Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the Figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any Equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant Values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgment on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q.1. (A) Attempt any SIX: **[12 M]**

(a) Name any two triggering devices used for SCR.

Ans: (1 M Each)

Triggering devices for SCR: :(any two)

1. UJT
2. SUS
3. PUT
4. LASCR

(b) List two features of IGBT.

Ans: (1 M Each)

Features of IGBT:

1. Low ON state voltage drop
2. Low ON state power loss
3. Higher switching frequency as that of BJT
4. Combines the best qualities of BJT& MOSFET

(c) Define (i)Latching Current and (ii) Holding Current.

Ans: (1 M Each)

Latching Current:

- It is the minimum on state anode to cathode current required to keep the thyristor in the ON state after the triggering pulse has been removed.

Holding Current:

- It is the minimum value of the anode to cathode current below which the thyristor stops conducting and return to its OFF state.

(d) List two applications of chopper.

Ans: (1 M Each)

Applications of Chopper:(any two)

1. DC motor control (eg: traction, forklifts).
2. Switch mode power supply.
3. Regenerative braking of DC motor
4. Battery operated vehicles

(e) Define commutation. What is meaning of Natural Commutation?

Ans: (1 M Each)

- **Definition of Commutation:** The process of reducing the anode to cathode current below the holding current in order to turn OFF the thyristor is called commutation.

  OR

  The process of turning OFF of SCR is known as Commutation.

- **Natural Commutation:** In AC circuits, the thyristor turns automatically OFF when the applied voltage crosses its natural zero and is being applied with a reverse voltage thereafter. This method of turning OFF is called natural commutation.

(f) State of concept of chopper.

Ans: (2 M)

Concept of chopper:

Chopper is a DC-DC converter. It converts a fixed DC voltage into variable DC voltage.

- Basically, chopper is an ON /OFF switch that connects and disconnects the input DC supply to the load at a very fast rate. It requires semiconductor switches and R, L, C components for its operation. The output voltage is controlled by varying the ON & OFF periods of the switch(duty cycle)

(g) Define firing angle and conduction angle.

Ans: (1 M Each)

- **Definitions:**

Firing angle (α): It is the angle measured from the zero crossing point of the input sine wave to the point at which the thyristor is "triggered" or turned ON. It varies from 0 to 180^0.

Conduction angle(β): It is the angle for which the thyristor remain ON before being commutated.

$\beta = \pi - \alpha$.

(h) State any two applications of UPS.

Ans: (1 M Each ,Any TWO)

- **Applications of UPS**

It is used for critical loads like

1) Medical Intensive Care systems
2) Control Stations of Industries
3) Safety Monitoring Computer Installations.

Q.1 (B) Attempt Any TWO: **[8 M]**

(a) Compare controlled and uncontrolled rectifier (any four points).

Ans: (1 M each for any 4 points-4 M)

Comparison between controlled and uncontrolled rectifier:

PARAMETER	CONTROLLED RECTIFIER	UN-CONTROLLED RECTIFIER
Device used	SCR & Diodes	Only Diodes
Control of load voltage	Can be controlled	Can't be controlled
Direction of power flow	Source to load and some case load to source	Source to load only
Freewheeling diode	Required if inductive load	Not necessary
Triggering circuit	required	Not required
Applications	DC motor controller, battery charger	Power supply

(b) Define inverter and give classification of inverter.

Ans: (Definition 1 M, Classification 3 M)

Definition of Inverter: Inverter is a circuit which converts DC power into AC power at desired output voltage and frequency.

Classification:

They are classified as:-

1) According to nature of input source:

- Voltage source inverter
- Current source inverter

2) According to the wave shape of the input voltage:

- Sine wave inverter
- Square wave inverter
- Quasi square wave inverter
- Pulse width modulated inverter

3) According to the type of commutation:

- Line commutated inverter
- Force commutated inverter

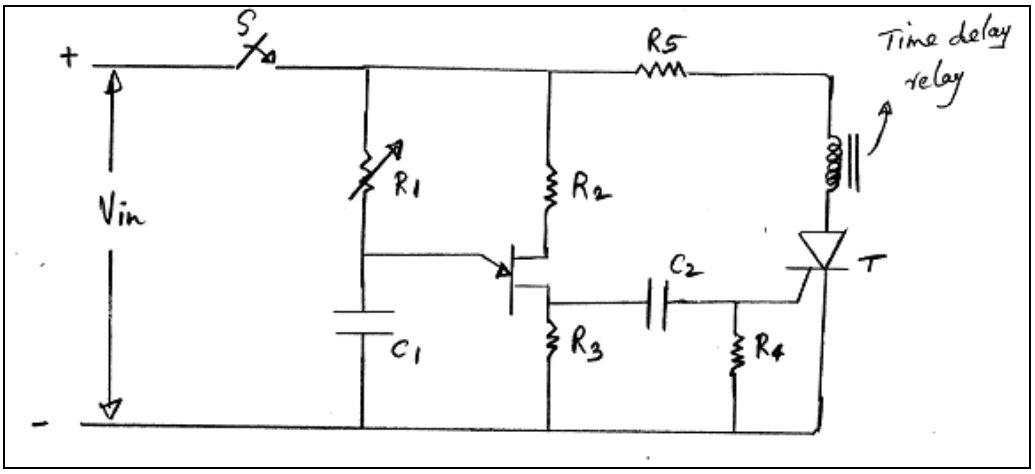
4) According to the connection of thyristor and commutation components

- **Series inverter**
- Parallel inverters
- Bridge inverters which are further classified as half bridge and full bridge

(c) Draw the labeled circuit diagram of Electronic Timer using SRC.

Ans: (Circuit diagram-4 M)

- **Circuit diagram of Electronic Timer using SRC:(any timer ckt using SCR & UJT)**



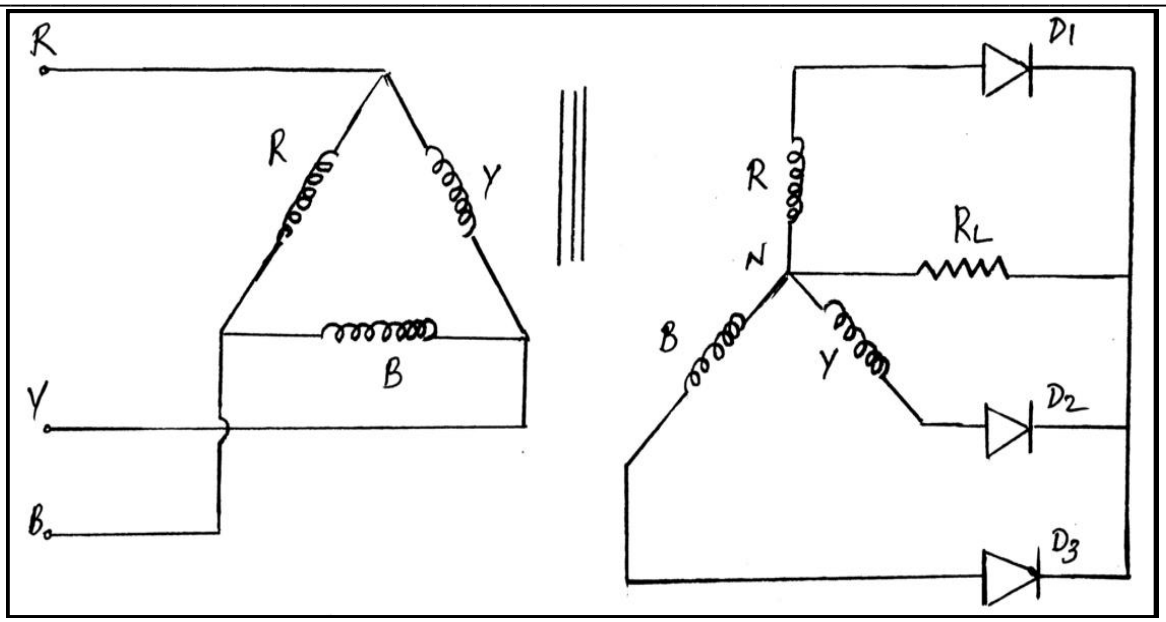
Q.2 Attempt any FOUR: **[16 M]**

(a) Draw the circuit diagram and input and output voltage waveforms of 3ϕ half wave rectifier with resistive load.
Diagram 2M, waveform 2M

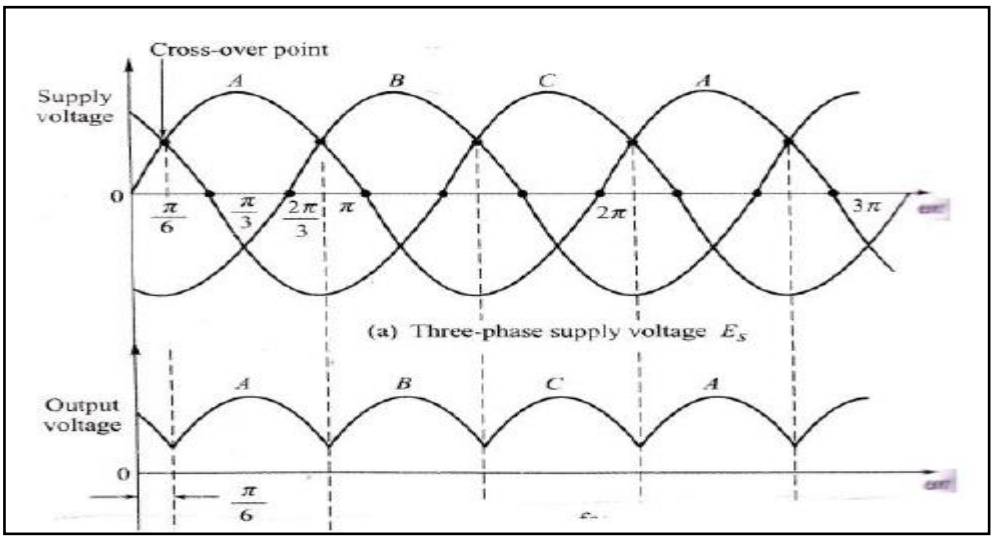
Ans:

Circuit Diagram 3- phase half wave rectifier with resistive load (uncontrolled):

[Note: Controlled rectifier also may be considered]



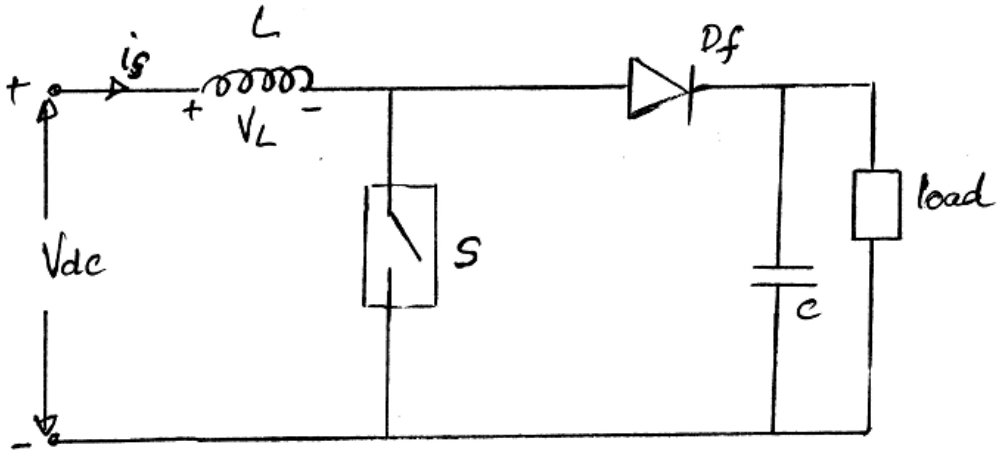
Waveforms:



(b) Draw the circuit diagram of step-up chopper and state its operating principle.

Ans: (Diagram 2 M Principal 2 M)

Diagram of Step-up Chopper:(instead of switch S SCR OR MOSFET can be drawn)



Working Principle:

Initially when chopper is ON inductor is connected to the supply and energy is stored, during a period T_{on} . For the moment when chopper is OFF, inductor induces a voltage making V_0 to become more than that of the input voltage.

$V_0 = V_{dc} + V_L$

A large value inductor at the input and/or a large value capacitor at the output will reduce the ripple content in the output voltage.

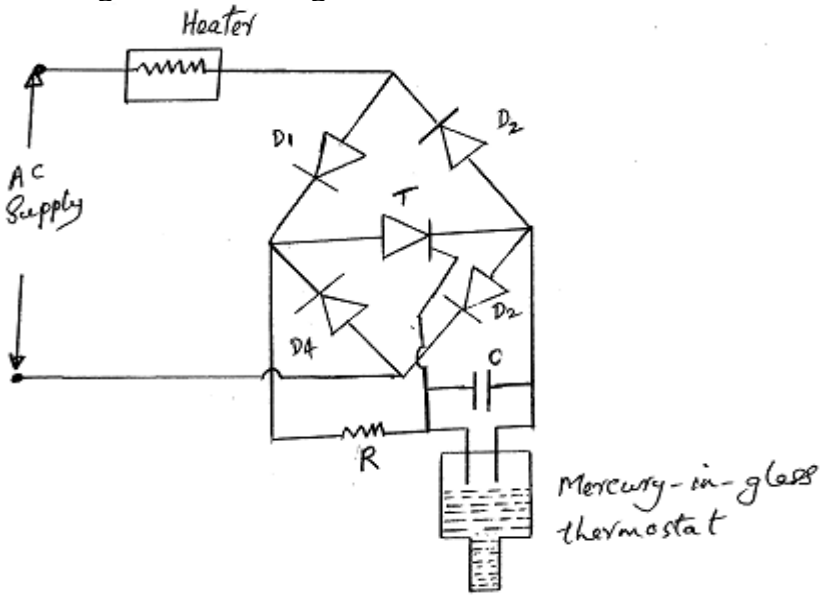
$V_0 = \frac{V_{dc}}{1-\alpha}$, where α is the duty cycle. For α between 0 to1, V_0 varies from V_{dc} to infinity.

(c) State the working of temperature controller circuit using SCR with neat diagram.

Ans: (Diagram 2 M Working 2 M)

Circuit Diagram of temperature Controller:

NOTE:-Any other relevant diagram & working can be considered



Working:

1. The circuit shows the arrangement of a heater control using SCR. Temperature is detected using mercury-In-glass thermostat. When the thermostat is open, the voltage across C_1 triggers SCR in each half cycle and current flows through the heater coil.
2. As the temperature increases beyond a set point the thermostat short circuits the capacitor making the SCR to turn OFF.
3. As the temperature drops down the set value, thermostat will again become open making the capacitor to charge and trigger the SCR.

(d) State the advantages and applications of GTO.

Ans: (2 M each)

Advantages of GTO:(any 2)

1. No commutation circuit required, reducing the cost, size and weight of the circuit.
2. As commutation choke is not used, the associated acoustic and electromagnetic disturbances are absent.
3. Less turn off time. Hence high frequency.

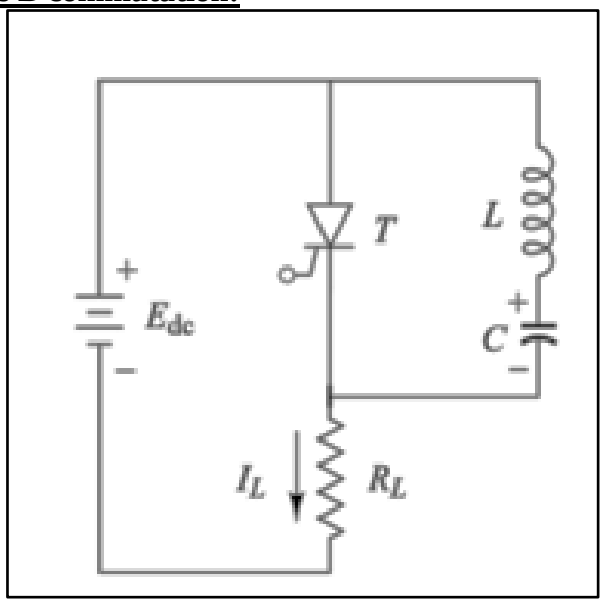
Applications of GTO:(any 2)

1. Inverter
2. UPS
3. DC motor drives

(e) Describe the working of Class-B commutation with neat circuit diagram.

Ans: (Diagram 2 M,Working 2M)

Circuit Diagram of Class B commutation:



Working:

1. As soon as the supply voltage E_{dc} is applied capacitor C charges upto E_{dc}(with upper terminal +ve)
2. When the SCR is triggered, along with load current I_L, capacitor current I_C flows through thyristor and L,C components, transferring the energy from capacitor to inductor.

3. When completely discharged, C gets charged by the inductor with opposite polarity. This reverse voltage causes a commutating current opposite to that of the load current.
4. When I_C increases above the holding current, the SCR turns OFF.
5. AS SCR is turned OFF, capacitor again charges with original polarity through L & R_L and the cycle repeats.

(f) State different performance parameters of inverter and describe any two in details.

Ans: (Listing the parameters 2 M, Any two definitions or formulae 2 M)

Performance parameters of Inverter:

1. Harmonic factor of nth harmonic (HFn)
2. Total harmonic distortion (THD)
3. Distortion factor (DF)
4. Lowest order harmonic(LOH)

Description (Any Two):

- **Harmonic factor of nth harmonic (HFn):**
  It is defined as the ratio of the rms voltage of a particular harmonic component to the r.m.s value of fundamental component.

$$HF_n = \frac{V_{n(rms)}}{V_{1(rms)}}$$

- **Total harmonic distortion (THD):**

  It is a measure of closeness in a shape between the output voltage waveform and its fundamental component.

$$THD = \sqrt{\frac{V_{0(rms)}^2 - V_{1(rms)}^2}{V_{1(rms)}}}$$

- **Distortion factor (DF):**

$$DF = \sqrt{\frac{\sum_{n=2,3\ldots}^{\infty} \left\{\frac{V_{n(rms)}}{n^2}\right\}^2}{V_{1(rms)}}}$$

  It indicates the amount of harmonies that remain in the output voltage waveform after the waveform has been subject to second order attenuation.

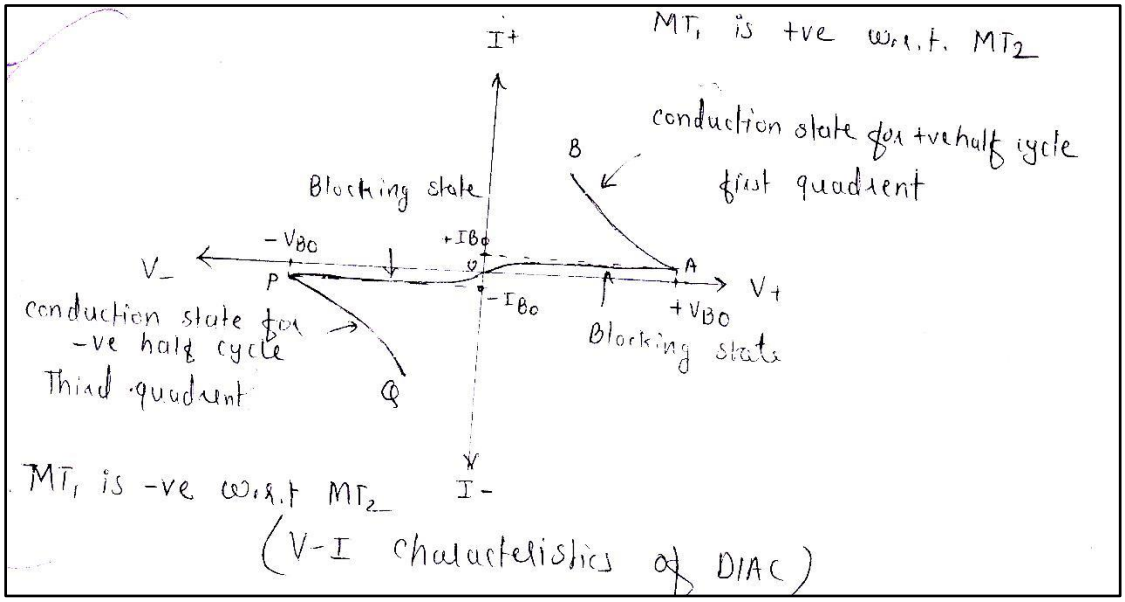
- **Lowest order harmonic (LOH):**

  It is the lowest frequency harmonic with a magnitude greater than or equal to 3% of the magnitude of the fundamental component of the output voltage.

Q.3 Attempt any Four: **[16M]**

a) Draw V-I characteristics of DIAC, Is DIAC equally sensitive in both the directions? Give two application of DIAC.

Ans: [V-I characteristics-2M, Application-1M, DIAC equally sensitive in both the directions-1M]



DIAC is equally sensitive in both the direction.

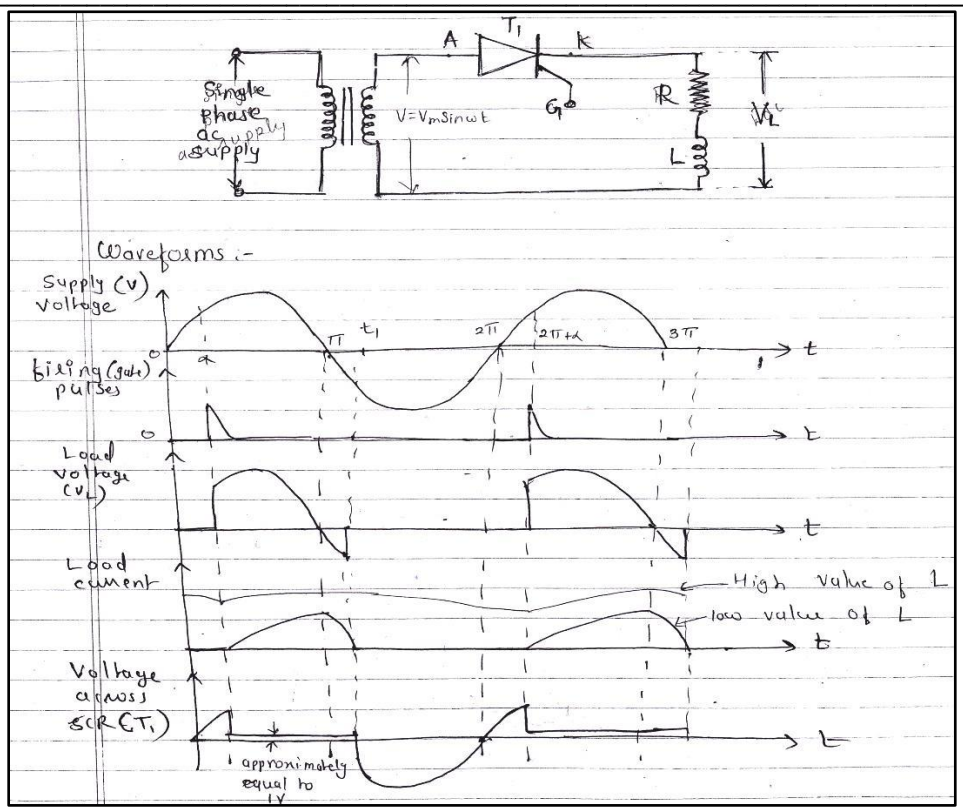
Application of DIAC: (any 2)

a) Used to trigger TRIAC
b) Heat control circuit
c) Triac light dimmer circuit
d) Triac fan speed control circuit
e) Low power triggering circuit

b) Draw and explain single phase half wave controlled rectifier circuit with RL load.

Ans :[Diagram-$1^1/_2$ M, Explanation-$1^1/_2$ M,waveform 1M]

Circuit Diagram:



- Figure shows the circuit diagram of a 1 ϕ HWCR with inductive load.
- Triggering circuit is not shown in the figure.
- The circuit is energized by the line voltage or transformer secondary voltage V= VmSinωt
- It is assumed that the peak supply voltage never exceeds the forward and reverse blocking rating of the thyristor.

Operation:(give marks for correct brief explanation)

Mode 1: (0 to α) (+ve half cycle)

SCR anode is a positive w.r.t. cathode but gate pulse is not applied therefore SCR is in off state though it is in forward biased therefore load current is zero therefore load voltage is 0.

Mode 2: (α to π) (+ve half cycle + gate signal is applied)

SCR is forward bias and gate signal is applied therefore SCR turns on at α. When SCR is triggered the load current will increase in a finite time through the inductive load. The supplier voltage from this instant appears across the load. Due to the inductive load the increase in current is gradual, energy is stored in inductor during α to π .

Mode3: (π to 2 π) (negative half cycle)

During negative half cycle, current continues to flow till the energy stored in the inductance is dissipated in the load-register and a part of the energy is feedback to the source, Hence due to energy stored in inductor, current continues to flow up to instant t_1.at a capital at instant t_1 is load current is zero and due to negative supply voltage SCR turns off.

At instant 2 π+ α , when again pulse is applied the above cycle repeats. Hence the effect of the inductive load is increase.in the conduction period.

c) Draw the two transistor model of SCR and explain it.

Ans: [Diagram-2M, Explanation-2M]

NOTE :-Any of these diagrams can be considered.

The principle of SCR operation can be explained with the use of its two transistor model (or two transistor analogy)

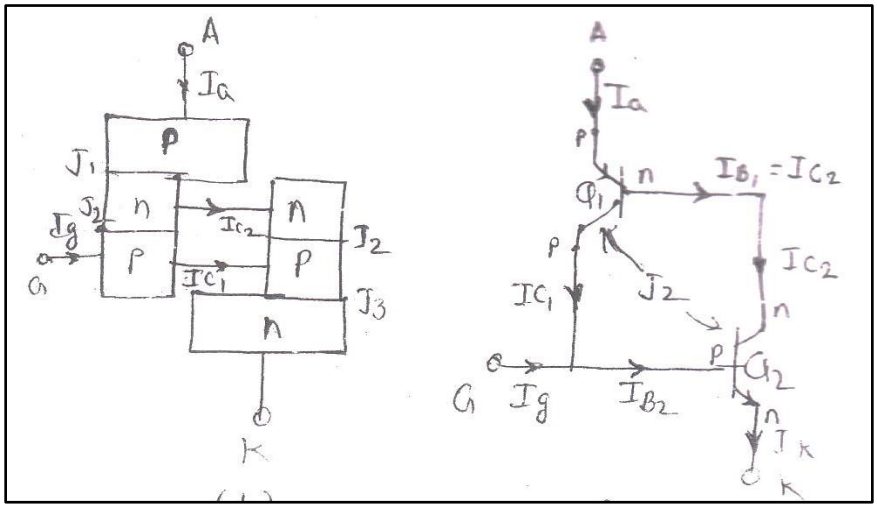


Figure a shows schematic diagram of a SCR from this figure, two transistor model is obtained by bisecting the two middle layers, along the dotted line, in two separate halves as shown in fig b. In this figure junction J_1-J_2 and J_2-J_3 can be considered to constitute pnp and npn transistors separately.
The circuit representation of the two transistor model of SCR is shown in fig.C

Working:

Positive current Ig of proper value and for short duration is applied at the gate terminal (Which is the base of Q_2) will cause a flow of current in Q_2 this will give rise to the flow of collector current Ic_2 in Q_2. Since Ic_2 is same as the base current of Q_1.($Ic_2 = I_{b1}$), the first transistor Q_1 will be switch ON. Each of the transistor would supply base current to the other,Thus the action is regenerative. Thus device will trigger.

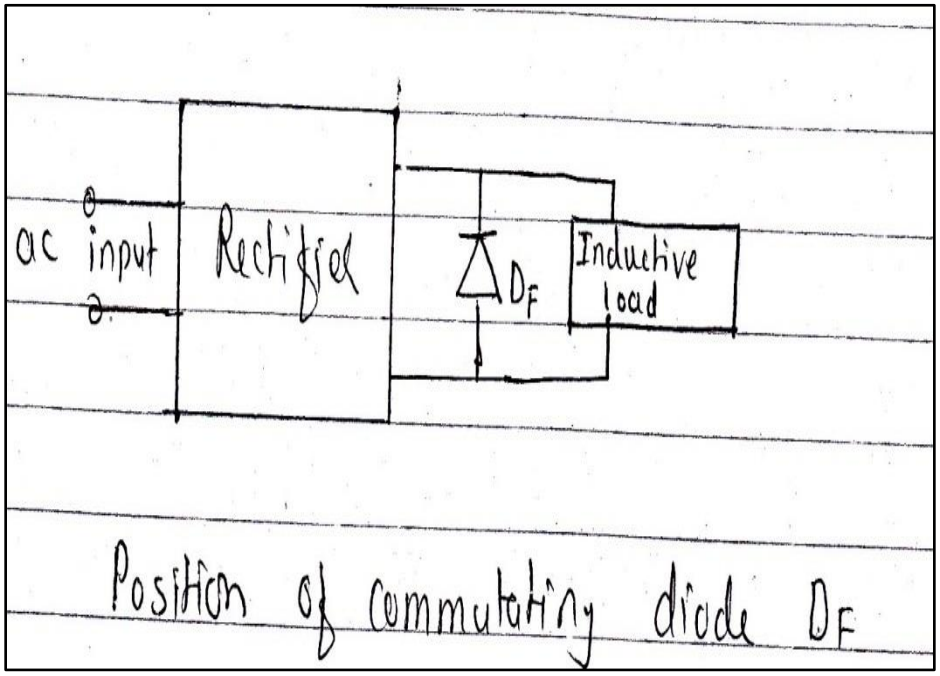
At this point even if the gate signal is removed the device does not turn OFF as long as the current flow is not less than the holding current.

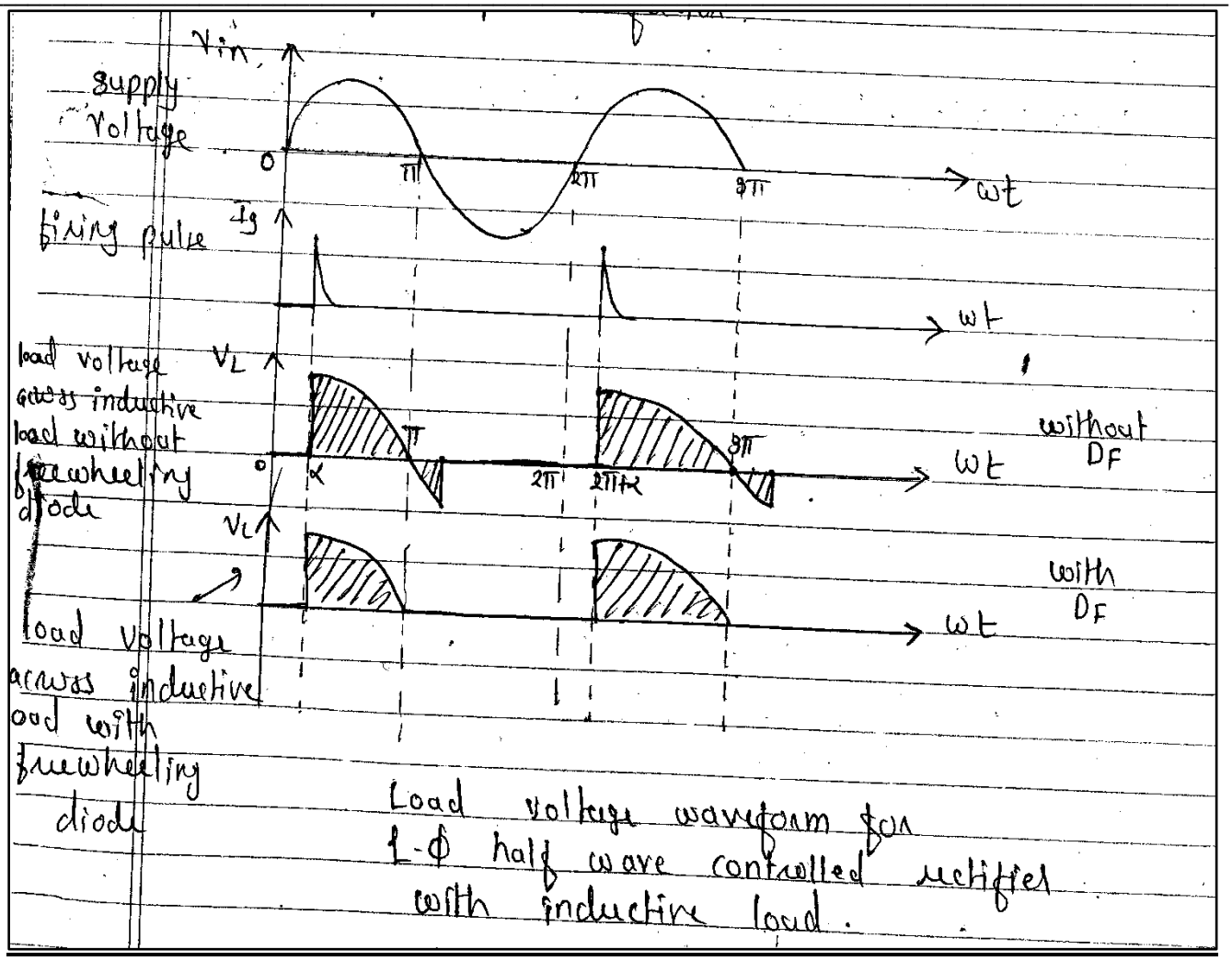
Thus, when the device is forward biased, it can be triggered by applying a small duration positive pulse at the gate. Once the device latches into its conducting state ,the gate losses its control and the device keeps on conducting even if the gate is opened, till the current level is maintained to minimum of that of the holding current.

d) Compare power BJT, power MOSFET and IGBT(any four points).
Ans: [Each point-1M]

Sr no	Device Characteristic	Power BJT	Power MOSFET	IGBT
1	Voltage Rating	High<1 kv	High<1 kv	Very High>1 kv
2	On state losses	less	More than power BJT	least
3	Device control	Current controlled	Voltage controlled	Voltage controlled
4	Input impedance	Low	High	High
5	Second break down	occurs	No second breakdown	No second breakdown
6	Switching speed	Slow (µs)	Fast (ns)	Medium
7	cost	Low	Medium	High
8	Current Rating	High<500A	Low<200A	High>500A
9	Input impedance	Low	High	High
10	Switching speed	Slow (µs)	Fast (ns)	Medium
11	cost	Low	Medium	High

e) Describe the effect of free wheeling diode in controlled rectifiers.
Ans: [Diagram-2M, Explanation-2M]
Effect of freewheeling diode(any rectifier ckt with freewheeling diode)
Waveforms other than load voltage are optional





Load voltage waveform for 1-ϕ half wave controlled rectifier with inductive load.

Many circuits, particularly those which are half or uncontrolled, include a diode across the load as shown in figure.

This diode is also called as commuting diode or flywheel diode or by-pass diode.

This diode is commonly describe as a commutating diode as its function is to commutate or transfer load current away from the rectifier whenever the load voltage goes into a reverse state.

Function of diode:

1. It prevents reversal of load voltage except for small diode voltage drop.
2. It transfers the load current away from the main rectifier, thereby allowing all of its thyristor to regain their blocking states.

With diode D_f, thyristor will not be able to conduct beyond 180^0

Hence after 180^0, the load current will firewheel through the diode and a reverse voltage will appear across the thysistor.

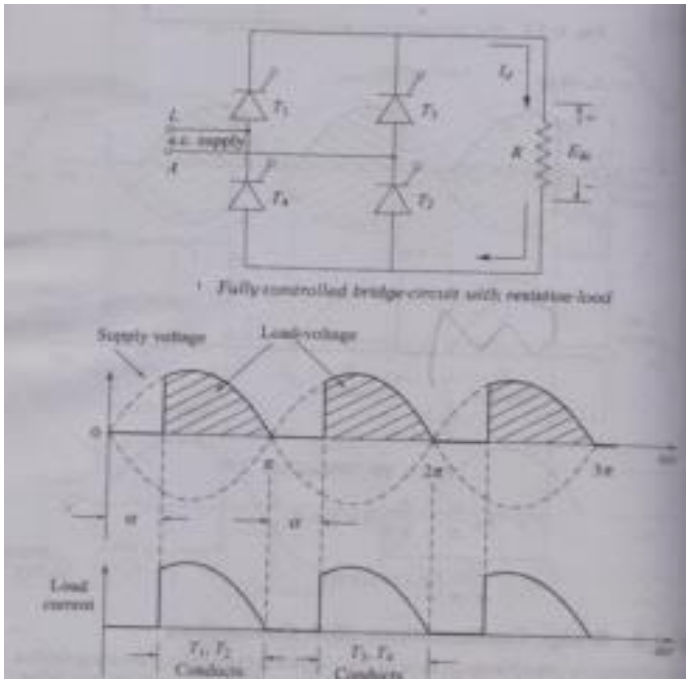
The power flow from the input takes place only when the thiristor is conducting if there is no freewheeling diode, during negative portion of the supply voltage, thyristor returns the energy stored in the load inductance to the supply line.

When diode Df, freewheeling action takes place & no power will be returned to the source. Thus freewheeling diode improves the input power factor.

f) Draw the single phase full wave bridge type controlled rectifier. Draw the waveforms of input voltage, load voltage and voltage across SCR.

Ans: [Diagram-2M, Waveforms i/p Voltage - ½ M, Load Voltage-½M, SCR-1 M]

Note : Give marks for ckt of R or RL load with or without freewheeling diode and for waveforms accordingly.



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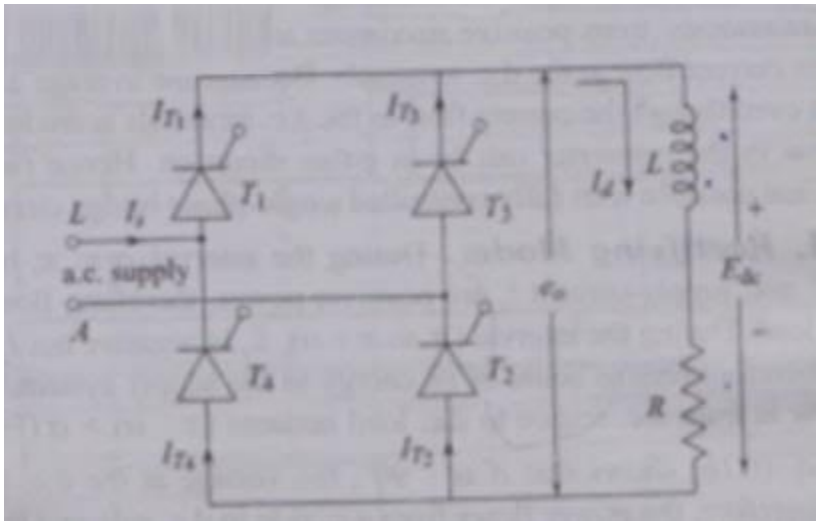
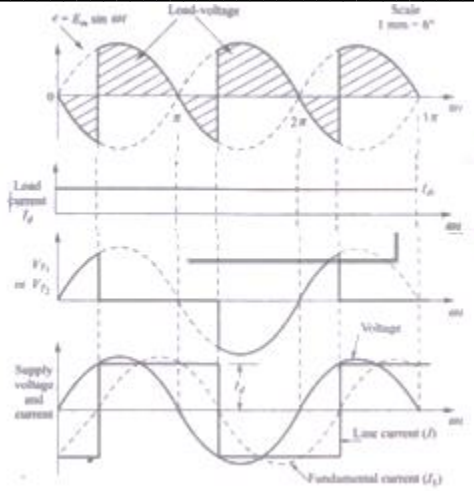
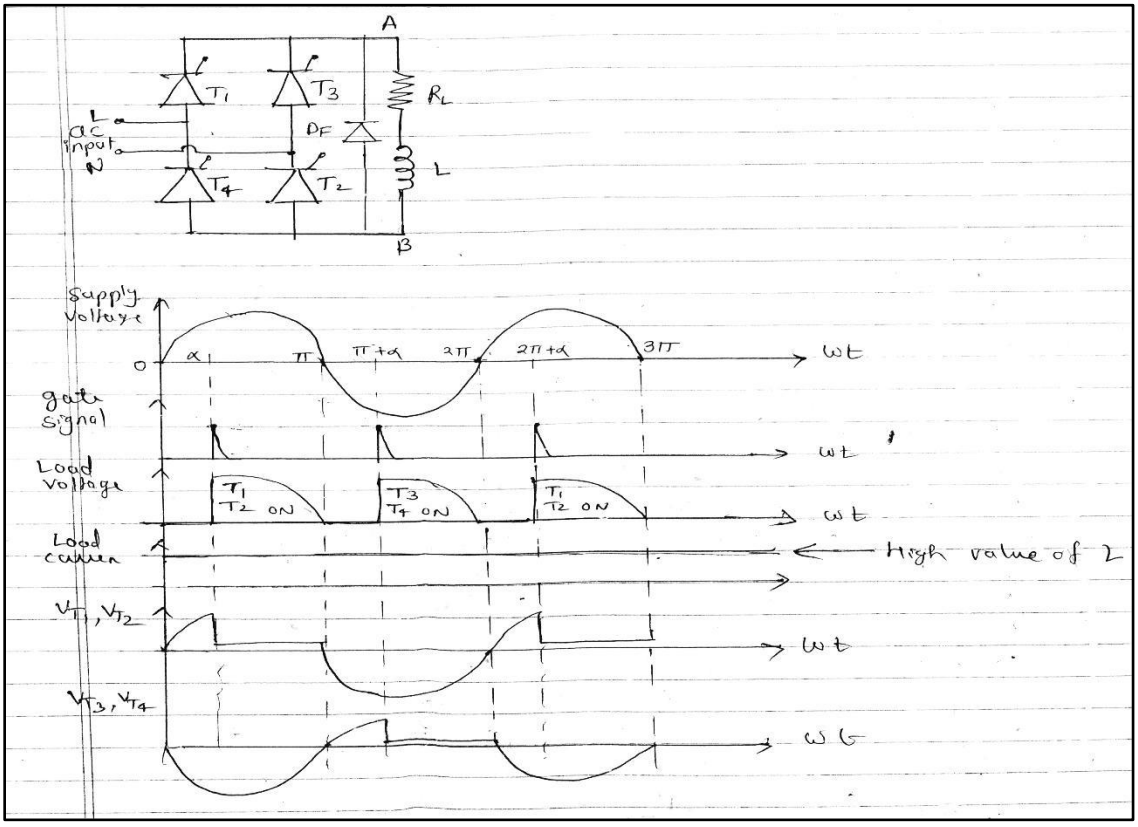



Load voltage
Scale
Load current
Voltage
Supply voltage and current
Line current (I)
Fundamental current (I1)

OR


A
T1
T3
RL
AC input
DF
T4
T2
L
B
Supply Voltage
0
α
π
π+α
2π
2π+α
3π
ωt
gate Signal
Load Voltage
T1 T2 ON
T3 T4 ON
T1 T2 ON
Load current
High value of L
VT1, VT2
VT3, VT4

Q.4 Attempt any FOUR: **[16M]**

a) Define the following terms w.r.t. inverters:

i) Harmonic factor of n th harmonic

ii) Total harmonic distortion

iii) Distortion factor

iv) Lowest order harmonics.

Ans: [Each 1M]

i) Harmonic factor of n th harmonic- The harmonic factor is a measure of the individual harmonic contribution on the output voltage of an inverter. It is defined as the ratio of the rms voltage of a particular harmonic component to the rms value of fundamental component.

$$HF_n = \frac{E_{n_{rms}}}{E_{1_{rms}}}$$

ii) Total Harmonic Distortion:- Total Harmonic Distortion (THD):- A total harmonic distortion is a measure of closeness in a shape between the output voltage waveform and its fundamental components. It is defined as the ratio of the rms value of its total harmonic component of the output voltage and the rms value of the fundamental component. Mathematically

$$THD = \sqrt{\sum_{n=2,3}^{\infty} E_{n_{rms}}^2} \Big/ E_{1_{rms}}$$

$$= \frac{\sqrt{E_{0_{rms}}^2 - E_1^2}}{E_1}$$

iii) Distortion Factor : A distortion Factor indicates the amount of harmonics that remain in the output voltage waveform, after the waveform has been subjected to second order attenuation .

$$DF = \sqrt{\sum_{n=2,3,\ldots}^{\infty} \left(\frac{E_{n_{rms}}}{n^2}\right)^2} \Big/ E_{1_{rms}}$$

iv) Lowest Order Harmonics: The lowest frequency harmonic with a magnitude greater than or equal to three percent of the magnitude of fundamental component of output voltage, is known as lowest order Harmonic. Higher is frequency of LOH, lower will be distortion in the current waveform.

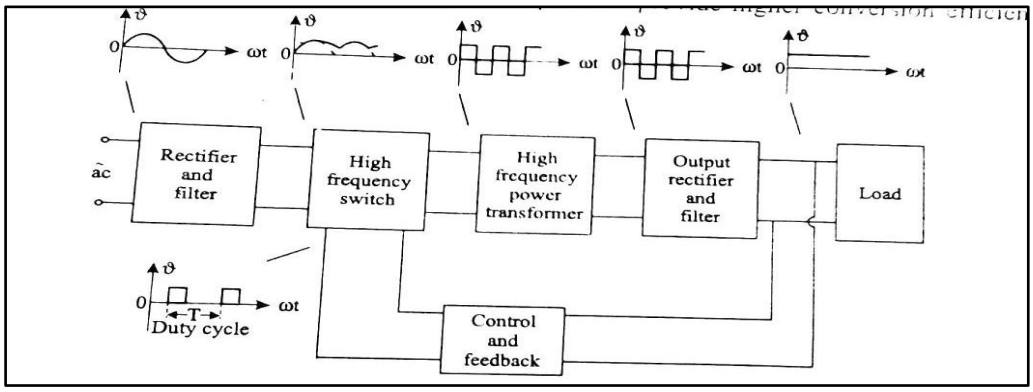
b) What is SMPS? State types of SMPS. Sketch block diagram of SMPS and label it well.
Ans: [Definition-1M, Types-1M(Any Two),Diagram-2M]
NOTE :- Consider any other relevant labelled block diagram

SMPS is switch mode power supply.
Optional : In SMPS the transistor does not operate in active region. It operates as a switch (in cut off & saturation). This reduces the power loss taking place in it and increases the efficiency normally above 95%. The response to SMPS in any change in load voltage is very quick.

TYPES
I) Isolated type
Buck
Boost
Buck-boost
II) Non Isolated type
Flyback
Forward converter
Half bridge
Full bridge

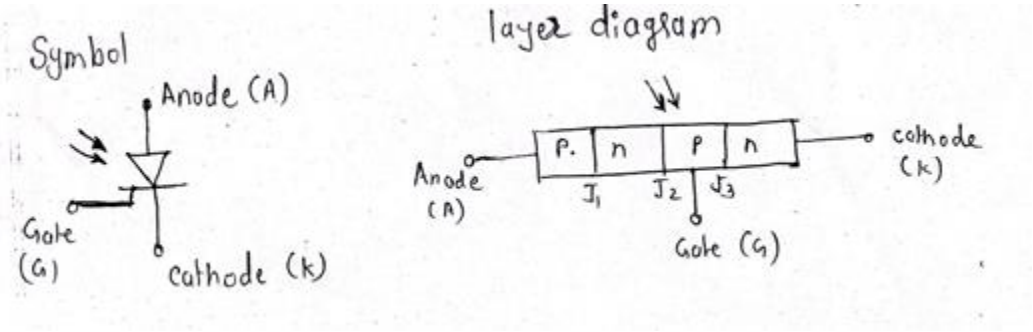
OR

DC to DC converter
Forward Converter
Flyback Converter
Self Oscillating flyback Converter
Push pull SMPS
AT SMPS
ATX SMPS
BTX SMPS



c) Describe LASCR. Give its industrial applications.

Ans: [Description-1 ½ M, Diagram-1 ½ M, Application-1M(Any Two)]



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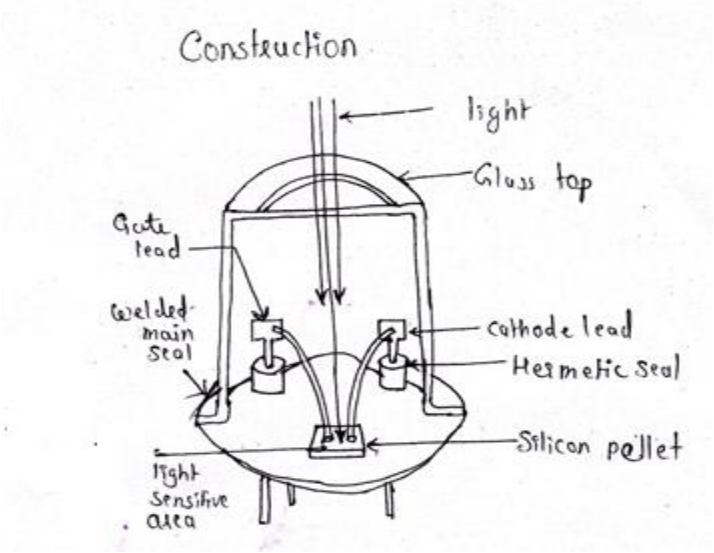


The light activated SCR is a three terminal, four layer device that can be turned on by direct radiation of light on the silicon wafer.

Operating Principle: When forward voltage is applied between anode and cathode terminals, junction J_1 & J_3 becomes forward biased. Junction J_2 is reversed biased therefore it blocks forward current when the pulse of appropriate wavelength is full on to the special sensitive area of the wafer, and if the intensity of light exceeds a certain value ,excess electron hole pairs are generated due to radiation and forward –Biased thyristor gets turned on.

OR

LASCR Construction

The LASCR (Light Activated Silicon Control Rectifier) is consist on four layer of semiconductor which forms PNPN or NPNP structure, it has tree junction J1 , J2 and J3 and also three terminals, the anode terminal of LASCR is connected to the P-Type of material of PNPN structure and the cathode terminal is connected to the N-Type layer of the Silicon Control Rectifies while the gate of the LASCR is connected to the P-Type of material near to the cathode,.

Operation / Working of LASCR

The LASCR (Light Activated Silicon Control Rectifier) start conduction when it is forward biased. For this purpose the cathode is kept at negative positional and anode is at positive positional. We apply a positive clock at the gate terminal and so the Silicon Control Rectifies turns ON. When forward bias voltage is applied to the LASCR (Light Activated Silicon Control Rectifier), or applied light of a required level the junction J1 and J3 become forward bias while the junction J2 become reverse bias. When we apply pulse at the gate terminal, the junction J2 become forward bias and the LASCR (Light Activated Silicon Control Rectifier) start conduction.

Applications:

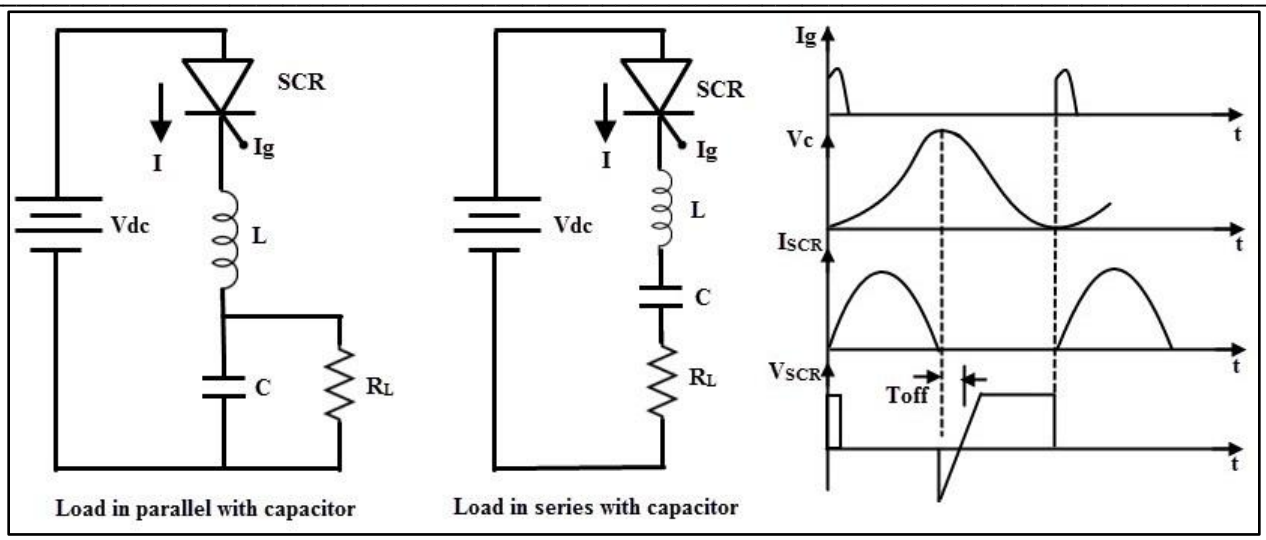
1) light coupling
2) Triggering circuits
3) Photoelectric control
4) Relays
5) Motor speed control
6) Used in computer
7) Used in high voltage dc transmission (HVDC)
8) Static reactive power or volt ampere reactive (VAR) compensation.

d) List various forced commutation methods. Explain self-commutation by resonating load.

Ans: [List-1M, Description-1 ½ M, and Diagram-1 ½ M, Note: Waveforms optional]

The Classification of forced commutation methods is based on the arrangement of commutating components & the manner in which zero current is obtained in the SCR.

- Class A - Self commutated by a resonating load
- Class B - Self commutated by an L-C circuit
- Class C - or complementary commutation
- Class D –or auxiliary commutation
- Class E - An external pulse source for commutation
- Class A: Self commutated by a resonating load



NOTE : Any one circuit diagram can be considered

This is also called as Resonant Commutation .This type of commutation circuit using LC components in series with the load.

In this process of commutation the forward current passing through the device is reduced to less than the level of holding current of the device.This method is known as current commutation method.

The load resistance R_L & commutating components are so selected that their combination forms under-damped resonant circuit.When such a circuit is excited by d.c.source,a current of nature as shown in fig will be obtained across the device.This current has zero value at the point K where the device is automatically turned off.Beyond point K,the current is reversed in nature which assures definite commutation of the device. The thyristor when ON carries only the charging current of capacitor C

which will soon decay to a value less than holding current of the device,when capacitor C is charged up to the supply voltage Edc. This simultaneously switches off the thyristor .The time for switching off the device is determined by resonant frequency which in turn depends on L & C & the total load resistance.

e) With neat sketch, explain SCR based battery charger circuit. Which component avoids overcharging?

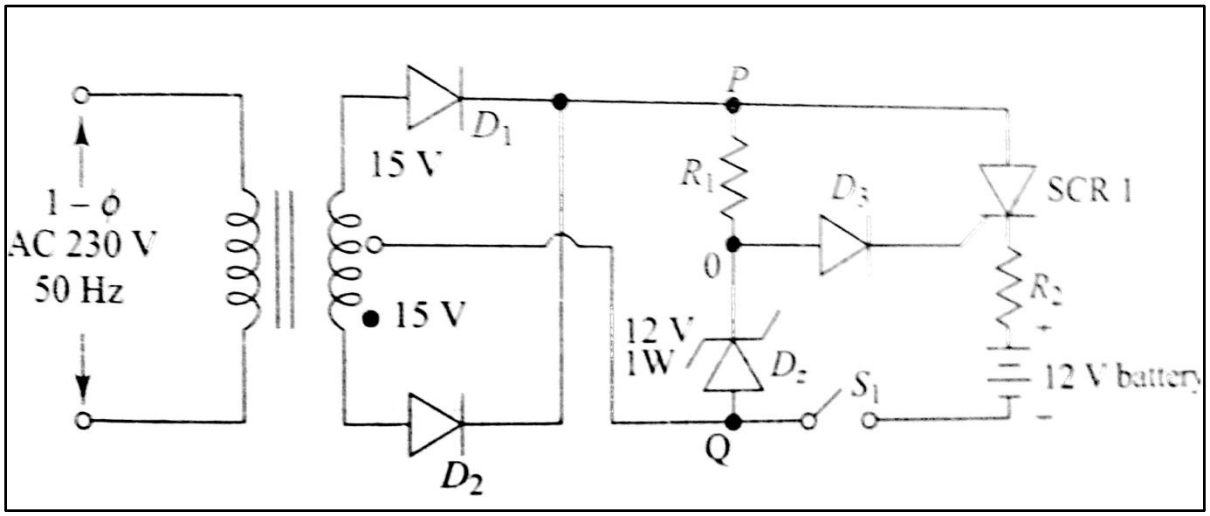
Ans: .[Diagram-2M,Explanation-1 ½ M, Component avoids overcharging-1/2 M]

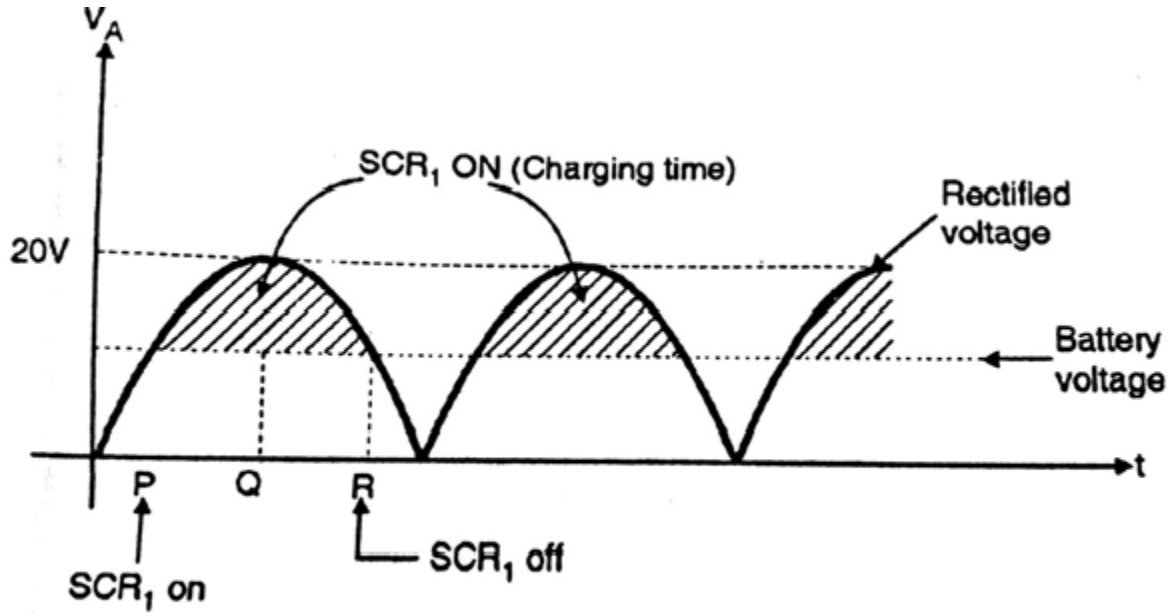
Working:- A 12v discharged battery is connected in the circuit. The single-phase 230 v supply is stepped down to (15*0*15) v by a center tapped transformer. Diodes D1 & D2 forms full wave rectifier. When switch s1 is closed , the pulsating DC voltage appears across terminals P&Q . When SCR1 is Off, its cathode is held at the potential of discharged battery. During each positive half cycle when the potential of point 0 rises to sufficient level so as to forwarded bias diode D3 & gate – cathode junction of SCR1, the gate pulse is provided to SCR1 & it is turned ON.

When SCR1 is turned ON, then charging current flows through battery. Thus during each positive half cycle of pulsating dc voltage across P-Q, SCR1 is triggered and charging current is passed till the end of that half cycle .

Due to Zener diode Dz , the maximum voltage point 0 is held at 12v. Due to the charging process, the battery voltage rises and finally attains fall value of 12v. Thus, when the battery is fully charged, cathode of SCR1 is held at 12v. Therefore, diode D3 & gate cathode junction of SCR1 cannot be forward biased.since potential of point O can reach upto 12 v . Hence no gate current is supplied and SCR1 is not triggered. In this way, after full charging further charging is automatically stopped.

SCR1 avoid overcharging.





Waveform for battery charger circuit

f) State different advantages of MOSFET inverter.
Ans: (Any 4,1 M each)

Advantages:

a) It is a voltage controlled device so easy to drive.
b) Requires negligible power to hold it in the ON state.
c) The gate drive circuitry is less complex & less costly.
d) Fast switching speed.
e) No additional ckt is required for commutation.
f) Small size and less expensive
g) More reliable
h) More efficiency.

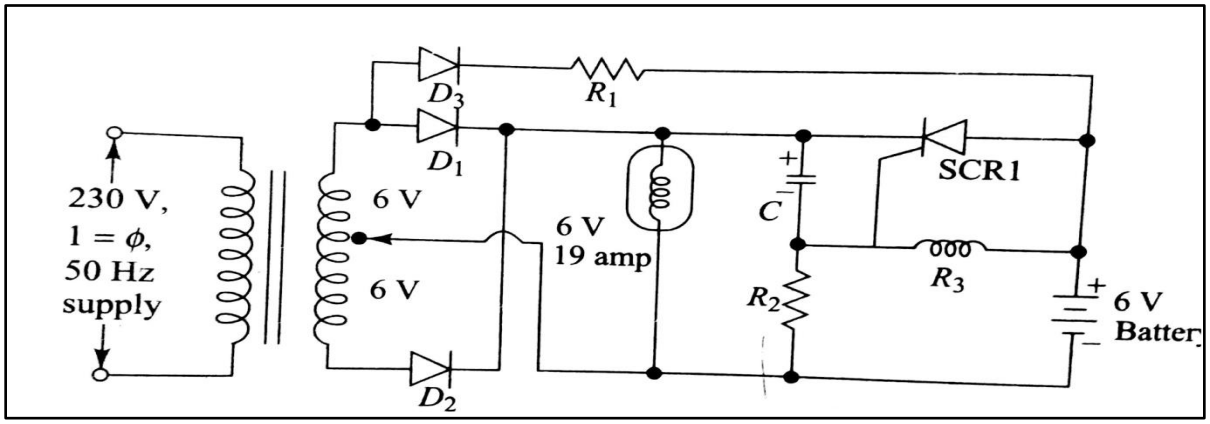
Q. 5 Attempt any FOUR:

a) Draw the neat circuit diagram of Emergency lighting system using SCR & describe its working.
Ans: [Circuit Diagram -2 M, Working -2M]
NOTE:-Any other relevant diagram & working can be considered

Working:-

In this circuit, 230v ac supply is applied as input. This supply is stepped down TO 6-0-6 v ac supply by center tapped transformer. The supply is stepped down full wave rectifier & converts ac to dc volt. When ac supply is available, 6V dc supply appears across lamp and it glows. Pulsating current also

flows through D3 & R1 to trickle charge the battery. Thus battery charging is carried out. The capacitor C gets charged with upper plate +VE to some voltage less than 6V.Due to capacitor voltage, gate cathode junction of SCR1 gets reverse biased. The anode is at battery voltage & cathode is at rectifier output voltage, which is slightly higher, hence SCR1 is reverse biased & cannot conduct. The lamp glows due to rectifier output dc voltage.

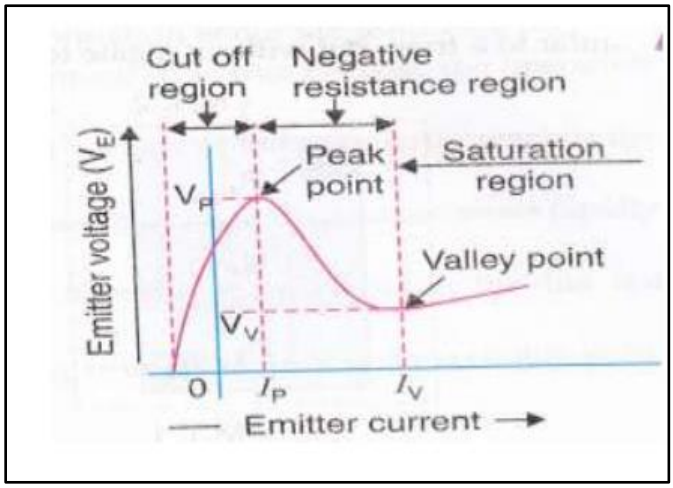


If power fails, the capacitor C discharges through D3, R1 & R3 until the cathode of SCR, is less positive than anode. At the same time the junction of R2 & R3 becomes +VE & establishes a sufficient gate to cathode voltage to trigger the thyristor. Once the thyristor turns ON, the battery discharges through it, &

turns the lamp ON when power is restored, the thyristor is connected & commutated & capacitor C is recharged again.

b) Draw VI characteristics of PUT & describe the role of its operating regions.
Ans:[VI characteristics 2M,Regions 2M]
Fig shows the VI characteristic of PUT. There are two important points on the characteristic curve namely the Peak -point and the valley point. These points divide the curve into three important regions i.e , cut off region , negative resistance region and saturation region . these regions are explained below

- **Cut off region:** The region, to the left peak point, is called cutoff region. In the region, the emitter voltage is below the peak point voltage (Vp) and the emitter current is approximately zero. The PUT is in its OFF position in this region.
- **Negative resistance region:** The region, between the peak point and the valleypoint called negative resistance region. In this region, the emitter voltage decreases from Vp to Vv and the emitter current increases from Ip to Iv. The increase in emitter current is due to the decrease in resistance rb1. It is because of this fact that this region is called negative resistance region. It is the most important region from the application point of view.
- **Saturation region:** the region, beyond the valley point, is called saturation region. In this region, the device is in its ON position. The emitter voltage (Ve) remains almost constant with the increasing emitter current.

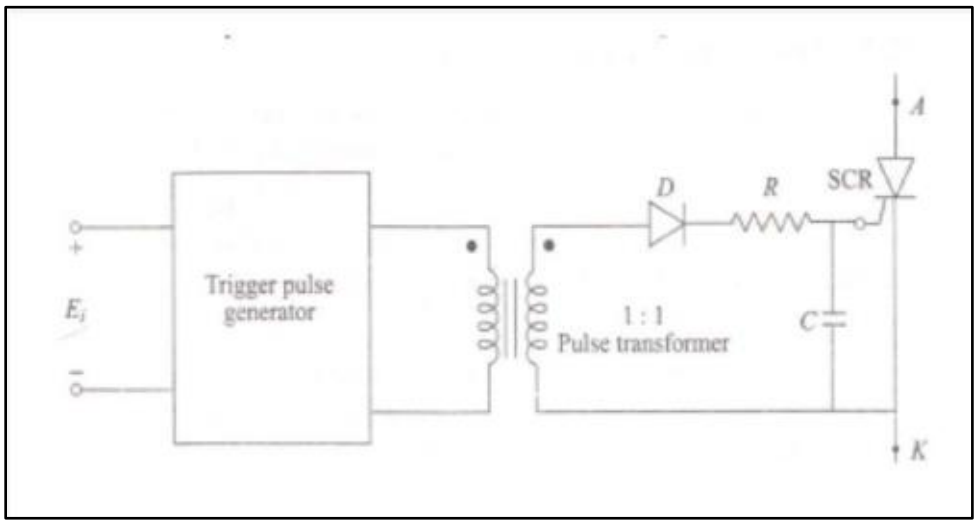


c) What is poly phase rectifier? State its need.

Ans: [Definition -1M, Need -3M]
Polyphase rectifier has 3 or more phases at input. A rectifier which utilizes two or more diodes (usually three), each of which operates during an equal fraction of an alternating current cycle to achieve an output current which varies less than that in an ordinary half wave or full wave rectifier.

Need of Polyphase rectifier Advantages: (Any Three, 1M each)
1)Ripple factor decreases rapidly with an increase in the number of phase
2)Poly phase rectifier gives smooth direct current
3)Low harmonics in the input supply current
4)Number of phases are more due to that average output can be more & hence output power is also more
5)High ripple frequency therefore small filters can be use.

d) Describe the operation of pulse transformer used in triggering circuits.
Ans:[Diagram -2M,Explanation- 2M]

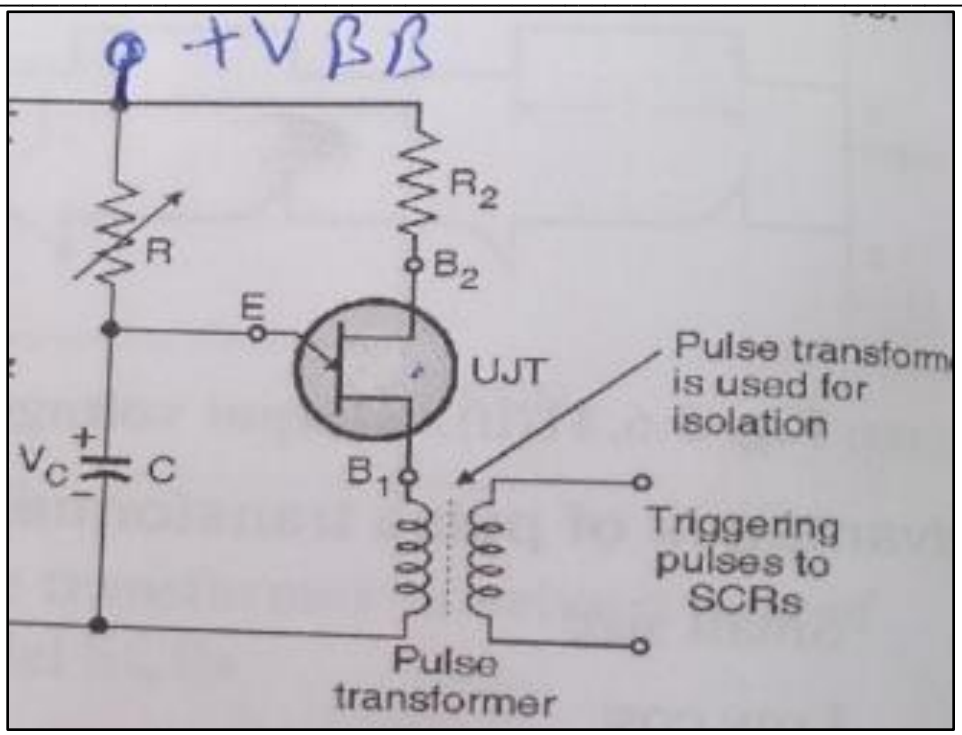


Pulse transformers are often used to couple a trigger pulse generator to a thyristor in order to obtain electrical isolation between the two circuits. The transformers commonly used for thyristor control are either 1:1 two winding or 1:1:1 three winding types. Figure shows a complete output circuit to fire a thyristor correctly.
The series resistor R either reduces the SCR holding current or balances gate current in a three winding transformer connected to two SCRs. The series diode D prevents reverse gate current in the case of ringing or reversal of the pulse transformer output voltage. The diodes also reduce holding current of the SCR.
In some cases where high noise levels are present it may be necessary to load the secondary of the transformer with a resistor to prevent false triggering.

OR

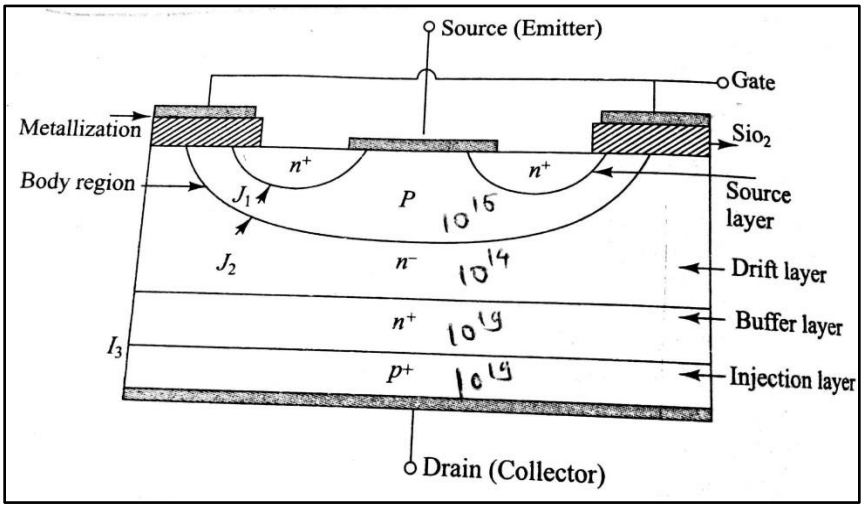
Explanation:
As soon as the biasing voltage VBB is applied to the circuit, capacitor starts charging towards VBB voltage through resistance R. As soon as capacitor voltage reaches upto Vp voltage, the UJT turns ON and the capacitor discharges. The Vpvoltage is set by the
voltage divider consisting of two resistors RB1and RB2,

Vg=RB1(RB1+ RB2)
As capacitor charges upto Vp,UJT turns ON and hence capacitor discharges
through UJT and R3and it produces positive triggering pulses.

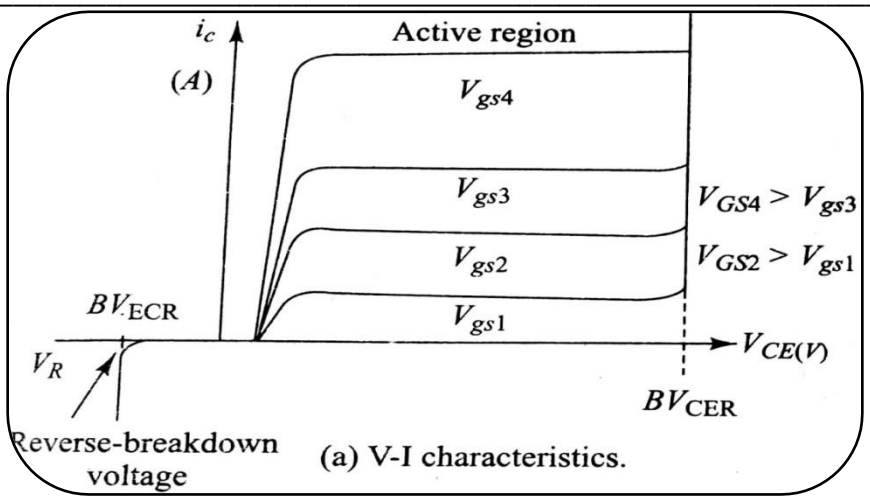


e) Draw the labelled layer diagram of N- channel IGBT. Draw its VI characteristics.

Ans:[Diagram 2 M(without doping levels can be considered),VI characteristics 2M]



NOTE : The characteristics in between I_D vs V_{DS} also can be considered



f) Differentiate between single phase controlled half wave rectifier & single phase controlled full wave rectifier.

Ans:(Any 4 Points 1M each)

NOTE :- Circuit diagram & waveform also can be considered.

Parameter	Half wave controlled Rectifier	Full wave controlled Rectifier
No.of SCR	1	2 or 4
Avearage load voltage	$Vm/2\pi(1+\cos\alpha)$ OR Vm/π	$Vm/\pi(1+\cos\alpha)$ $2Vm/\pi$
Ripple Frequency	50 Hz	100 Hz
Cost	Less	More
Weight	Less Bulky	More Bulky
Efficiency	Less	More
Applications	In small battery charger	In DC motor speed control

Q.6 Attempt any FOUR: **[16M]**

a) Sketch circuit diagram of low power DC flasher and state how flashing occurs.

Ans: (Circuit Diagram 2 M , Explanation 2M)

NOTE: ***Any other circuit diagram & explanation can be considered***

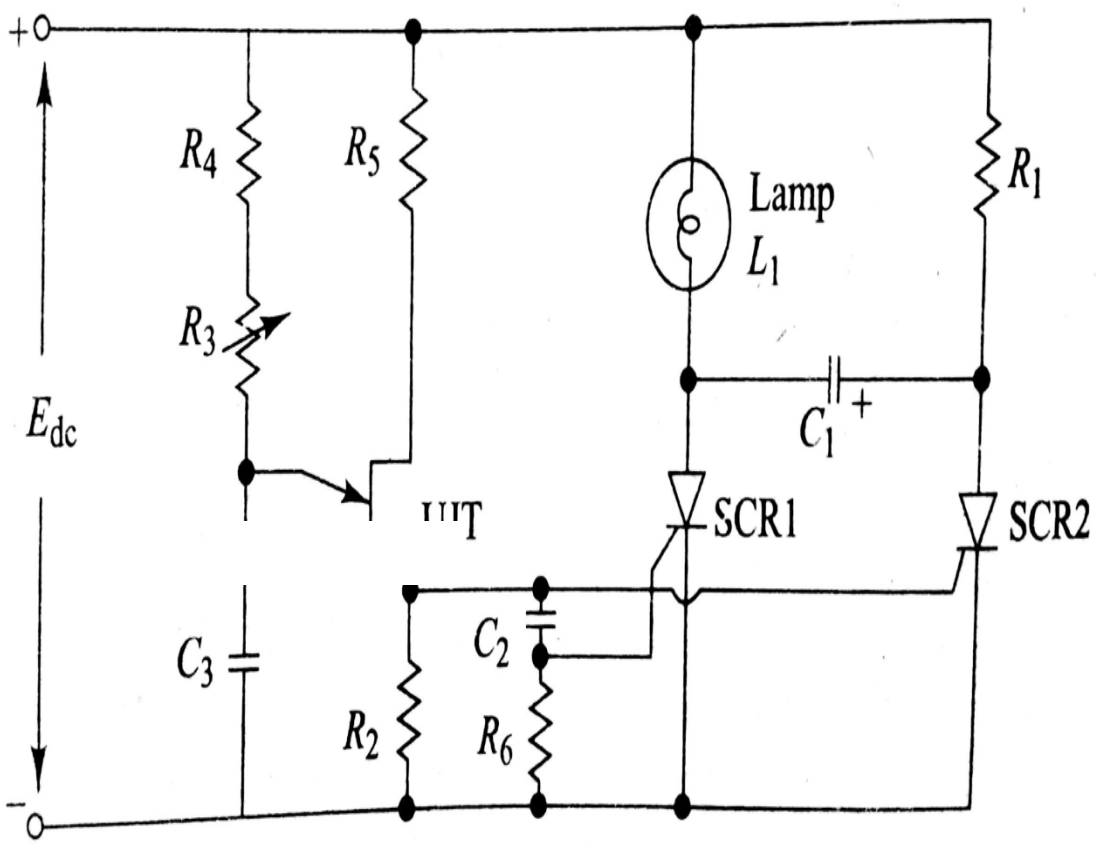


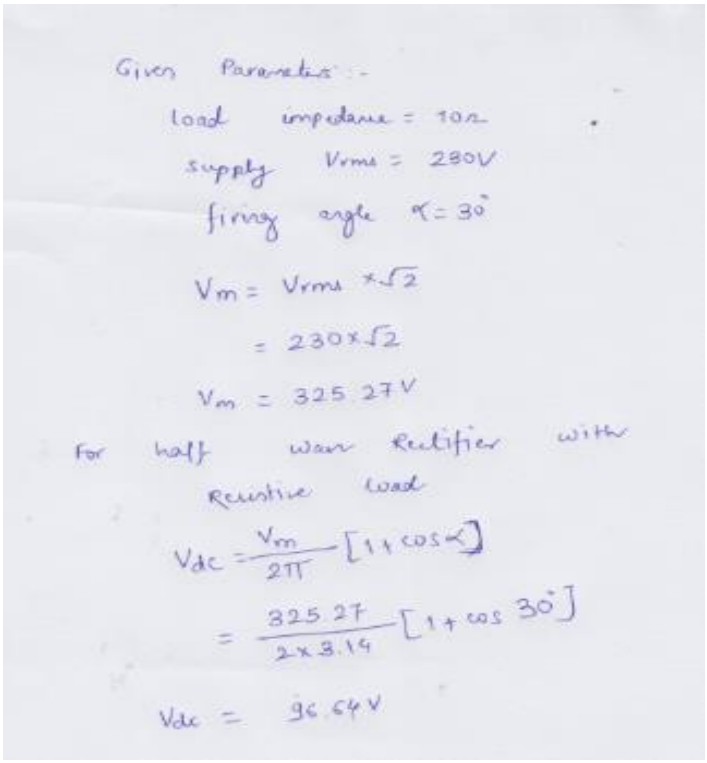
Fig. 16.42 *DC low power flasher*

Working:-

The circuit consists of UJT relaxation oscillator and Class „C" commutation circuit. UJT relaxation oscillator produces a train of pulses. It is directly applied to SCR1 and it is delayed & applied to SCR2. The delayed is decided by C & R6. Initially let SCR 1 is ON and lamp is On. Capacitor C1 charges through R & SCR1 to supply voltage Vdc .With the next trigger pulse SCR2 will be turned ON. Now voltage across C1 reverse biases SCR1 & turns it off. Capacitor discharges through SCR2 & charges in opposite direction. Since SCR1 is reversed biased, it will not turn ON even if the gate pulse arrives. When the current through SCR2 reduces below holding current, SCR2 turns Off. A large R1 reduces the current through SCR2. When next trigger pulse comes SCR1 is turned On lamp glows again and capacitor C1 gets charged though R1 to develop commutating voltage for SCR1. Switching of SCR1 gives flashes from lamp. The flash rate depends on firing pulse frequency of UJT relaxation oscillator. Therefore by adjusting R3, the required flash rate can be obtained.

b) A single phase half wave rectifier is used to supply power to load impedance 10Ω from 230V,50 Hz A.C. supply at firing angle 30^0.Calculate average load voltage.

Ans:[Formula 1M, correct steps 3 M]



c) Compare natural and forced commutation.
Ans: (Any 4 Points, 1M each)

Parameters	**Natural Commutation**	**Forced Commutation**
Need of external commutating components	Not required	Required
Types of supply	Source is AC	Source is DC
Cost	Less Cost	costly
Power dissipation	Less as no power loss takes place in the components	More as some power loss takes place in the components
Nature of Current to switch of SCR	current naturally reduces to zero	Current is forced to zero
Cost	Less cost	More cost

d) State one application each for

i) SCR

ii) PUT

iii) TRIAC and

iv) GTO

Ans: (One Application- 1M each)

i) **SCR -** Used for temperature control Used in light dimmer, phase control, power control, inverters, choppers, static switch

ii) **PUT -** Saw tooth generator, as a triggering device

iii) **TRIAC -** It is used in static switch, phase control, speed control of AC motor, light dimmer ,heater control, liquid level control, AC power control, , flasher

iv) **GTO** –inverters, AC Drives, DC Drives

e) Explain dv/dt turn on methods of an SCR

Ans:

dv/dt Triggering:-

When the device is forward biased, J1 and J3 are forward biased, J2 is reverse biased. Junction J2 behaves as a capacitor, due to the charges existing across the junction.

If voltage across the device is V, the charge by Q and capacitance by C then,

$i_c = dQ/dt$

$Q = CV$

$i_c = d(CV)/dt$

$= CdV/dt + V.dC/dt$

as $dC/dt = 0$

$i_c = C.dV/dt$

Therefore when the rate of change of voltage across the device becomes large, the device may turn ON, even if the voltage across the device is small.

f) State any two features of power MOSFET which makes it suitable for medium power applications.

Ans: (Any 2 , Each Features 2M)

Features of Power MOSFET:

1) MOSFET is voltage controlled device
2) No possibility of second breakdown
3) High input impedance
4) More switching frequency compared to power BJT
5) MOSFET is less sensitive to voltage spikes.