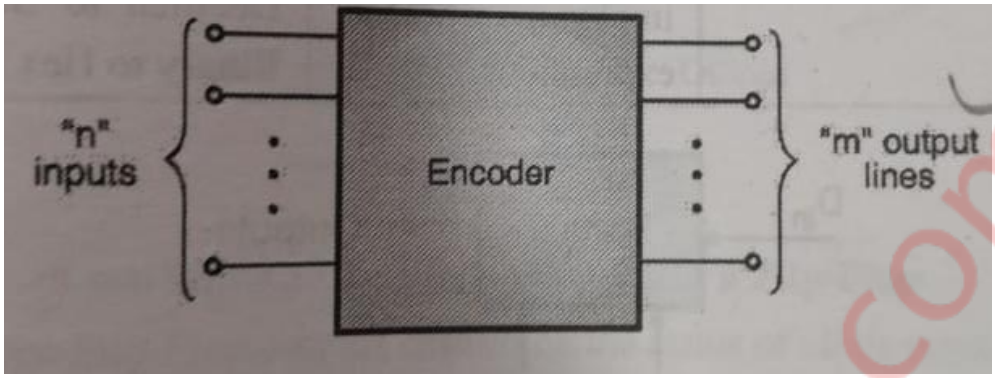


Natural commutation for AC source

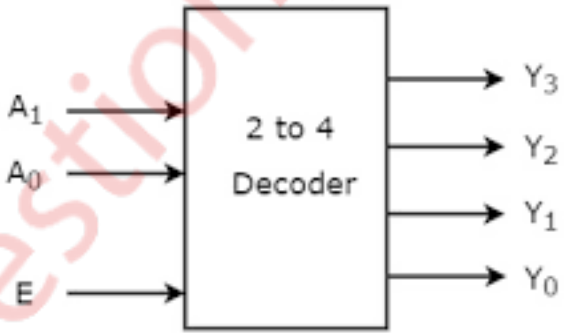
- Natural commutation usually takes place when AC supply is used at the input of thyristorized circuits.
- the current flowing through the thyristor T1 is same as that flowing through R1 the thyristor current passes through a natural zero and a reverse voltage appears across the thyristor, thereafter.
- The conducting thyristor is then turned off due to its anode current going to zero naturally. Hence it is known as natural commutation



Q5] B) Explain encoder and decoder in digital circuits. Enlist their applications. (7)



- Encoder is a combinational circuit which is designed to perform the inverse operation of a decoder
- An encoder has n number of input and m number of output lines.
- Encoder producers and m bit binary code corresponding to the n bit digital number applied to its input.
- The encoder accept an n input digital word and converts it into an m bit digital word.



- Decoder is a combinational circuit. It has n number of inputs and a maximum 2n outputs.
- Decoder is identical to a demultiplexer without any data input it performs operations which are exactly opposite to those of an encoder.

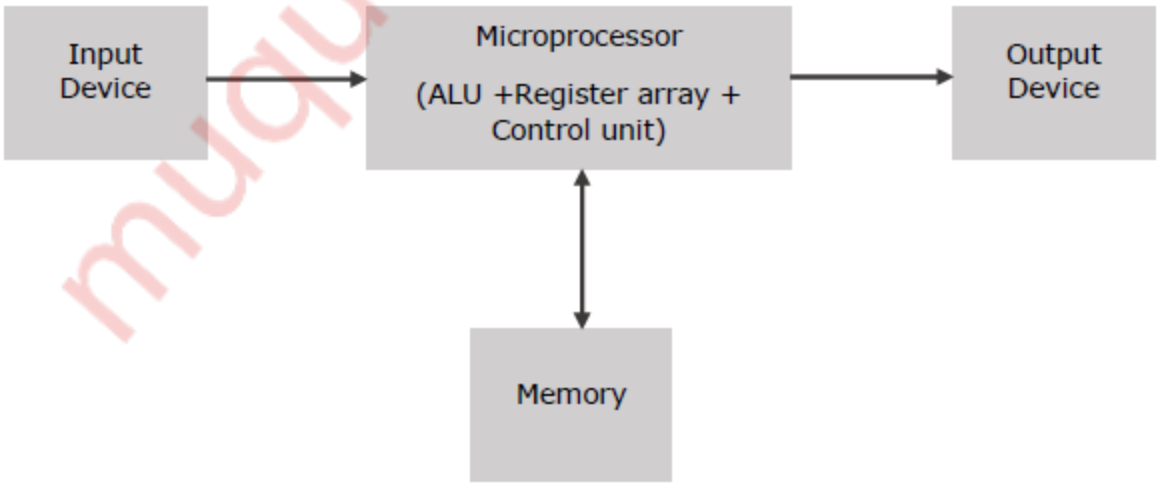
APPLICATIONS

[1]Code converter
[2]Relay actuators
[3]Nixie tube decoders
[4]BCD to 7 segment decoder

Q5] C) Give an overview of a generic microprocessor. (6)

Micro-computer is a computer system that uses Microprocessor. It acts as a controlling unit of a micro-computer, fabricated on a small chip which is capable of performing ALU (Arithmetic Logical Unit) operations and communicating with the other devices that are connected to it. It is considered as the brain of the computer.

Microprocessor contains ALU, register array, and a control unit. As it is called as heart of the system, each unit in the microprocessor perform its own activities resulting in proper output for the users. So, ALU performs arithmetical and logical operations on the data that is stored in the memory or an input device. Register array includes registers indicated by alphabets like B, C, D, E, H, L and accumulator which helps in fast memory accessing. The control unit as usual gives instructions to the computer's memory, ALU and input and output devices to respond to the program's instructions within the computer.



Working of Microprocessor

The microprocessor follows a sequence: Fetch, Decode, and then Execute.

The first step is to arrange the instructions in a sequential order that are stored in the memory. The microprocessor then fetches those instructions from the memory, decodes it and executes those instructions untill the STOP instruction is reached. Later, it sends the result in binary form as the computer does not understand human language it sends the instructions in its code language to the output port. In the meanwhile of processes, the register that stores the data temporarily and ALU performs arithmetic and logical functions.

List of Terms Used in a Microprocessor

- Instruction Set − It is the set of instructions that the microprocessor can understand.
- Bandwidth − It is the number of bits processed in a single instruction.
- Clock Speed − It indicates the number of operations that the processor can perform per second. It is expressed in megahertz (MHz) or gigahertz (GHz) and it is also known as Clock Rate.
- Word Length − It depends upon the width of internal data bus, registers, ALU, etc. An 8-bit microprocessor can process 8-bit data at a time. The length of the word ranges from 4 bits to 64 bits depending upon the type of the microcomputer.
- Data Types − The microprocessor has multiple data type formats like binary, BCD, ASCII, signed and unsigned numbers.

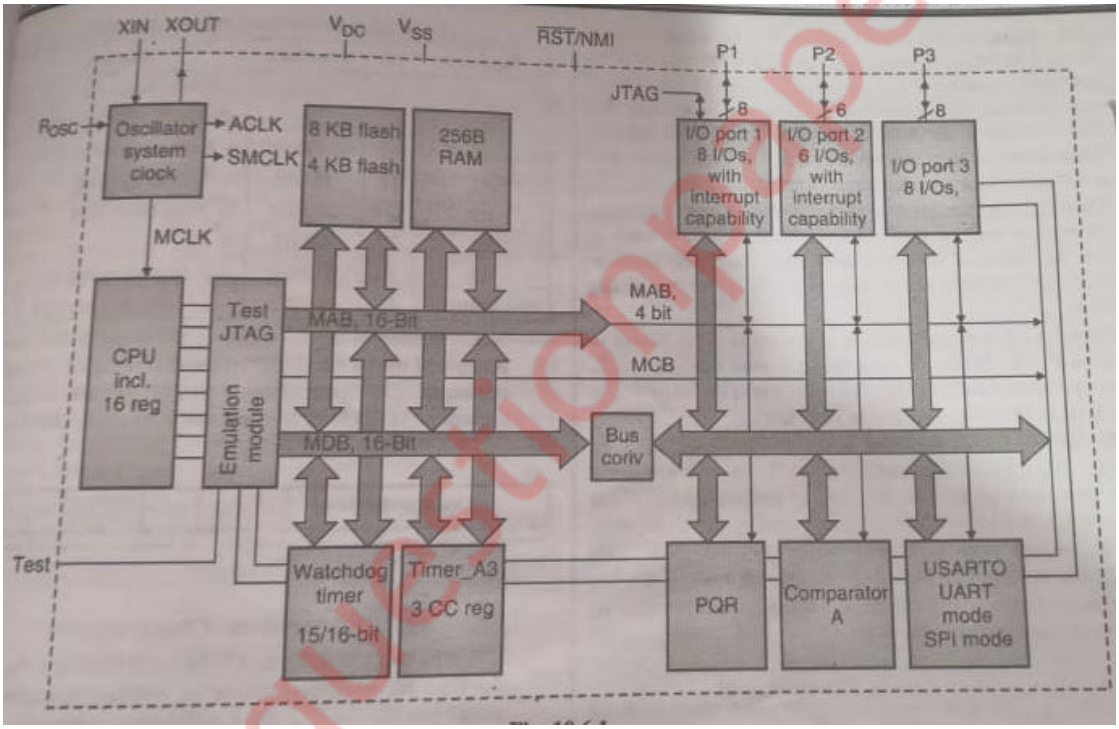
Features of a Microprocessor

- Cost-effective − The microprocessor chips are available at low prices and results its low cost.
- Size − The microprocessor is of small size chip, hence is portable.
- Low Power Consumption − Microprocessors are manufactured by using metaloxide semiconductor technology, which has low power consumption.

- Versatility − The microprocessors are versatile as we can use the same chip in a number of applications by configuring the software program.
- Reliability − The failure rate of an IC in microprocessors is very low, hence it is reliable.

Q6] A) Explain the different peripherals of MSP430 microcontroller. (7)

The MSP430 microcontrollers have a number of integrated smart peripherals that operated independent in the CPU interface allowing it operate at a lower clock speed and conserve energy without compromising performance. Additionally, the MSP430 family of devices has many tools available to aid the designer in every step of the design process, reducing time-to-market and development cost.

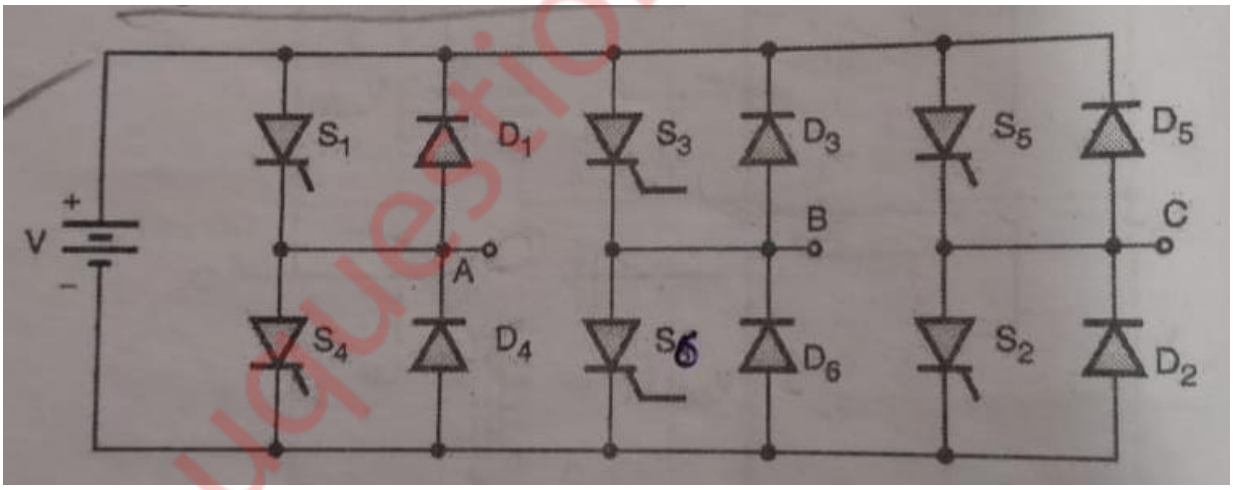


- Integrated smart analog piripherals reduce CPU load and allow for high performance at a lower energy cost.
- These peripherals include : ADC10/ADC12, SD16/SD16_A, COMPARATOR_A+,Op-Amp, DAC12, SVS, EESP430,Scan IF, LDC/LDC_A, DMA,Hardware Multipiller, Timer A,Timer B, USART, USCI and USI.
- The ADC10 is a fast, flexible 10-bit analog to digital converter with upto 16 inputs available to measure external signals.

- The ADC12 module supports fast, 12-bit analog to digital conversion at a rate in excess of 200ksps.
- The DAC12 module is a 12bit, voltage output DAC which can be configured in 8 or 12 bit mode.
- The comparator A+ module supports precision slope analog to digital conversions, supply voltage supervision and monitoring of external analog signals.
- The USCI modules support multiple serial communication modes with different modules supporting difdifferent modes.
- The USI is very high performance serial interface with an 8-16 bit shift register that can be used to output data streams or when combined with minimal softwares, can implement serial communication.
- The MSP430 family has many tools and resources available to aid in the design process.

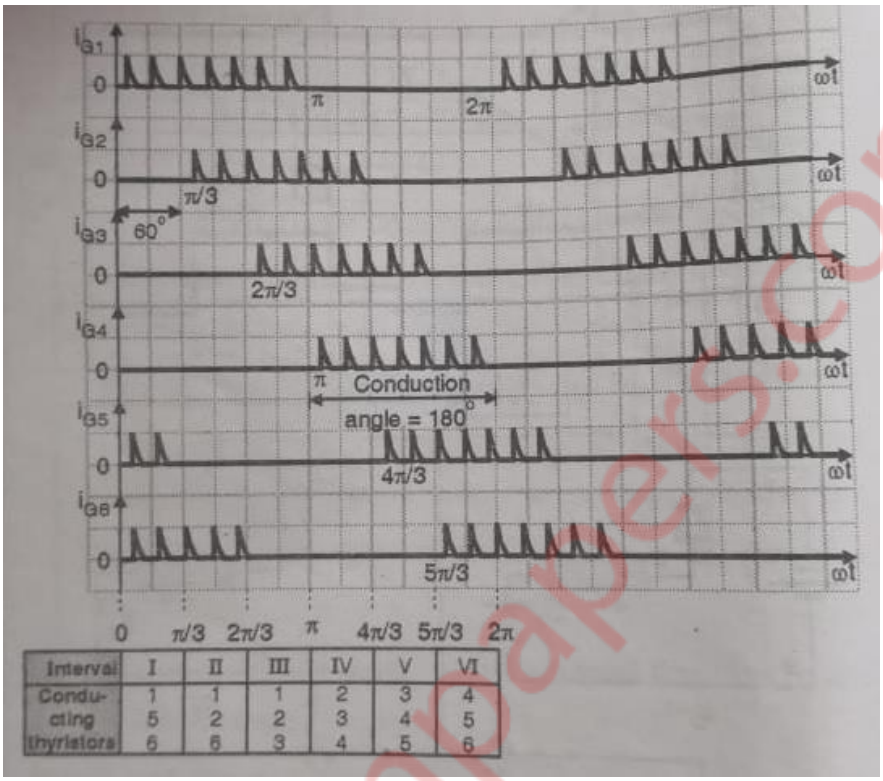
Q6] B) Explain 180 degree mode of conduction for a three phase bridge inverter circuit. (7)

Three phase Bridge Inverter



- 3 phase output can be obtained from a configuration of six power devices and six diodes configuration is known as three phase bridge configuration
- The diode D1 and D6 connected across the transistors are called feedback diodes

- This diodes will return back and store energy from the inductive load to the DC supply. They also protect the power transistor against the negative V_{CE}



Interval	I	II	III	IV	V	VI
Conducting thyristors	1 5 6	1 2 6	1 2 3	2 3 4	3 4 5	4 5 6

- 180 degree mode of conduction:at any given instant of time, three thyristor will conduct simultaneously, two of which are from one group and the remaining one is from other group.
- After every 60^o one of the conducting thyristor is turned off and some other thyristors comes into conduction therefore there are 6 intervals in one cycle of output each intervals is 60 degree wide.
- For the period 0° − 60° the points S1, S5 and S6 are in conduction mode. The terminals A and C of the load are connected to the source at its positive point. The terminal B is connected to the source at its negative point. In addition, resistances R/2 is between the neutral and the positive end while resistance R is between the neutral and the negative terminal.

Q6] C) With respect to digital circuits, define the following terms: Noise Immunity, Fan Out and Propagation Delay. (6)

- Noise immunity is defined as the ability of a logical circuit to tolerate the noise without causing the output to change undesirably.
  Quantitative measure of noise immunity of logical family is known as noise margin.

- Fanout is defined as the maximum number of inputs of the same ICC family that a gate can drive without falling outside the specified output voltage limits.
  Higher and output indicates higher the current supplying capacity of a gate.

- Propagation delay:the output of a logic gate does not change its state instantaneously when the state of its input is changed.
  There is a time delay between these two time instant, which is called as propagation delay.

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