Important Instructions to examiners:

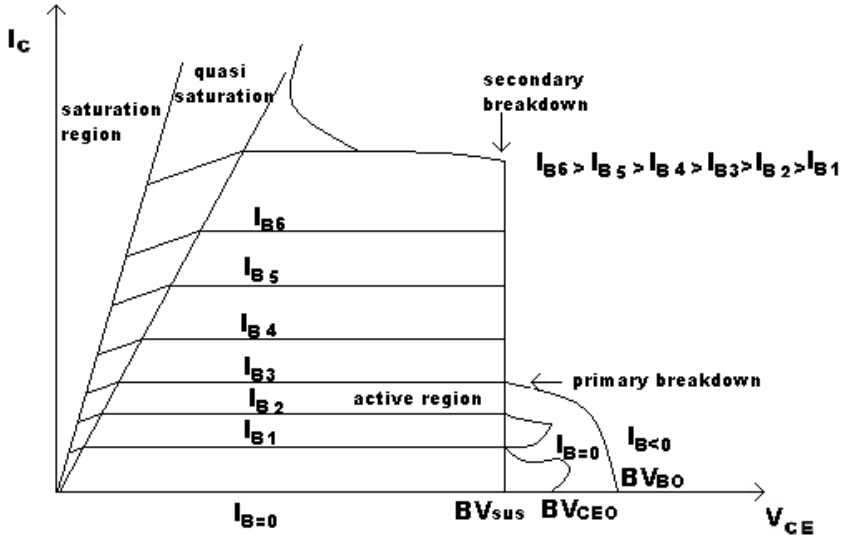
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling 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 judgement 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 three:

a) Draw and explain V-I characteristics of power transistor. What is meant by second breakdown?

3 mks

Power BJT is divided into four region.



1. Cut Off Region
2. Active Region
3. Quasi Saturation Region
4. Hand saturation Region

1.Cut- Off Region :-

In the region the emitter-base junction and the collector base junction are reverse biased and base current IB=0 & the collector current ICO. The power transistor offer a large resistance to Flow of Current & it operate as open switch.

2.Active Region :-

The emitter junction is forward biased and collector junction is reverse biased.

The collector current increases slightly with increase in the voltage VCE.

The collector current depend on the base current. The power transistor used as amplifier.

3.Quasi Saturation :-

The difference between a Power transistor and ordinary Transistor is the region called quasi-saturation region. This region is due to the ___ lightly doped drift region. This region is between hard Saturation Region and active region.

When the power transistor has to be operated at high switching frequency. It is operated in this region.

4.Hard Saturation Region :-

By increase in the base current, the power transistor is pushed into Hard saturation. It is used as closed switch.

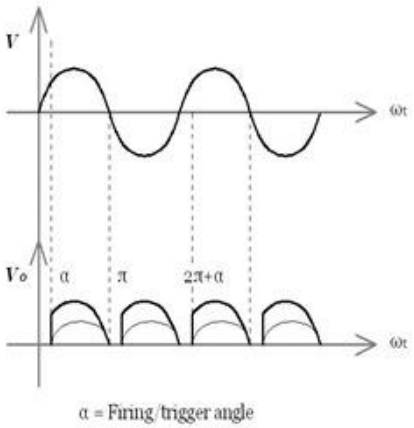
2nd Break down :- **1 mks**

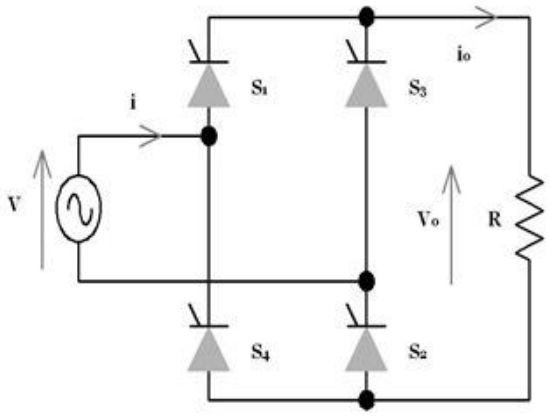
BJT and other type of minority carrier device have a potential Failure mode termed as 2nd Breakdown .

The 2nd Break down is destructive phenomenon because it produce localized not spot.

b) Draw a neat circuit diagram of single phase fully controlled bridge circuit with resistive load. Sketch the load voltage waveform for firing angle = 90°.

Single phase fully Controlled Bridge with Resistive load. 4 mks

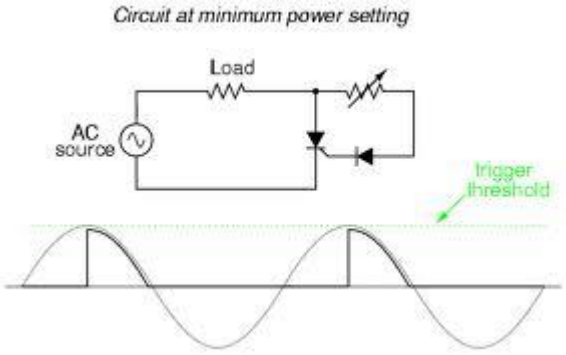




α=90

c) Justify the statement, "firing angle of Thyristor with Resistance firing circuit cannot exceed 90°". Support your answer with necessary circuit and waveforms.

Resistive load.. 3 mks



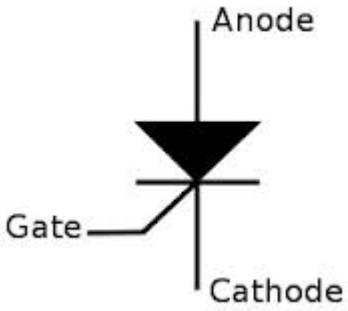
1 mks

Because by increasing or decreasing resistance SCR gate current can increase or decrease which control upto Peak value IG can very 0 to Max. and O/p can very 0 to peak.

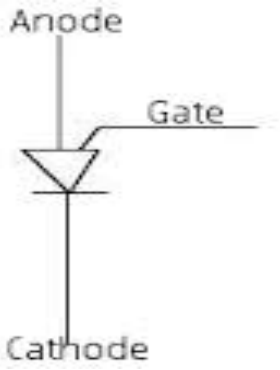
d) Draw a neat labeled symbol of

1) SCR 2) PUT 3) IGBT 4) UJT **1 mks for each symbol**

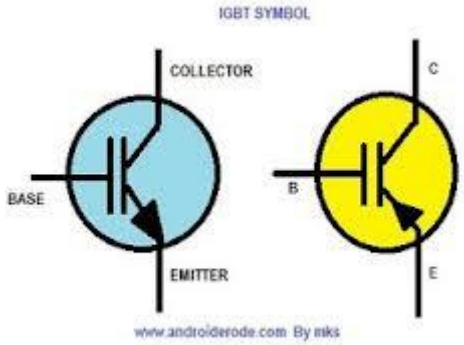
1) SCR



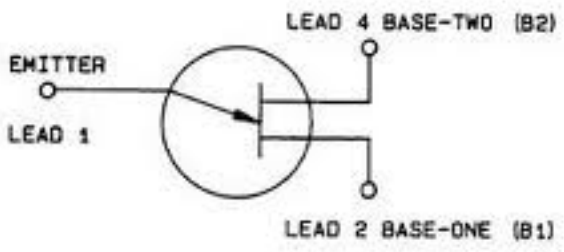
2) PUT



3) IGBT



4) UJT



B) Attempt any one:

State the necessity of thyristor turn OFF method. With a neat circuit diagram and waveforms, explain how class a method can be employed to turn off thyristor

2 mks

A thyristor that is in the on state can be turned OFF by reducing the forward current to a level below the holding current IH. Since thyristor cannot OFF automatically we have turn OFF SCR by some method.

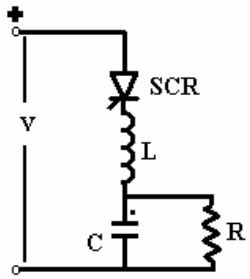
There are two method of turn OFF SCR.

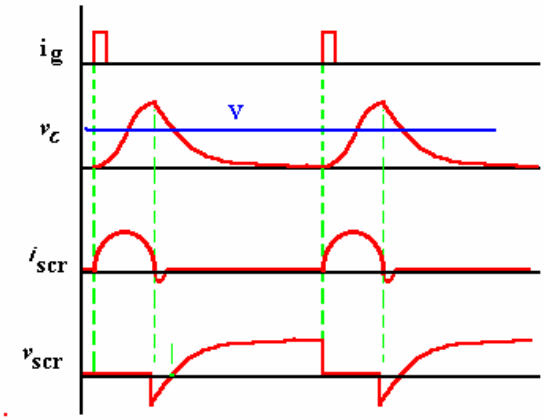
1) Natural commutation
2) Force Commutation

Class A Commutation :

(Self commutated by Resonating Load)

2 mks



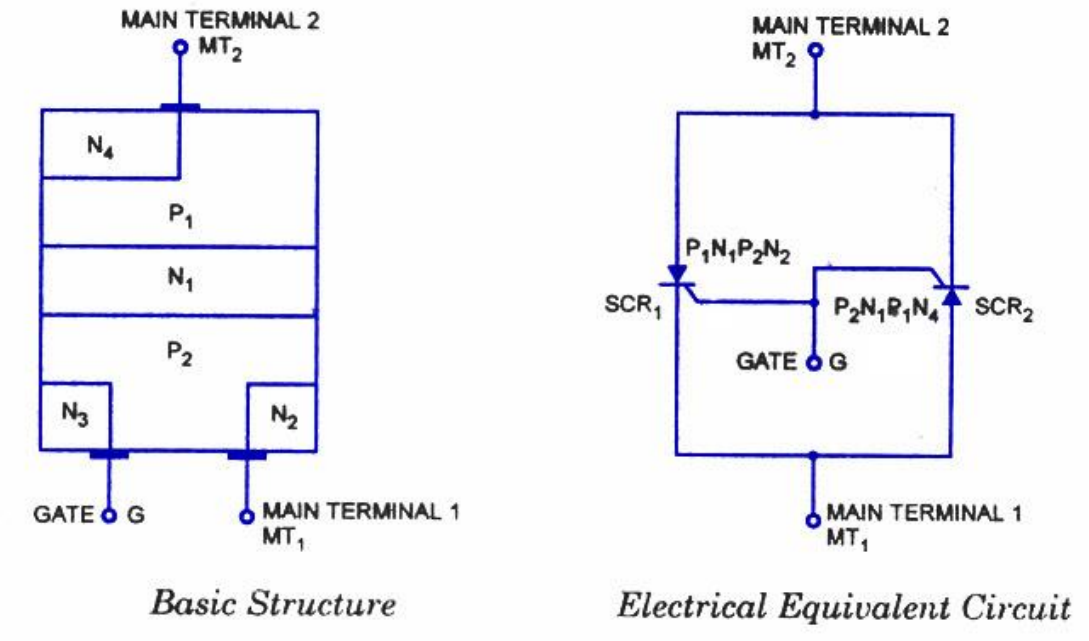


Working 2 mkr

When is triggered, anode current flow and charges UPC with positive. LCR is form resonating circuit. The current through SCR build up and complete a half cycle. Indicator current will then attempt to flow through the SCR in the reverse direction and the SCR will be turned OFF. The capacitor voltage is at its peak when the SCR turns OFF and capacitor discharges into the resistance is an exponential manner. SCR is reversed biased till the capacitor voltage return to the level of the supply voltage V.

b) With a neat constructional sketch and V-I characteristics explain working of TRIAC

2 mks



Explanation 2 mks

1. It has three terminal, Four layer bilateral semiconductor device.
2. It incorporate two SCR connected in inverse with common gate terminal.
3. It has six doped region. The gate terminal G makes ohmic contact with both the U & P terminal. This permit trigger pulse of either polarity to start conduction.
4. Since Triac is bilater device Instead of Anode and Cathode terminal name is MT_1 & MT_2 and Gate.
5. Through the Triac can be turned on without any gate current provided the supply voltage become equal to the break over voltage of the triac, but the normal Triac can operated through gate current. There are four different possibilities of operation.

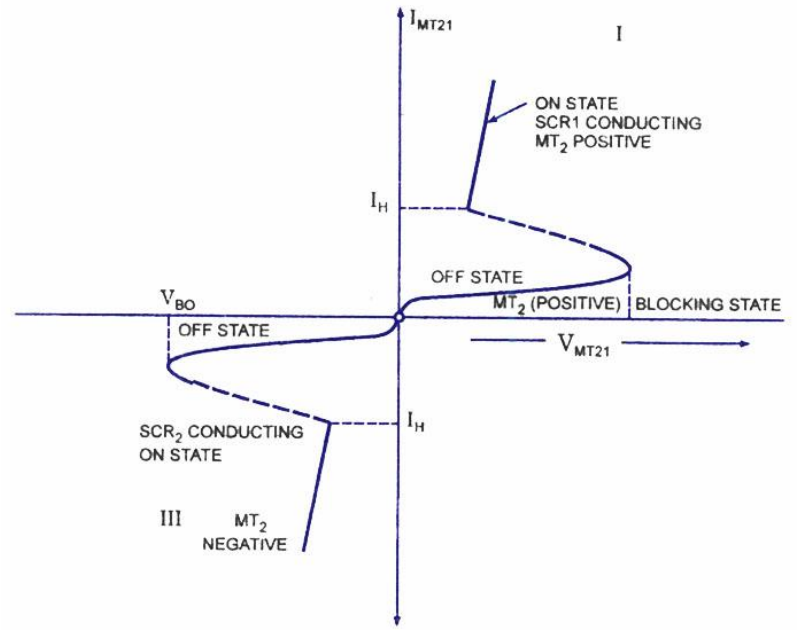
MT_2 & Gate (+ve) MT_1 (-ve).

MT_2(+ve) Gate(-ve) with MT_1

MT_2 & Gate (+ve) MT_1 (+ve).

MT_1 (-ve). Gate (+ve) MT_1 (+ve).

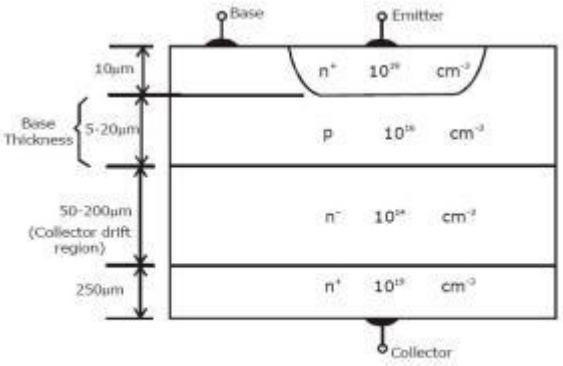
2 mks



V-I Characteristic of a Triac

Q2 Attempt any four:

a) Sketch and explain the vertical structure of power transistor. 2 mks



Explanation 2 mks

A power transistor has a vertically oriented four layer structure of alternating P type and N type layer with doping similar to an NPal transistor .

The Power transistor has three terminal.

1. Collector
2. Base
3. Emitter

The figure shown the vertical crass section of an NPN power BJT.

The emitter layer is heavily doped .

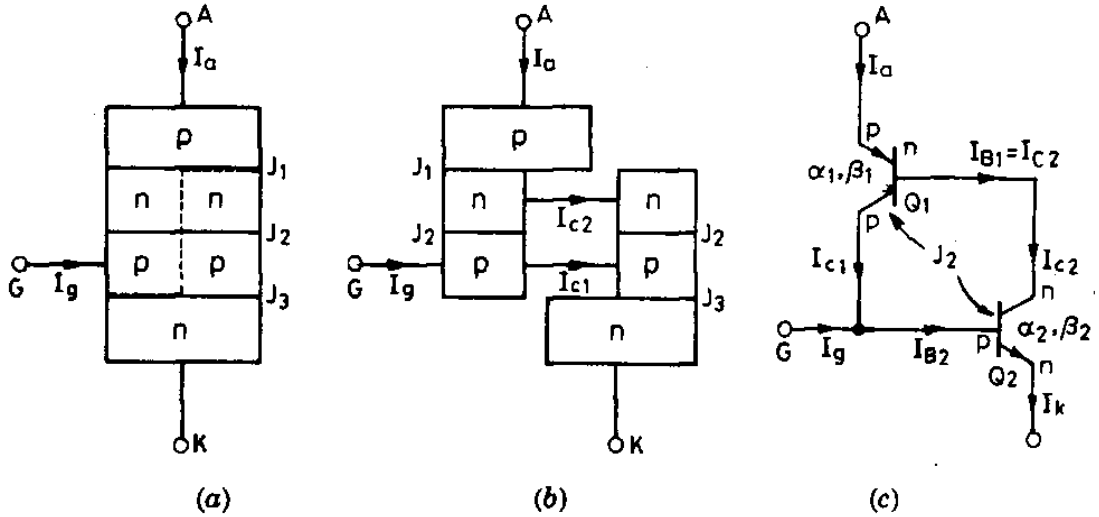
The 2nd layer i.e the base region (P) is moderately doped.

The 3rd layer i.e. collector drift region (N-) is lightly doped

The fourth layer adjacent to the drift region. i.e. Collector region (nT) is also heavily doped. The nT Region reverse as the collector contact.

The properties of power BJT depend on the doping concentration an thickness of each individual.

b) Draw and explain the two transistor analogy of SCR. 2mks



(a) (b) (c)

Fig. 4.15. Thyristor (a) its schematic diagram, (b) and (c) its two-transistor model.

Explanation 2 mks

The regenerative or latching action due to positive feedback .This can be demonstrated using two transistor for SCR. SCR can be considered as two complementary transistor one PNP and one NPN. The equivalent model is shown as figure.

The collector current I_c is related in general to emitter current I_E and leakage current I_{CBO}

$$I_C = I_E + \alpha I_{CBO}$$

And common base current gain is defined as $\alpha = \frac{IC}{IE}$

For Transistor Q1 $Ic1 = \alpha 1 I_a + I_{CBO}1$

Transistor Q2 $Ic2 = \alpha 2 I_k + I_{CBO}2$

Combine current $I_a = Ic1 + Ic2$

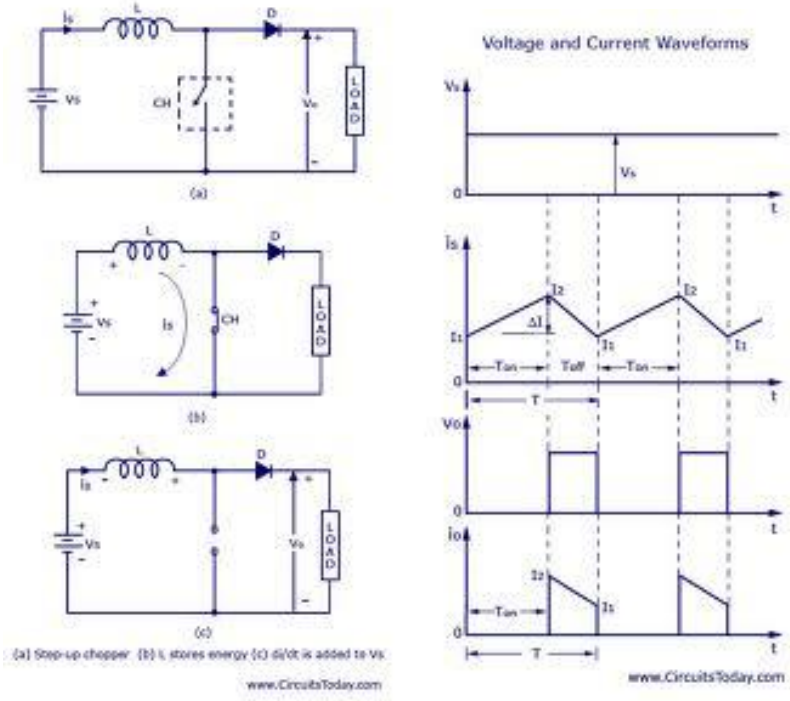
$$I_a = \frac{\alpha Ig + Icbo1 + Icbo2}{1-(\alpha 1+\alpha 2)}$$

Thus During turn on process of thyristor there is regenerative feedback which latch SCR in on state

[Note: Explanation can be other word but logical]

c) With a neat circuit diagram, explain the working principle of step up chopper.

[*Note: the switch can be SCR, MOSFET, BJT or IGBT]* 2 Mks



2 mks

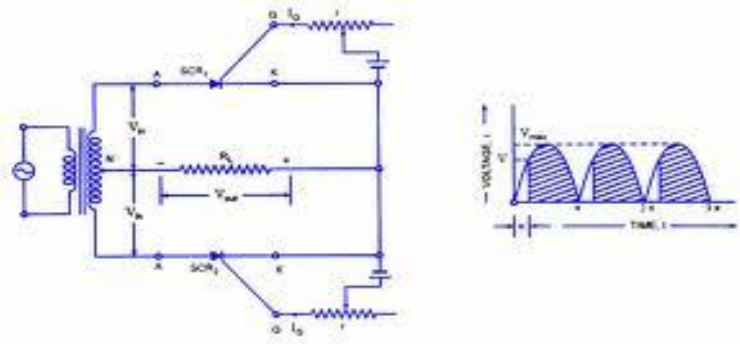
A step up chopper provides an output voltage higher than input

1. In a step up chopper output is more than input when switch is on for period Ton current through inductor rises and $Vl = Ldi/dt$
2. If vin is i/p voltage, ton= on time, toff=off time t= total time, Ein=input energy to inductor, Eout=output to load
3. then Ein=vin tonI
4. Eout=(vo-vin)I toff
5. then Ein=vin tonI= Eout=(vo-vin)I toff
6. vin ton=(vo-vin) toff

vo=vin(1/(1-D) where D =ton/total time

d) Draw a neat circuit diagram and associated waveforms of midpoint converter with RL load.

4 mks

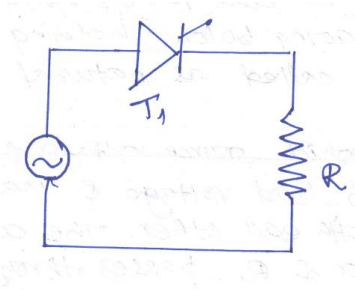


Circuit Diagram *Output Waveform*

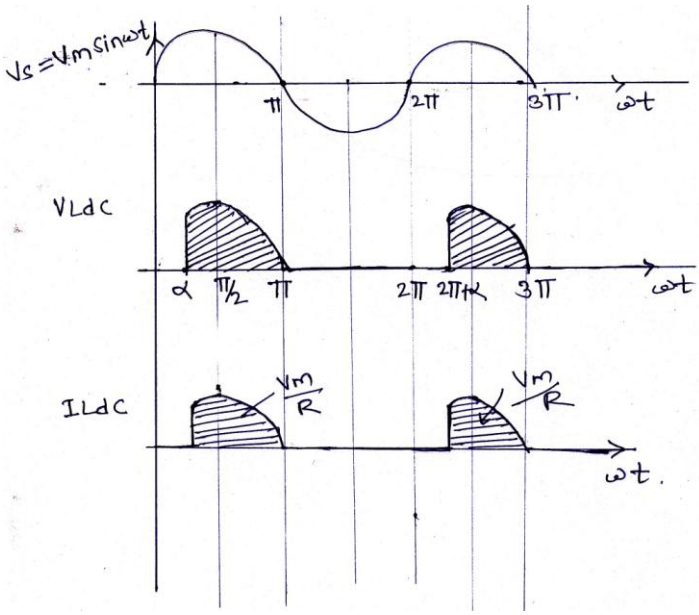
Full-Wave Rectifier Circuit Using Two SCRs

e) With a neat circuit diagram and associated waveforms, explain the working of single phase half wave controlled rectifier with resistive load.

1 mks



1 mks

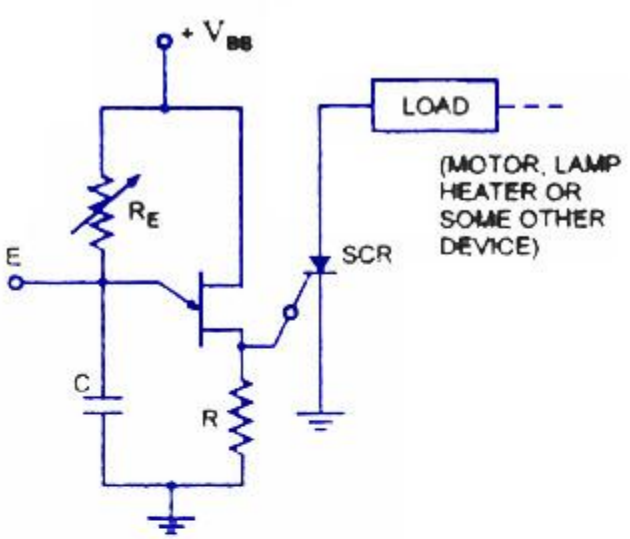


Explanation: 2 mks

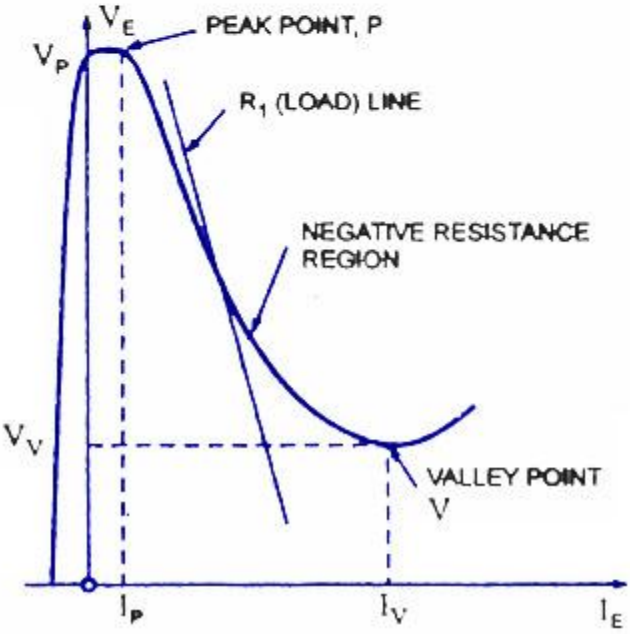
In Single phase half wave controlled rectifier single SCR is used, depending α O/p at the cycle will be at O/P and negative Half cycle completely clip. For ckt. diagram as shown in fig. wave form is also given . If α is less O/p will be maximum if α is more o/p will minimum

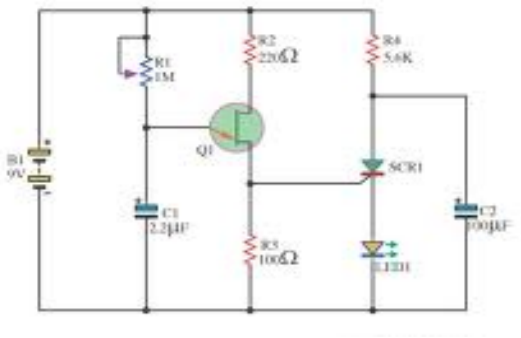
f) With neat circuit diagram, explain the working of SCR triggering using UJT.

2 mks



UJT Triggering of An SCR





Explanation 2 mks

Using UJT relaxation oscillator SCR can be triggered as shown figure. Firing angle can be controlled using RC Ckt. at UJT. Pulses are connected to SCR through pulse transformer.

Q3 Attempt any four

a) Describe the various turn on methods for thyristor.

Ans List **1 mks**

1) Forward voltage triggering
2) Thermal triggering
3) Light triggering
4) Dv/Dt triggering
5) Gate triggering

Explanation **3 mks**

1) Thermal Triggering –

In a SCR when the voltage applied between the anode and cathode is very near to its breakdown voltage, the device can be triggered by increasing its junction temperature increasing temperature will decrease the width of the depletion layer. At one stage of increasing temperature a situation come when the reverse biased junction collapse making the device.

2) **Forward voltage triggering**: - when we increase the forward +ve voltage applied between anode & cathode as soon as the forward voltage reaches the VBO the middle junction break down & thyristor turn on.

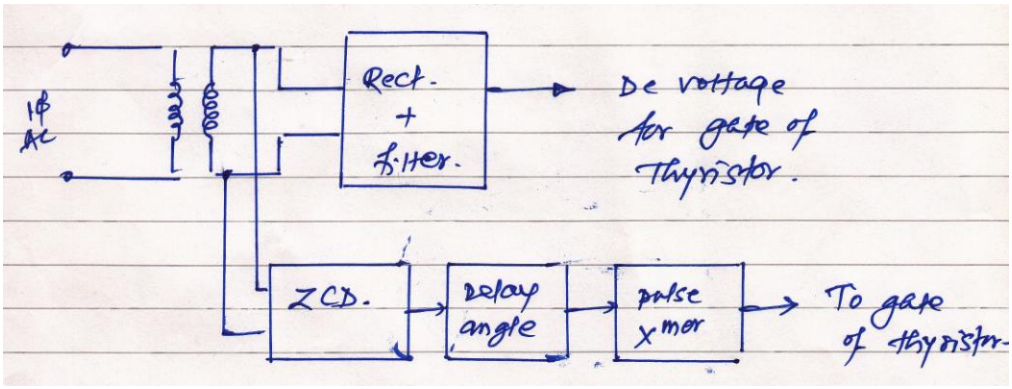
3) **Official triggering:-** when light falls on junction than photons will strike the electrons & increase the no of electrons holes pairs, thyristor will turn on.

4) **Dv/dt triggering** :- when we suddenly apply a very high voltage between anode & cathode of thyristor then it is said that the rate of change of voltage.

5) **Gate triggering**:- if sufficient amplitude & duration is applied to the gate terminal of flow biased thyristor to turn on

b) Draw general block diagram of a thyristor gate triggering circuit and explain the same

2 mks

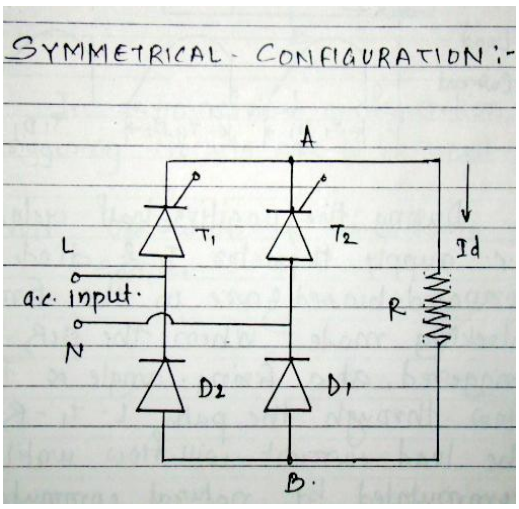


2 mks

When ac supply given to step down transformer. Which given to rectifier & filter then o/c, o/p voltage is given to gate of thyristor at the same time step down voltage is given to ZCD produces short rectangular pulses, the delay angle block internally produces a Saw tooth waveform synchronized with the ac supply, the pulse transformer couples magnetically the triggering pulse to the gate cathode terminals of a thyristor, it physically isolate the gate triggering ckt from the high power thyristor ckt.

c) **With a neat circuit diagram, explain the working of single phase half controlled bridge rectifier with resistive load.**

2 mks



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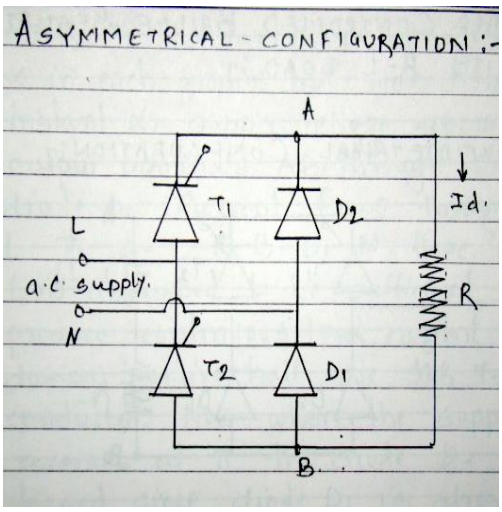


2 mks

During the positive half cycle of the Ac supply, thyristor T_1 & diode D_1 are forward biased & are in the forward blocking mode. When the SCR T_1 is triggered, at a firing – angle α the current flow through the path L – T_1- R – D_1- N. The load current will flow until it is commutated by natural commutation. During the negative half cycle of the Ac power supply SCR T_2 & diode D_2 are forward biased. When SCR T_2 is trigger at an angle α the current would flow through the path N- T_2 – A – R- B- D_2- L. This current is continuous till angle 2 π when SCR T_2 is turned OFF.

d) What is inverter? Give classification of inverter.

Inverter is a circuit which convert dc into ac 1 mks

Classification: ½* 6= 3 mks

i) Voltage source

ii) Current source

iii) Series inverter

iv) Parallel Inverter

v) Bridge Inverter

vi) Square wave inverter

vii) Quasi square wave inverter

viii) PWM inverter

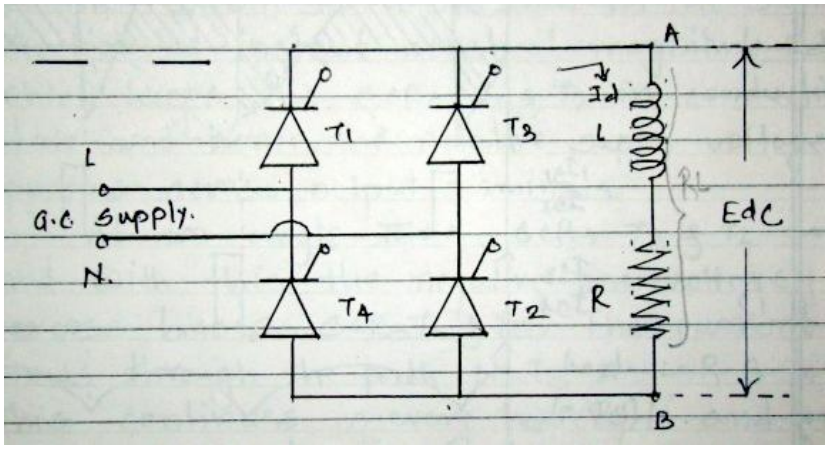
ix) Sine wave inverter

x) Thyristorised inverter

xi) transistorized inverter

e) Draw a nest circuit and associated waveform of fully controlled bridge circuit with inductive load in inverting mode.

2 mks



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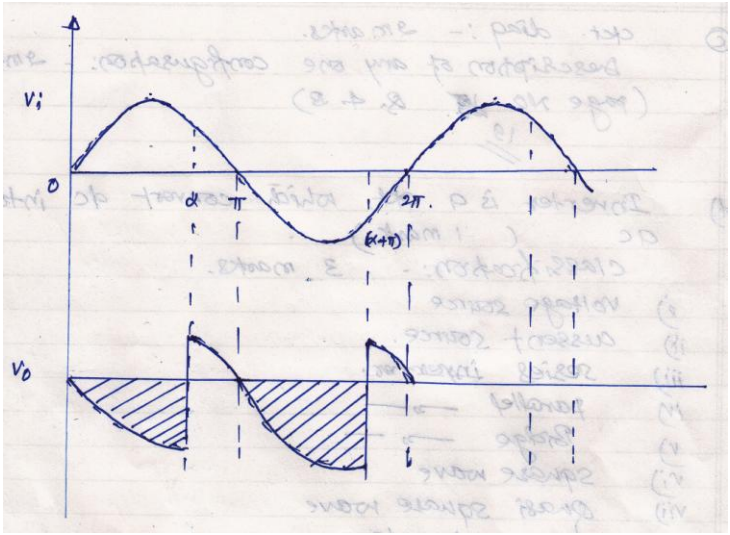


4. A) Attempt any three **4 mks**

a) State the need and use of polyphase rectifiers **2 mks**

Need of polyphase rectifiers:

1. The power supplying capacity of the single phase rectifiers is limited (say upto 2kW).
2. If power higher than 2kw, this has to be delivered to the load, then we have to need the polyphase rectifiers.

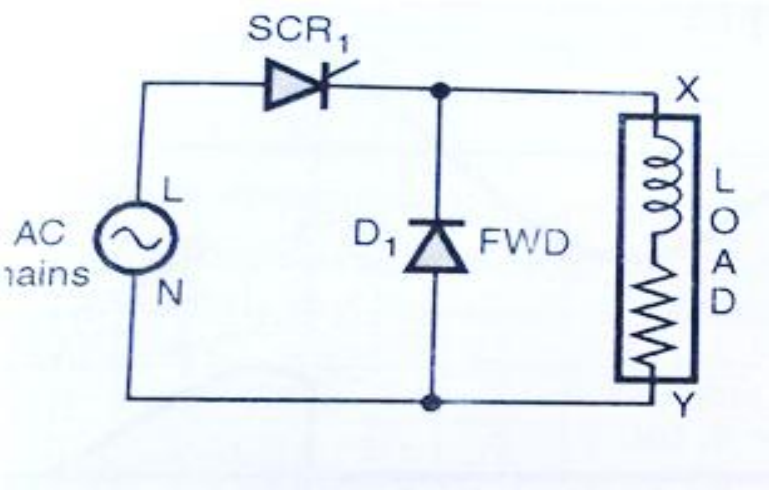
Use of polyphase rectifiers **2mks**

1. When the power rating exceeds 2kW, polyphase rectifier are used in place of single phase rectifiers
2. Polyphase rectifiers can be used for **Higher values of average load voltage and average load current**
3. To drives 3-phase induction motor

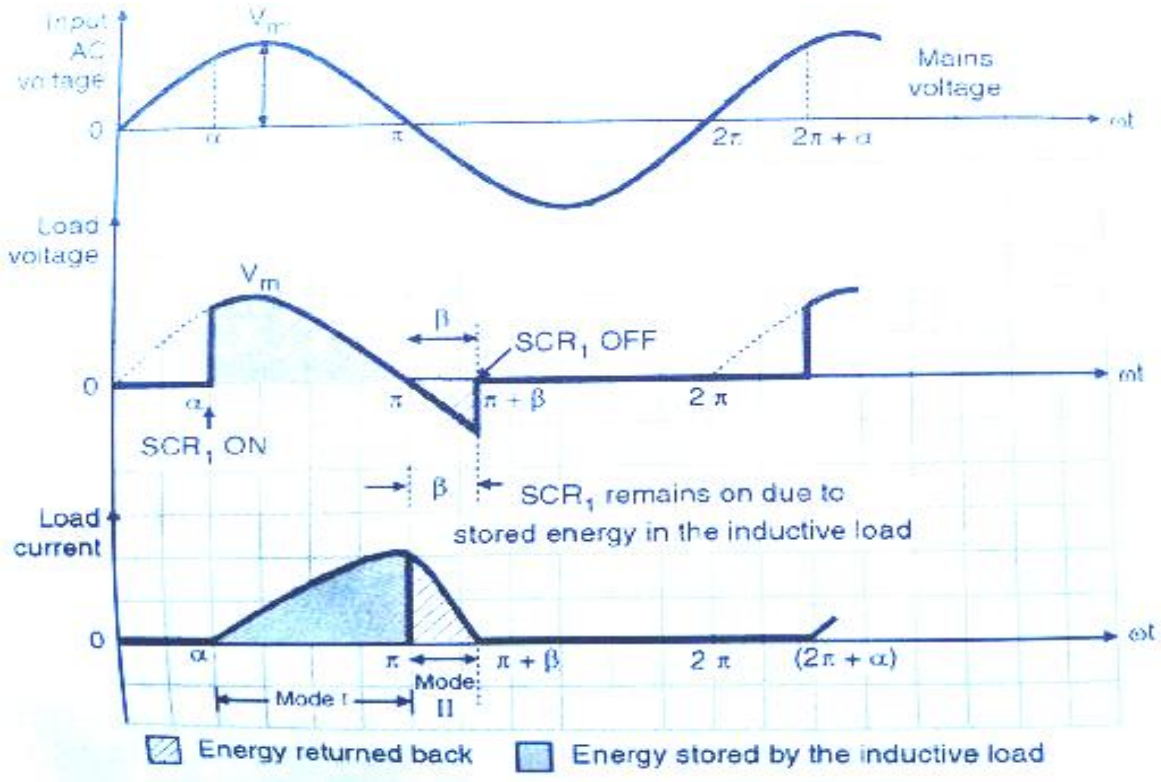
[Note: additional points can be considered]

b) Draw a neat circuit diagram and associated waveforms for single phase half wave controlled rectifier with RL load. State the use of freewheeling diode.

1mks



2mks



Associated waveforms for single phase half wave controlled rectifier with RL load

State the use of freewheeling diode **1 mks**

1. When all the device connected in converter circuit turn off, the current through RL load is disturbed there is a negative self induced voltage across the load which turn on the freewheeling diode.
2. This diode will dissipate the storage energy in the RL load in the form of heat.
3. It also ensure that the load voltage is unipolar, because it does not allow the Load voltage to become negative.
4. It can be used to convert a full converter into a semi-convertor
5. It makes load current continuous

c) Compare: Single phase half wave controlled rectifier and single phase full wave controlled rectifier'(four points).

[*Note ; any four points. Each point 1 mark]* 4 mks

S. No	Single phase half wave controlled rectifier	Single phase full wave controlled rectifier
1.	It uses one thyristor.	It uses four thyristor
2.	One quadrant converter	Two quadrant converter
3.	At time one thyristor is conducting	At a time two thyristor are conducting
4	POWER FLOW UNIDIRECTIONAL	POWER FLOW BIDIRECTIONAL
5	Ripple frequency is 50Hz	Ripple frequency is 100Hz
6	PIV=Vm	PIV=2Vm
7	VLDC= Vm\π	VLDC= 2Vm\π

d) What is meant by step up chopper and step down chopper? Draw a neat circuit diagram of step down chopper.

ANS:--

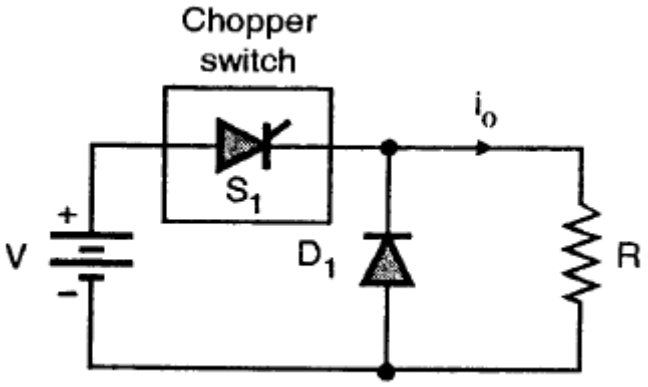
Step down chopper **1 mks**

If chopper output voltage is less than input voltage it is called step down chopper.

Step up chopper **1 mks**

If chopper output voltage is greater than input voltage it is called step up chopper.

2 mks

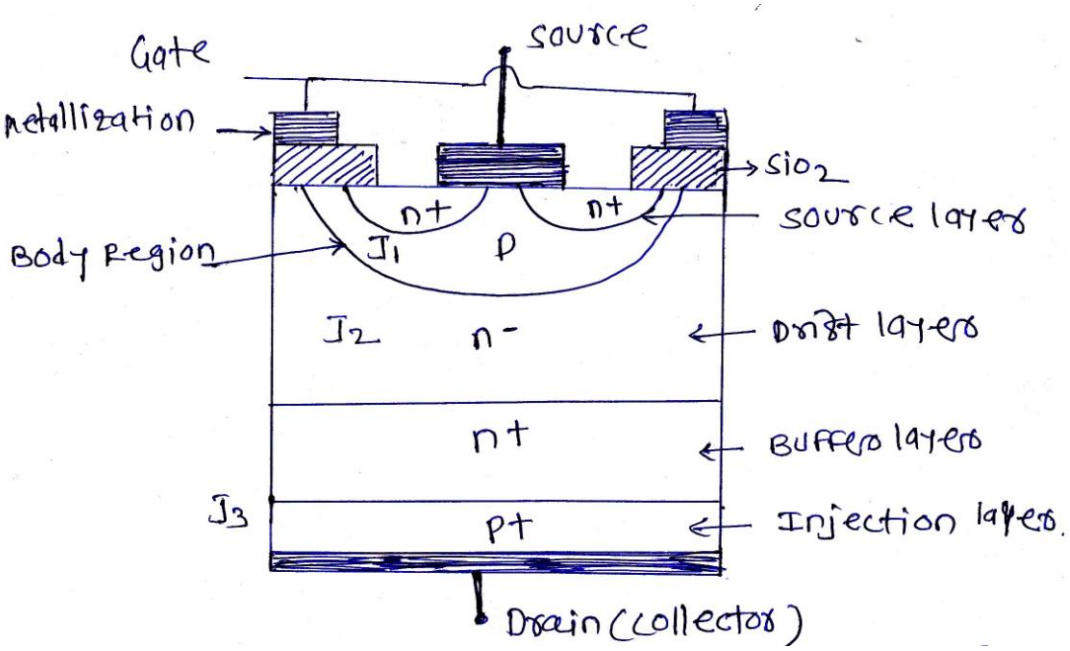


Neat circuit diagram of step down chopper.

4 B) Attempt any one :

a) With a neat constructional sketch and V-l characteristics explain the working Principle of IGBT

2 mks



1 mks

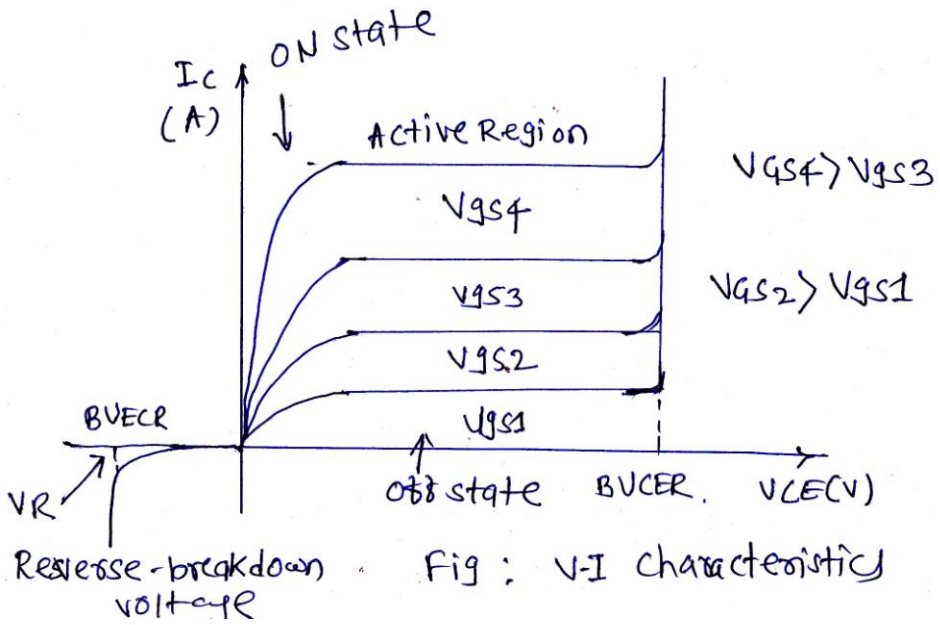


Fig : V-I Characteristics

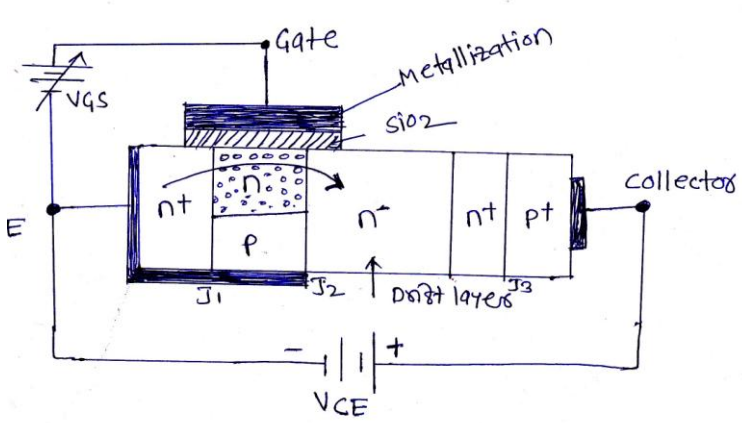
Working Principle of IGBT 3 mks

The operating principle of IGBT can be divided into two parts

i) Creation of an inversion layer

ii) Conductivity Modulation

i) Creation of an inversion layer

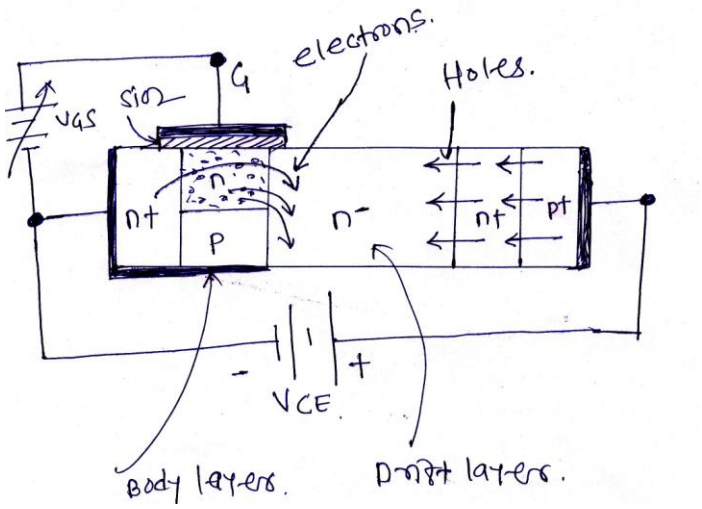


Working principle of IGBT

The operation of an IGBT is based on the principle of creation of an inversion layer. When the gate to source voltage (VGS) greater than VGS is applied. N-type inversion layer is created below the Sio_2 layer, as shown in figure.

Due to the formation n-type layer in the p-type body layer a channel (n^+ n n^-) is formed which helps to establish the current as shown in figure.

ii) Conductivity Modulation



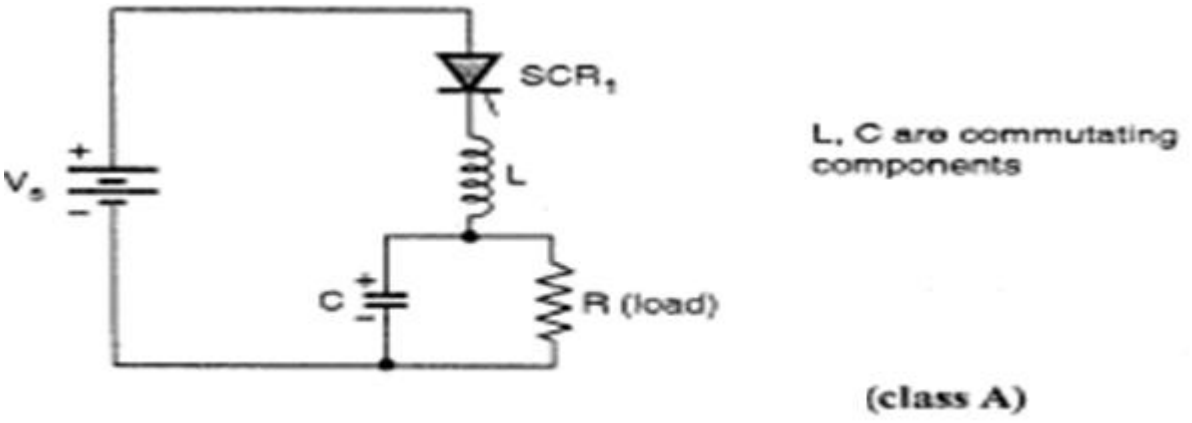
As shows above figure there is junction (J3) is forward biased, when the forward voltage is applied between the collector and emitter. Due to the creation of inversion layer, electrons from the emitter are injected into the n^- drift layer via the n-channel (n^+ n n^-). As the junction J3 is already forward based and it will be injected holes in the n^-drift layer create a space charge which will attract holes from the n^+ buffer layer which were injected by the p^+ layer. This way there is take place double injection into the drift Region from both side as shown. This increases the conductivity of the drift region and reduces the resistance to its minimum and IGBT will be conducted.

b) Define forced commutation and explain the class A and class B commutation method.

Forced commutation **1 mks**

1. When the SCR operate on a pure DC input voltage, their forward voltage current cannot be reduced below holding current naturally.
2. Therefore the thyristor must be commutated "forcibly" by using additional" commutation circuit".
3. This external commutation will turn off the thyristor by either current or voltage commutation. It is called Forced commutation

class A method (self commutation by resonating the load) **3½ mks**



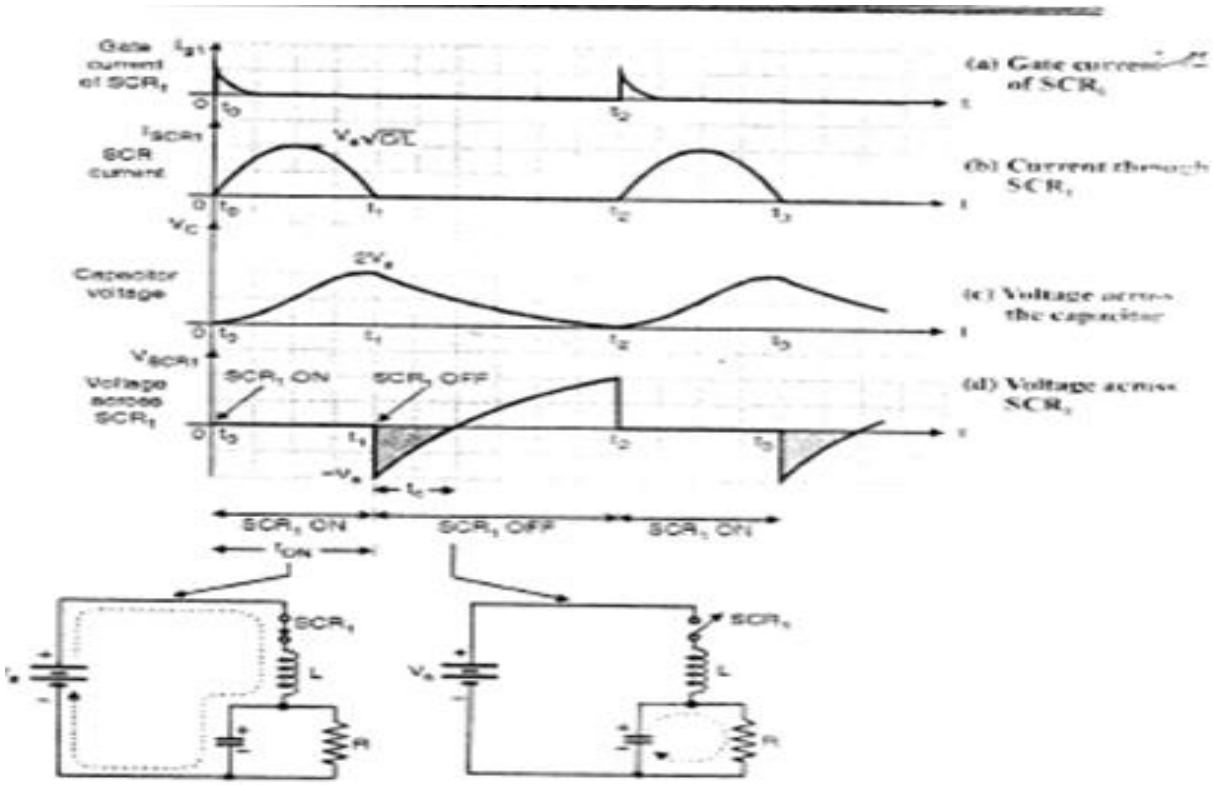
(class A)

1. Load in parallel with capacitor:
2. The figure shows the SCR circuit that uses a class A commutation. The class A commutation is also called as self commutation.
3. L and C are the commutating components and R is the load resistance.
4. The commutation components L and C from an under damped resonant circuit.

Operation of the circuit

At t=to the SCR is turned on, the dc supply voltage is applied to the resonant circuit. Due to presence of under damped LC resonant circuit, the anode current of SCR is sinusoidal in nature. At t =t1 the voltage on capacitor C reaches Its maximum & the anode current goes to Zero. The capacitor will then attempt to Force a reverse current through SCR1 and SCR will be turn off. As soon as SCR is turned off, the capacitor Starts discharging through R. the voltage Across SCR1 at the instant t1 is negative as The Voltage on capacitor C is higher than the Input supply voltage Vs.

Waveform of class A method



Waveforms and equivalent circuits for self commutation (class A) circuit

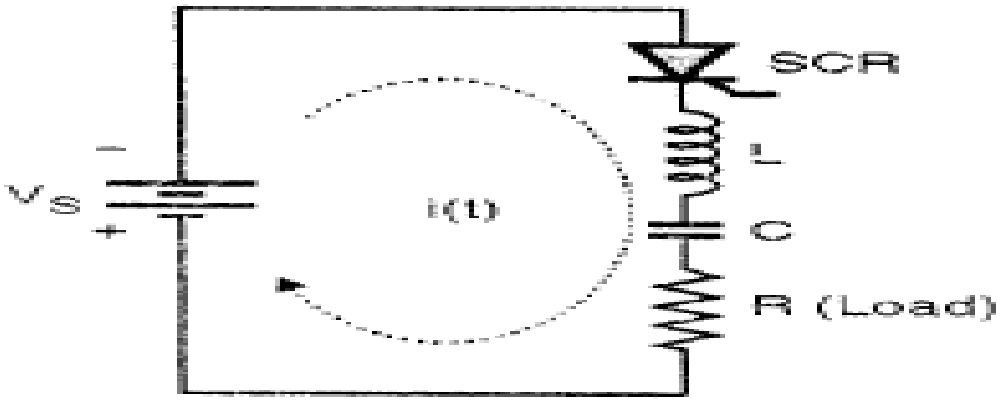
OR

Load in Series with the SCR :class A method

This is another arrangement of Class A type commutation.

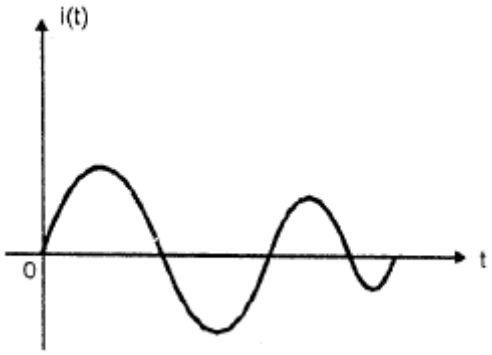
Operation:

When the SCR is turned off by applying a gate pulse the Charging current i(t) of the capacitor starts flowing. As the LC components form an under damped circuit the charging current will be sinusoidal in nature. As soon as the capacitor is fully charged, the charging Current reduces to zero and the SCR turned off due to Natural commutation.



Load in Series with the SCR :class A method

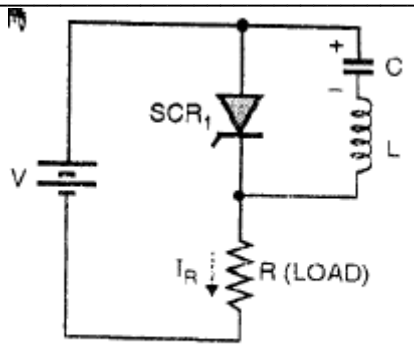
Waveform Of Class A Method



Class B commutation method. OR Self commutated by an LC circuit **3½ mks**

The commutating component L & C are now connected across the SCR1 instead of connecting them in series with it. This will ensure that the commutating component do not have to carry the load circuit.

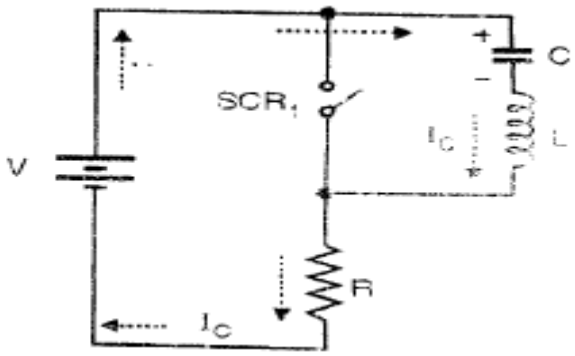
The operation of the circuit can be divided into three modes.



(a) Class B commutation

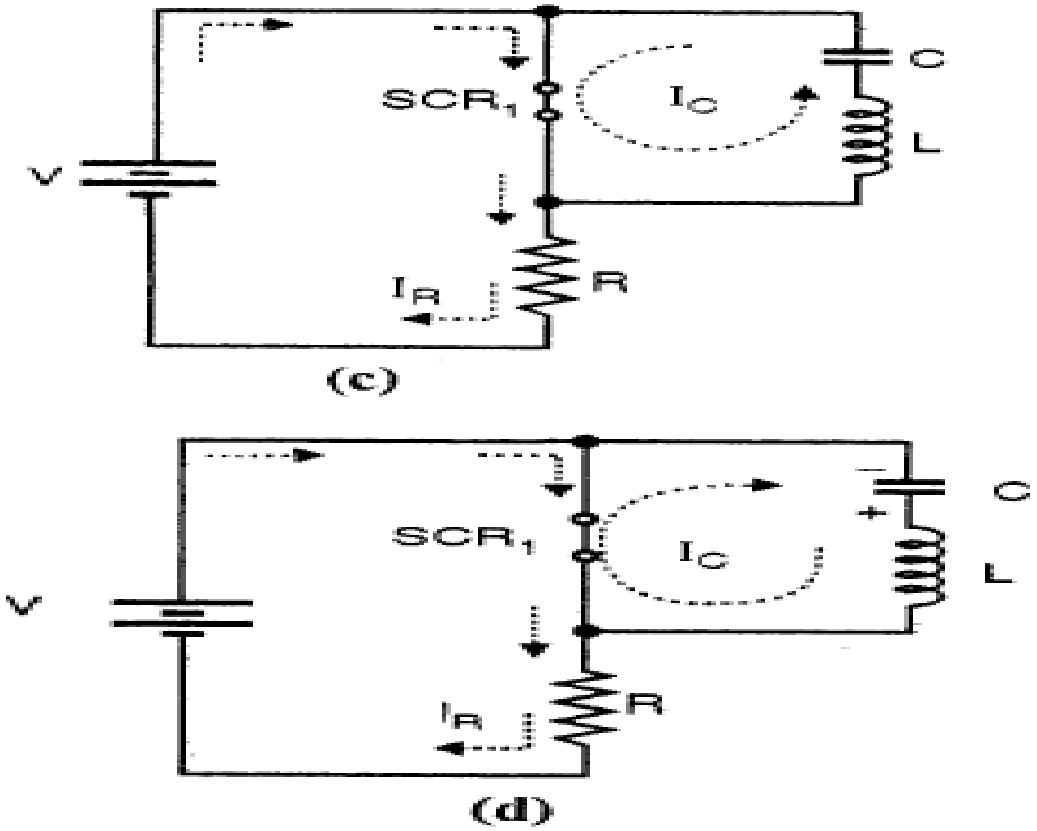
Mode 1 (before t=to)

Before the gate pulses is applied to SCR1 the commutating Circuit will be charged with the polarities as Shown in figure through L & R. The peak voltage on the capacitor will be higher Than the supply voltage V due to the presence of Inductance L in series with it. The SCR1 is not yet turned on, hence it is Equivalent to an open circuited switch as shown In the figure.



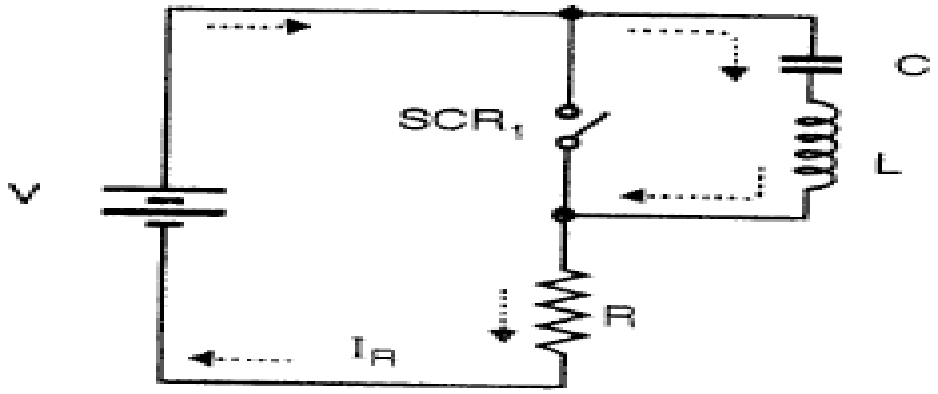
Mode 2 (to≤t≤t1)

At instant t=t0 the SCR1 is triggered When the SCR1 is turned on it acts Like closed switch. The current through SCR1 is then sum of two current, the load current Ir which is constant And the discharge current of capacitor C which is sinusoidal, as shown in figure (c).The voltage on the capacitor C will reverse its polarities and Ic=0.The reverse voltage on the capacitor C will try to force a reverse current through the Conducting SCR1. The net current through SCR1 is the difference between Ir & Ic. When Ir=Ic, Iscr1=0 and SCR will be come Out of conduction.

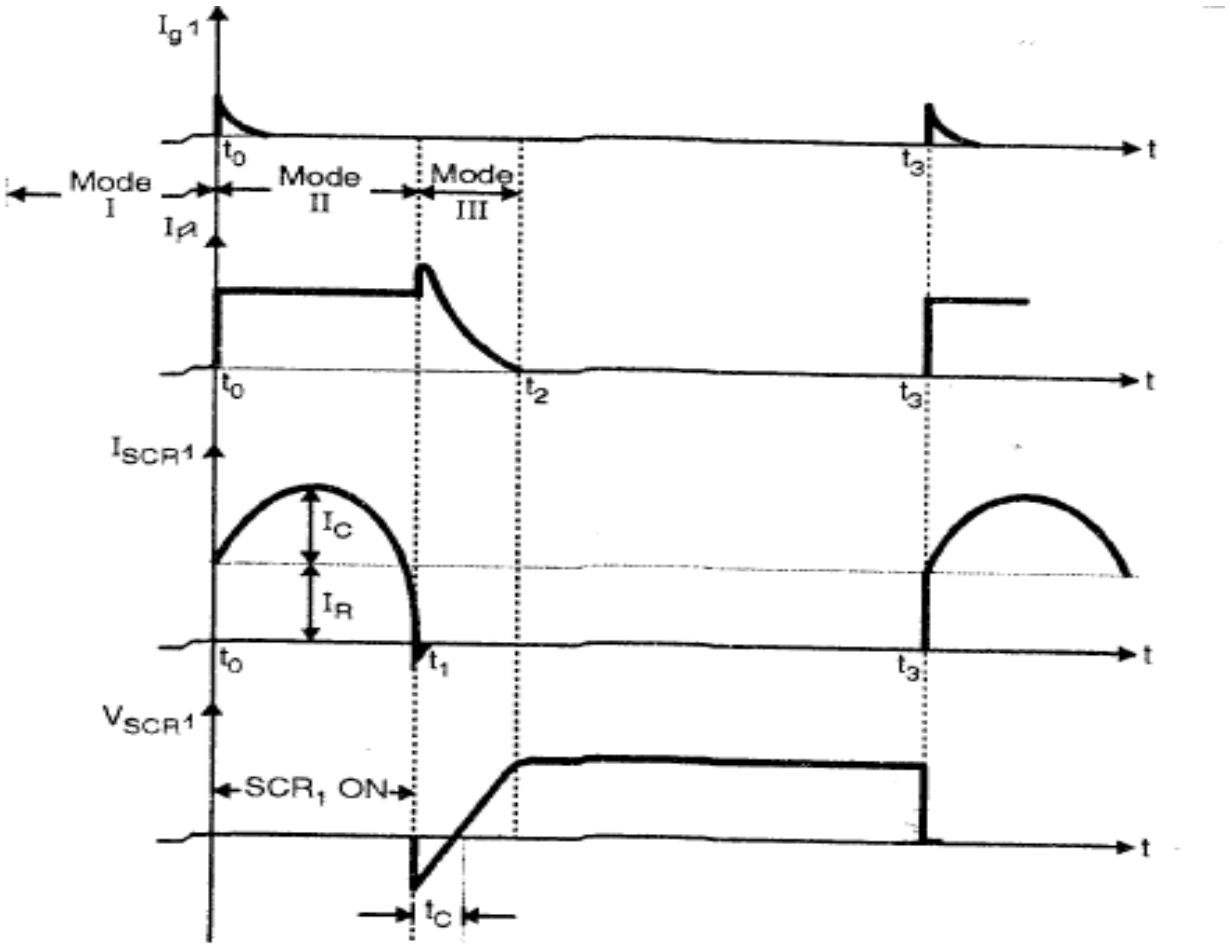


Mode 3 (t1≤t≤t2)

As soon as the SCR1 is turned off, the Capacitor C will start charging through L & RAs shown in figure. The load current Ir sharply increases at Instant t=t1 due to negative charge on the capacitor C, at t1.The charging current reduces exponentially as the capacitor Accumulates charge. When it is charged to full voltage, the charging current will be zero. The positive voltage on the capacitor will be held till the instant t3 where the SCR1 is turned on again. The cycle then get repeated. For successful commutation the period "tc" for which the main Thyristors SCR is reversed biased, must be greater than the turn off time of SCR1.



Voltage and current waveform for Class B commutation

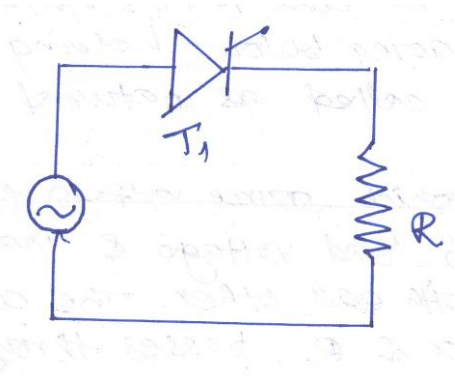


Q5

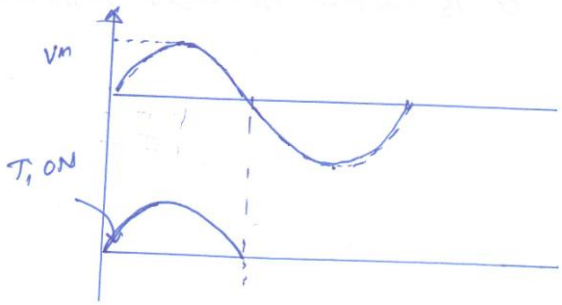
a) What is natural commutation? Support the answer with a neat circuit diagram and associated waveforms.

Ans When SCR turn off due to its forward current going below holding current naturally it is call as natural commutation 1 mks

1 mks



1 mks



1 mks

In which load voltage and load current will be in phase with each other therefore the current flowing in thyristor and R passes through a natural zero & reverse voltage appeared across the thyristor hence the conducting thyristor is then turn off. Due to natural behavior of the source voltage hence it is called natural commutation.

b) Compare : fully controlled bridge circuit in rectifying mode and in inverting mode (any four points)

Note: Additional points can be considered 1 mks each point

Fully Controlled Bridge Rectifying Mode	Inverting Mode
$\alpha < 90^o$	$\alpha > 90^o$
Average load voltage is +ve	Average load voltage is -ve
Net energy transfer in one cycle is form source to load	Net energy from load to source
Therefore the operation is called Rectification	Thus the converter works as inverter.

c) Write the necessary condition to turn on the SCR and to turn off the SCR

Condition to turn on the SCR **2 mks**

i) Anode voltage is positive with respect to cathode

ii) Forward biased voltage should be greater than break over voltage

iii) Anode current should be greater than holding current

iv) Sufficient amplitude of gate pulse applied to the gate of SCR

Condition to turn off the SCR **2 mks**

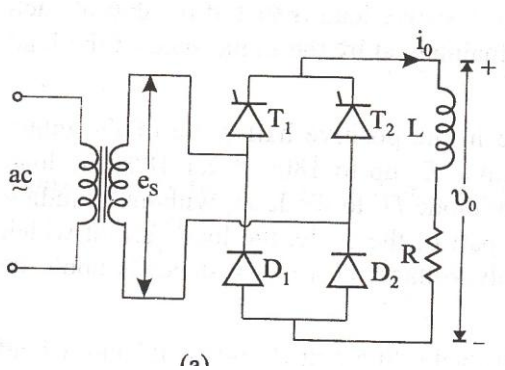
i) Anode voltage is negative with respect to cathode

ii) Anode current should be less than holding current

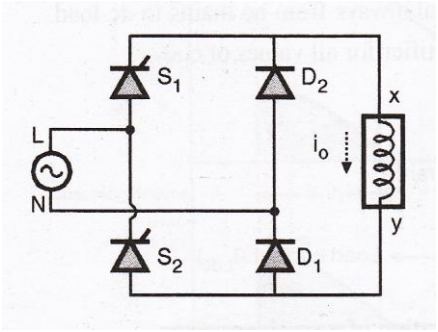
iii) $V_{AK} = 0$

d) Draw a neat circuit diagram and associated waveform of single phase half controlled bridge rectifier with RL load.

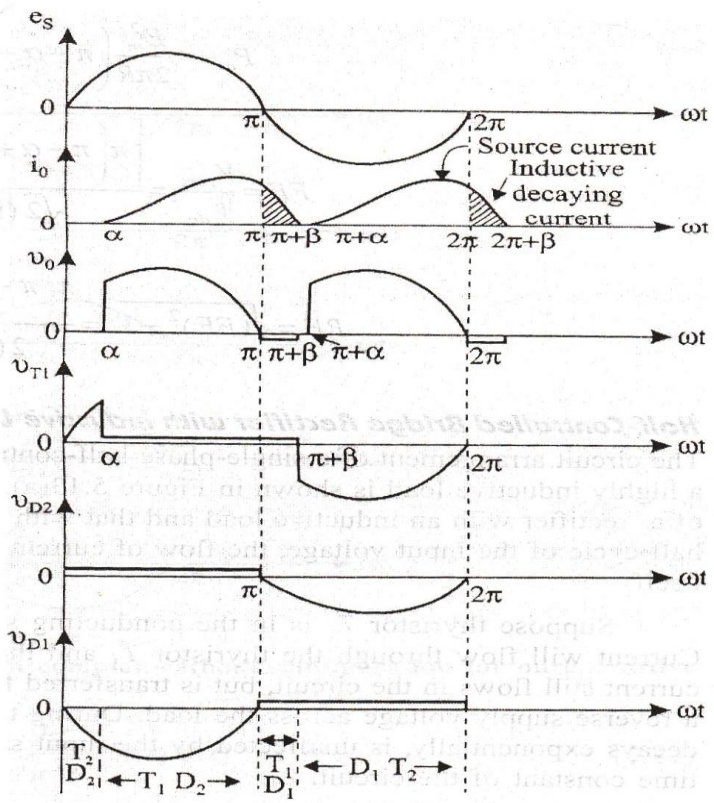
2 mks



OR

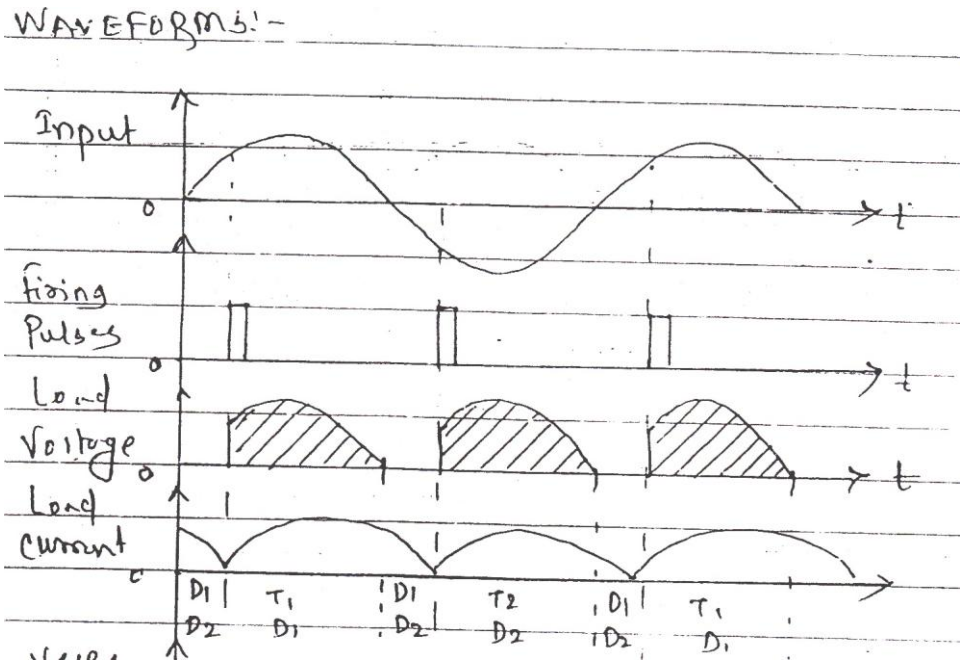


2 mks



OR

2 mks


WAVEFORMS:-
Input
0
t
firing
Pulses
0
t
Load
Voltage
0
t
Load
current
0
D1
D2
T1
D1
D1
D2
T2
D2
D1
D2
T1
D1

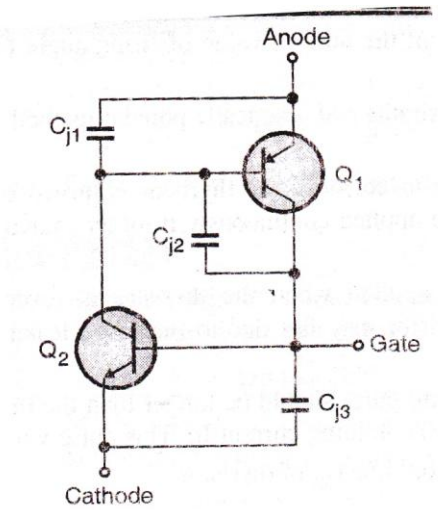
e) Compare : single phase midpoint converter and single phase bridge converter (four point)

1 mks for each point

Single Phase Midpoint Converter	Single Phase Bridge Converter
Center tap transformer is required	Not required
Configuration are center tap half wave and center tap full wave converter	Configuration are half bridge and full bridge converter
Minimum 1 and 2 SCR is required	Minimum 4 SCR are required for bridge
It is difficult to find out the center point of center tap transformer it is disadvantage of midpoint	Due to absence of center tap transformer it is easy to connect the SCR

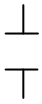
f) Draw and explain the dv/dt triggering of S.C.R.

2 mks



Dv/Dt triggering : - **2 mks**

Under forward bias condition junction J1 & J3 are forward biased whereas junction J2 is reverse biased. This reverse biased junction J2 behaves as a capacitor. Now if the forward voltage is applied suddenly a charging current will flow through capacitor. Thus device turn on

C_J = junction J2 

If V = voltage applied across the device

C_J = junction capacitance

Then the instantaneous current is due to suddenly applied voltage is $I_C = C_J \frac{dv}{dt}$

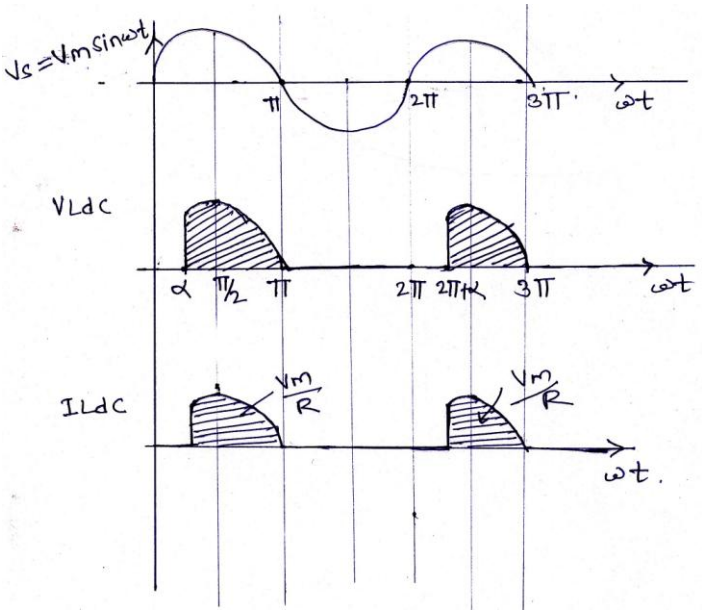
If $\frac{dv}{dt}$ is large the device may turn-on or trigger on, even when the voltage across the device is small.

This is known as dv/dt triggering.

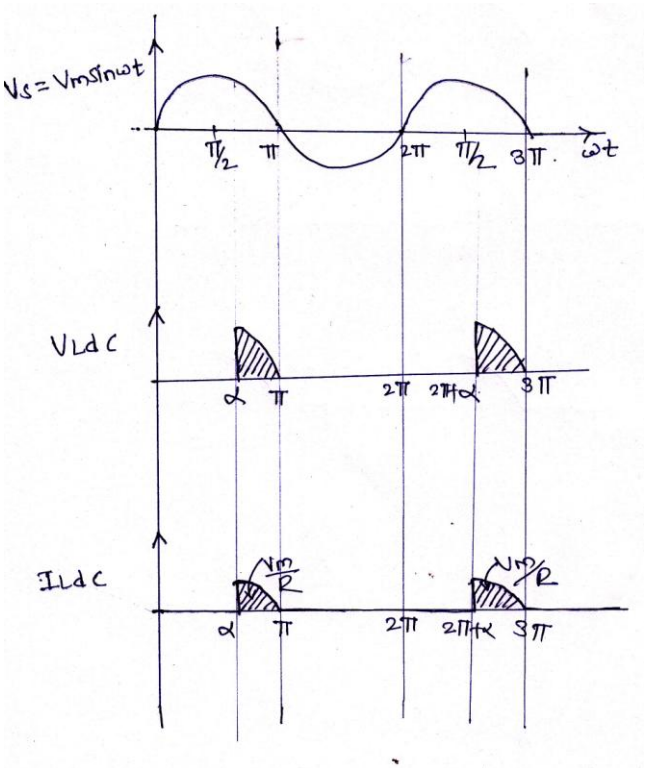
6. Attempt any four ' 16

a) Draw the output waveform for single phase half wave rectifier with resistive load for firing angle

i) Less than 90' 2 mks

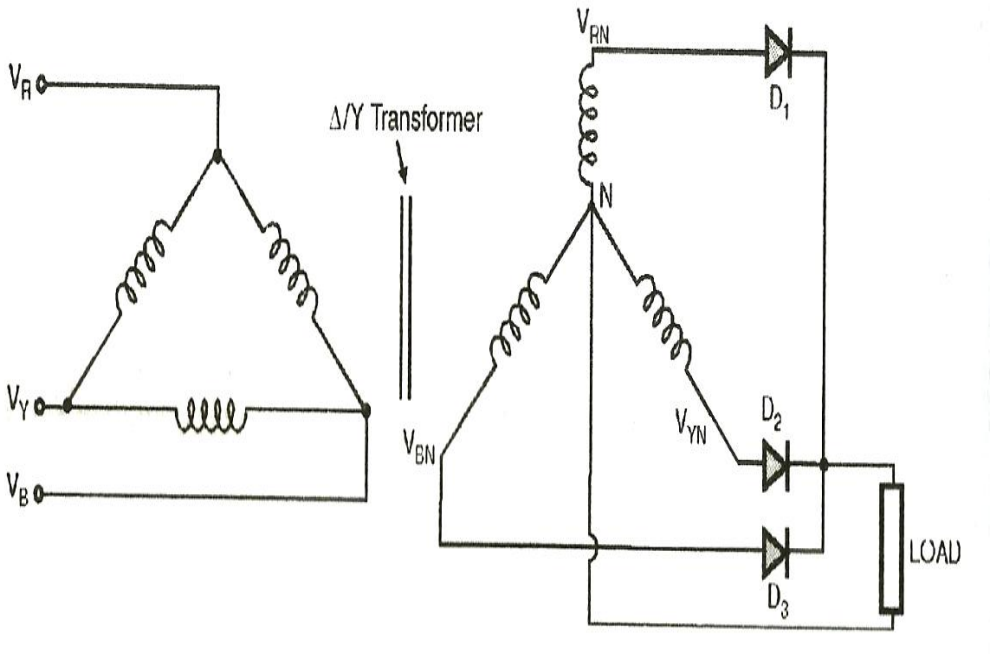


ii) Greater than 90". 2 mks

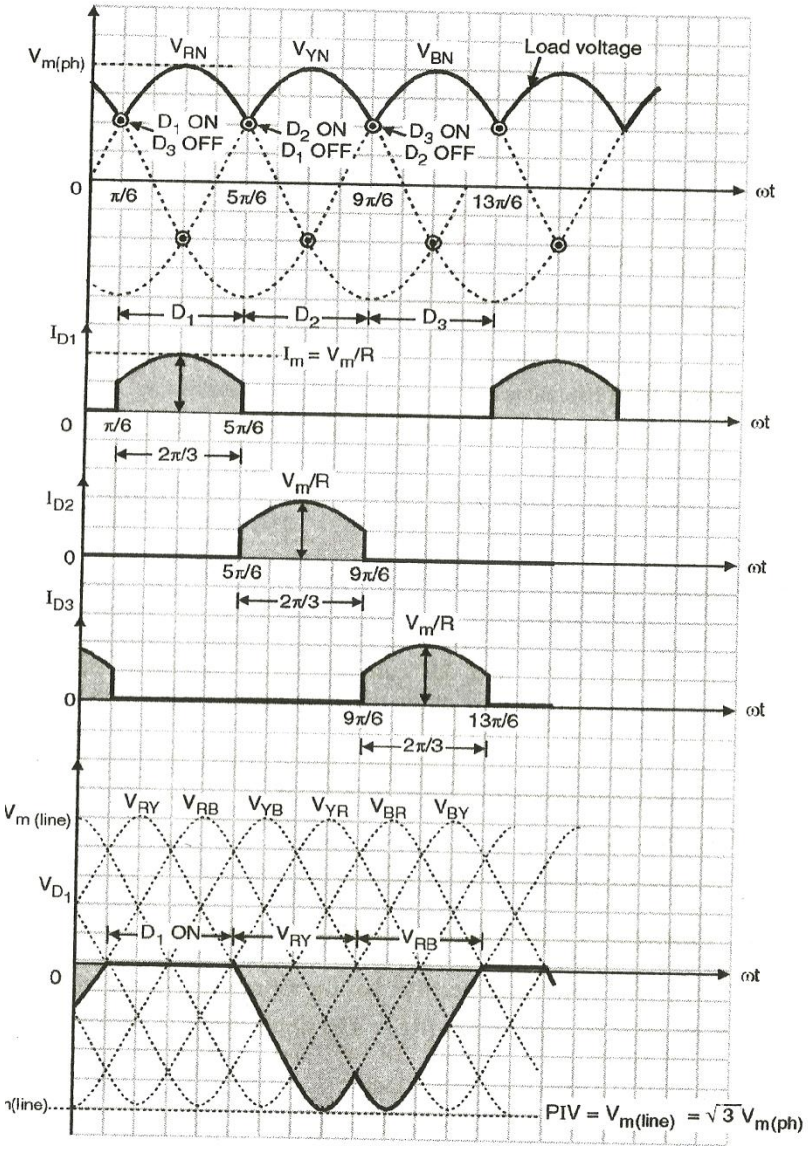


b) Draw a neat circuit diagram and associated waveforms of three phase half wave delta-wye rectifier

2 mks

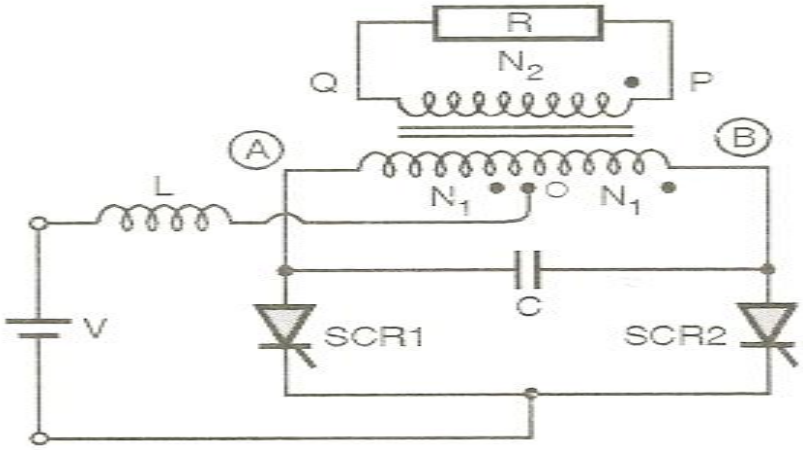


Associated waveforms of three phase half wave delta-wye rectifier **2 mks**



c) Draw a neat circuit diagram and explain the working of parallel inverter.

2 mks



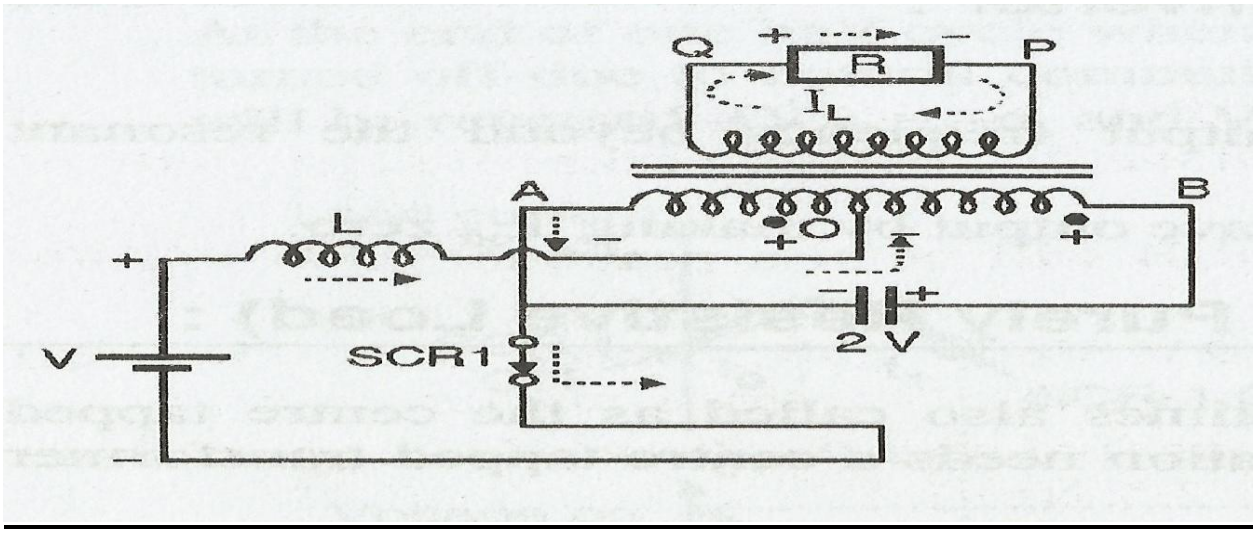
circuit diagram

1. Parallel inverter is sometimes also called as the center tapped inverter because this configuration needs a center tapped transformer
2. The thyristor S1 and S2 are switched alternately to connect the input dc source V in alternating senses across the two halves of the transformer primary.
3. This induces a square wave voltage across the load in the transformer secondary.
4. C is the commutating capacitor .the voltage of the capacitor is used to turn off the conducting scr, by turning on the non conducting scr

Working of parallel inverter **2 mks**

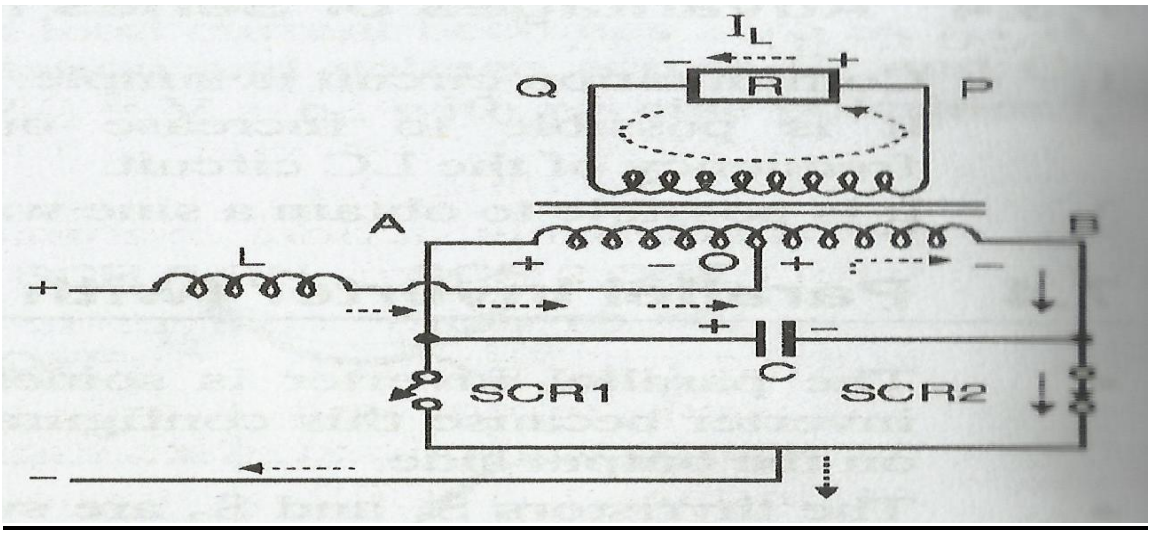
Working of the inverter can be divided into two mode they are following

Mode 1



* when **scr1** is turned on, the dc voltage source appear across the left half of the primary 0A.
* the primary current flow from 0 to A. due to the transformer action the voltage between the AB is 2V volts .
* hence the capacitor gets charged to a 2V volts .the load voltage is positive so is the load current

Mode2

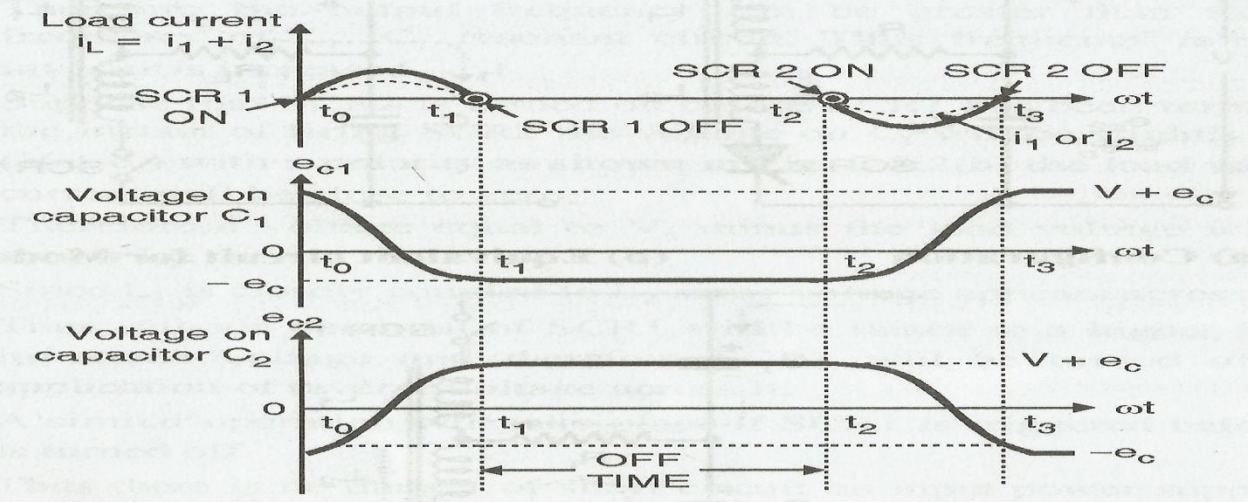


* The firing of **scr2** turns off scr1 by the principle of parallel capacitor commutation (the capacitor voltage is applied across scr1 directly to reverse bias it.

* the dc voltage gets applied across secondary winding OB. the primary current flows from O to B, through scr2 as shown in fig

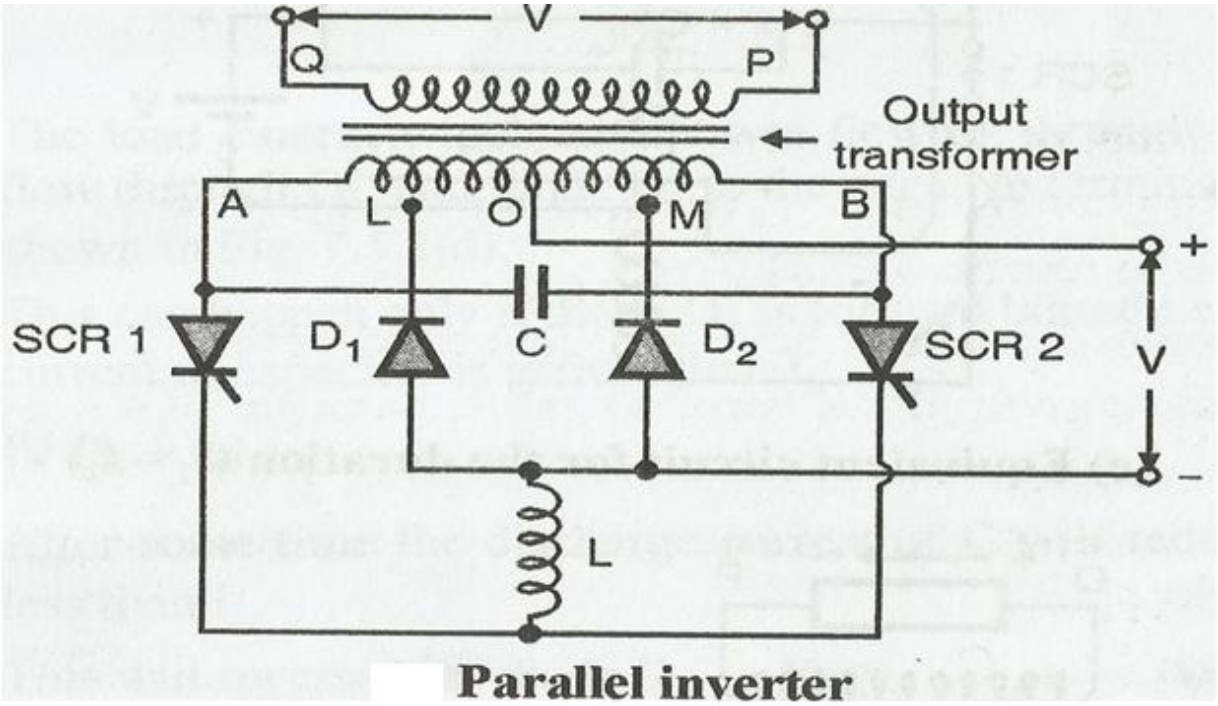
* the load voltage changes it polarity and the direction of load current is reversed.

The square output waveform is thus obtained across the load.



Output waveform of Parallel inverter with resistive load

OR



Parallel inverter

d) Draw a neat circuit of six phase star half wave rectifier? List any two advantages of the same.

3 mks

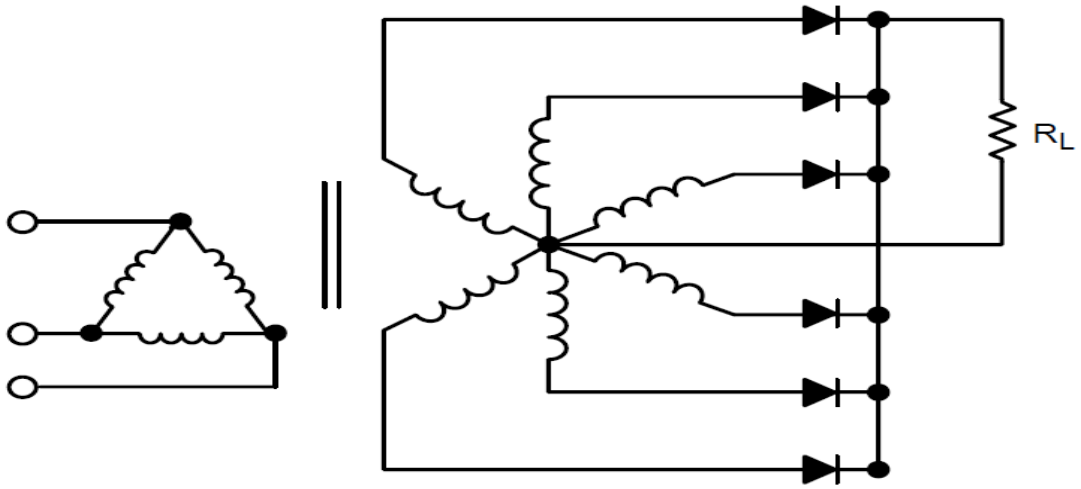
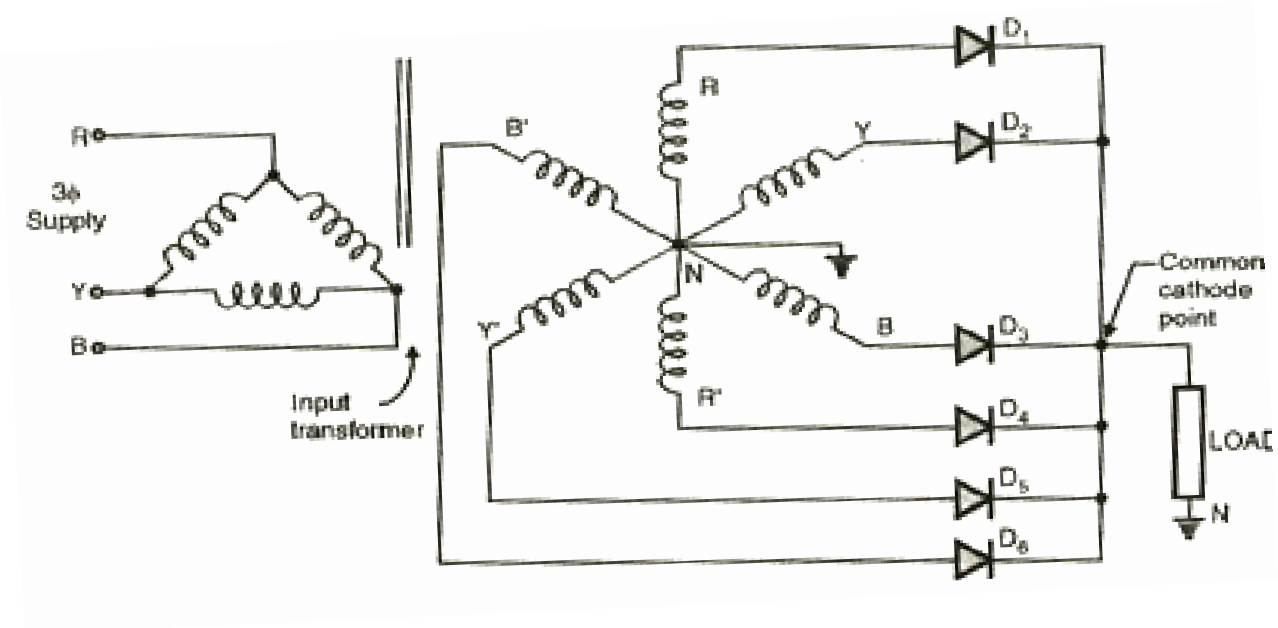


FIG. SIX PHASE STAR HALF WAVE RECTIFIER

OR



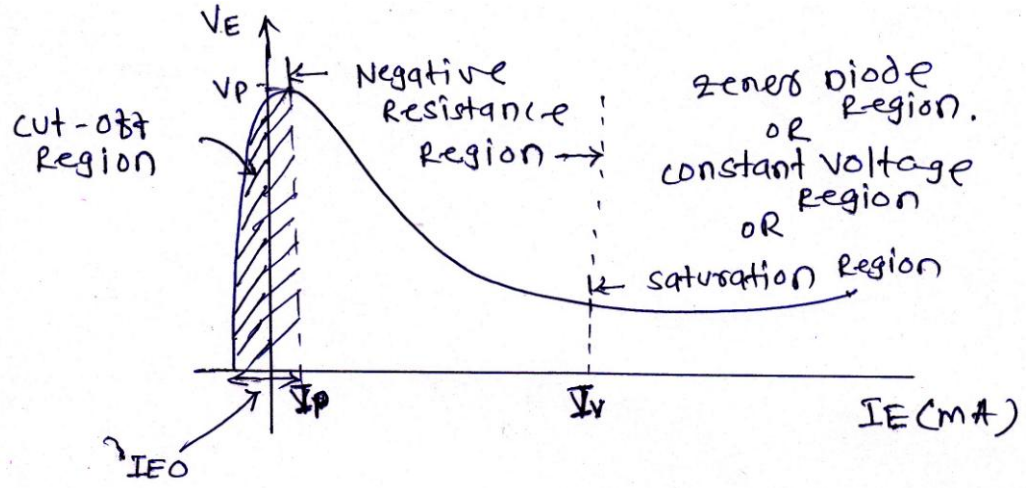
[Note : Any two advantages each advantage ½ mark] 1 mks

- **Higher output power**
- Low ripple content

- Low harmonics in the input supply current
- When the power rating exceeds 2kW, six phase star half wave rectifier are used in place of single phase rectifiers.
- Low ripple factor as compared to HWR.
- **Better rectification efficiency.**
- Better TUF.
- **Higher values of average load voltage and average load current.**
- No possibility of transformer core saturation because transformer current flows equally in both the half cycles.

e) Draw the v-l characteristics and label various points: 2 mks

i) UJT



ii) DIAC 2 mks