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.

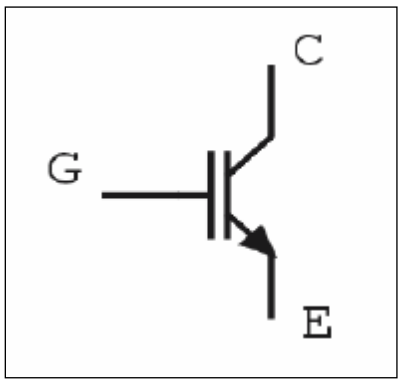
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q1 (A) Attempt any SIX: **(12 Marks)**

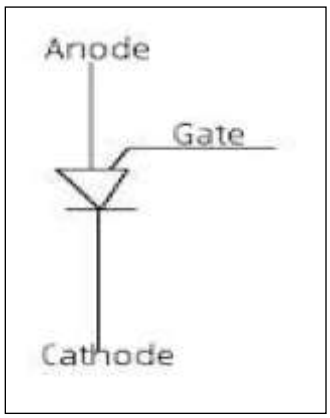
(i) Draw the symbols of (a)IGBT (b)PUT (c)LASCR (d)GTO

Ans:} Diagram:- **(½ M each)**

(a)IGBT

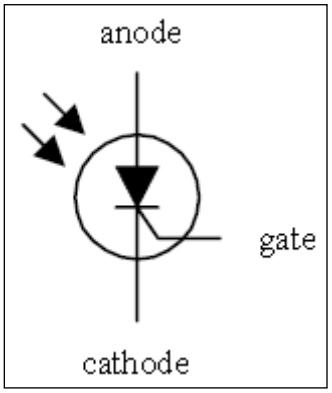


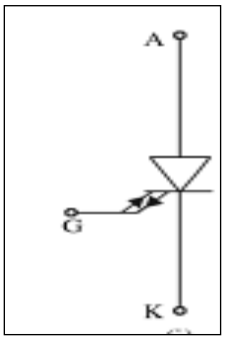
(b) **PUT**



(c)LASCR

(d) **GTO**





(ii) State two advantages of IGBT.

Ans}

Advantages:- **(any two: 2M)**

- High input impedance
- No second breakdown
- Low on-state conduction loss
- Simple driver circuit
- High power, high frequency application
- Large safe operation area

(iii) Draw static characteristics of UJT and define peak point voltage.

Ans} **(Characteristic 1M, Definition 1M)**

Characteristic:-

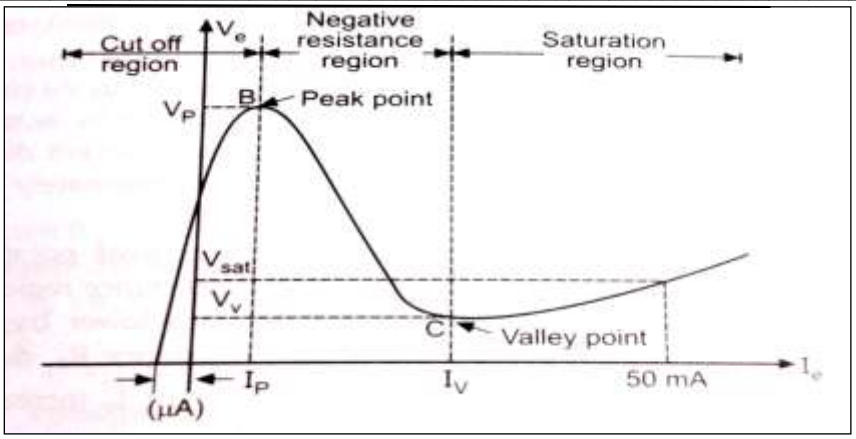


Figure:- Characteristic of UJT

Definition:-

Peak Point Voltage: The maximum voltage across base to emitter at which current starts flowing is called peak point voltage

OR

It is the maximum voltage developed across base and emitter of UJT

OR

It is the maximum voltage (Vbe) developed across UJT beyond which increase in current leads to decrease in voltage.

(iv) Define chopper. Classify it.

Ans:} **(Definition 1M,any one classification 1M)**

Definition of chopper:-

Chopper is a circuit used to convert a fixed DC into variable DC Voltage.

1) **Chopper can be classified as**

- Step up chopper
- Step down chopper

2) **According to the direction of output voltage and current**.

- Class A
- Class B
- Class C
- Class D
- Class E

3) According to circuit operation

- First quadrant chopper
- Two quadrant chopper
- Four quadrant chopper

4) According to commutation method

- Voltage commutated
- Current commutated
- Load commutated
- Impulse commutated

(v) Compare forced commutation and natural commutation (any 2 points)

An}

Comparison:- **(any 2 points 2M)**

Sr.No	Natural Commutation	Forced Commutation

1.	Source is AC.	Source is DC.
2.	External commutating components are not required.	External commutating components are required.
3.	SCR turns off when its forward current goes below the holding current when the input AC cycle changes.	Conducting SCR turns off by applying a reverse voltage across it or a revrse current pulse in forced through conducting SCR.
4.	Cost of commutating circuit is less.	Cost of commutating circuit is more.
5.	Used in controlled rectifiers, AC controllers etc.	Used in choppers ,inverters etc.

(vi) Define inverter and classify it.

Ans} **(Definition 1M, any one classification 1M)**

Definition:-

Inverter is a circuit which convert DC power into AC power at desired output voltage and frequency.

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 wave inverter

- 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

(vii) Draw and label single phase center tapped full wave controlled rectifier with resistive load.

Ans}

Diagram:- **(2M)**

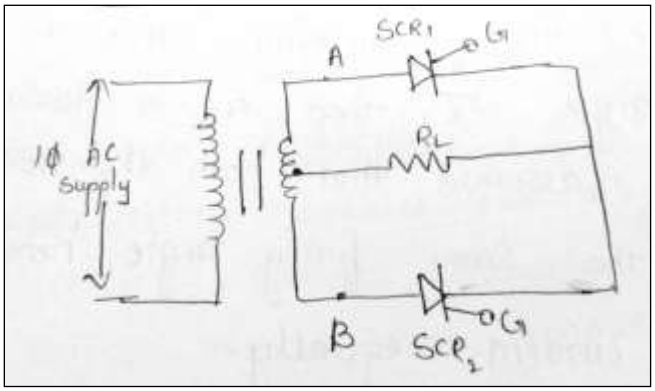


Figure:- Single phase center tapped rectifier

(viii) Draw labelled block diagram of SMPS. List 2 applications.

Ans} **(BD 1M,any two appln ½ M each)**

Diagram:-

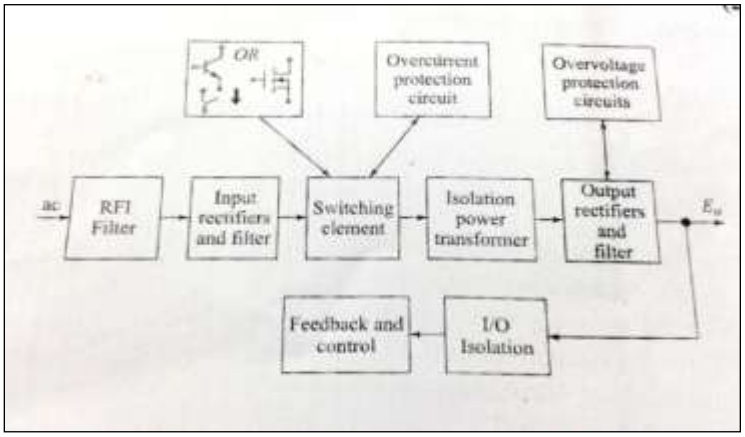


Figure:- Block diagram of SMPS

Application of SMPS:- (any two)

1) Computer

2) EPABX System

3) TV Receiver

4) Medical Equipment

5) Photo Copying machine

Q1(B) Attempt any TWO: 8 Marks

(i) Compare controlled and uncontrolled rectifier (any 4 points).

Ans} (any 4 points 4M)

Comparison:-

Parameter	Controlled Rectifier	Uncontrolled Rectifier
Device used	SCR and Diodes	Only Diodes

Control of Load Voltage	Load voltage can be controlled	Load voltage cannot be controlled.
Direction of power flow	Source to load and sometimes load to source.	Source to load only.
Freewheeling diode	Required if inductive load	Not necessary.
Triggering circuit	Required.	Not Required.
Application	DC motor controller, Battery chargers.	Power supply.

(ii) Draw step down chopper circuit. State how o/p is related with duty cycle.

Ans} **(circuit 2M, explanation 2M)**

Diagram:-

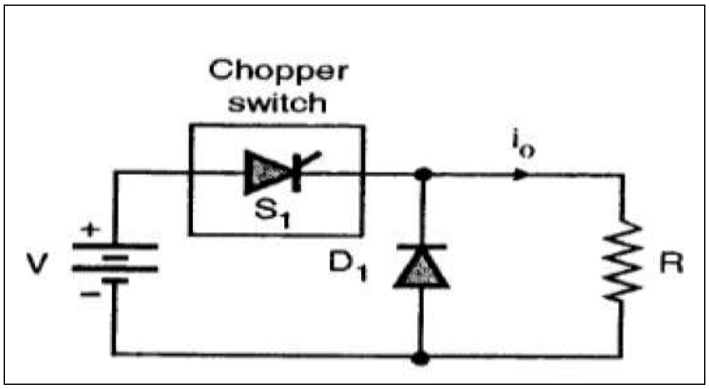


Figure:- Step –down chopper

Average output voltage= V_{in} * D

Where D = $T_{on}/T_{on} + T_{off}$ is called duty cycle.

D can be varied from 0 to 1 and the output voltage can be varied from 0 to V_{in} volts.

(iii) Draw the labelled circuit diagram of emergency light system.

Ans} (any other relevant diagram can be given marks) (4M)

Diagram:-

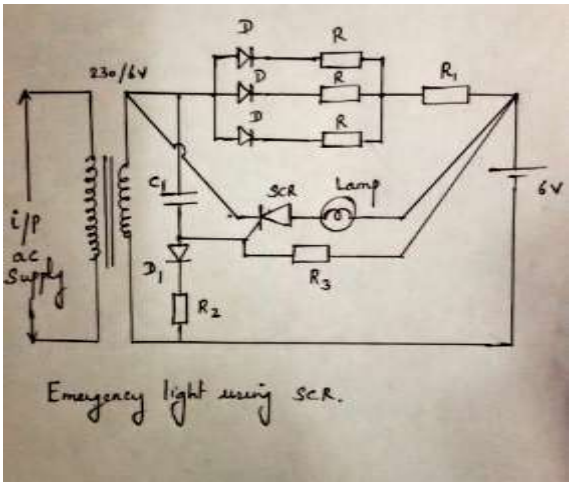


Figure:- Circuit diagram of emergency

Q2. Attempt any FOUR: (16 Marks)

(i) Draw the circuit diagram of 3ϕ HW rectifier. Sketch the i/p & o/p waveforms for resistive load.

Ans} (circuit 2M,W/F 2M)

Diagram:-

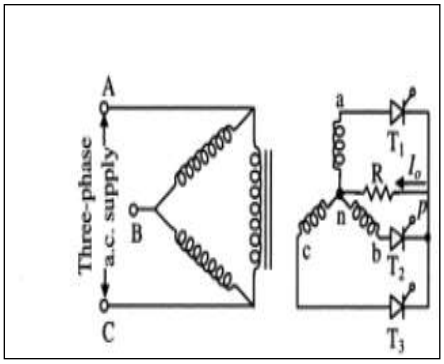


Figure:- circuit diagram of 3ϕ HW rectifier

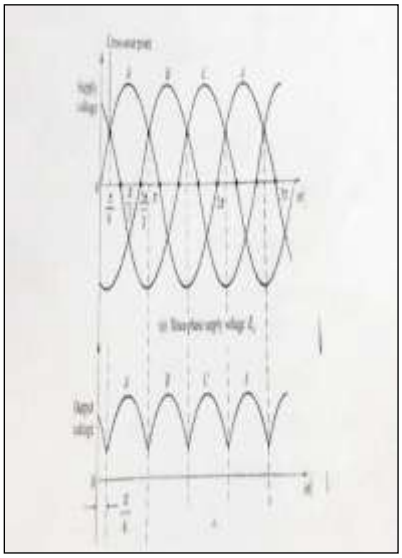


Figure:- i/p & o/p waveforms for resistive load

(ii) Compare between step up and step down chopper (any 4 points).

Ans} **(any 4 points 4M)**

Comparison:-

Parameter	Step up chopper	Step down chopper
Input output voltage waveform		
Output voltage equation.	$V_0 = V / (1-D)$ Volts	$V_0 = DxV$ volts
Switch position (connection)	In parallel with load	In series with load
Application	Battery charging, voltage booster	Motor speed control.

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

Ans} **(working principle 2M,circuit 2M)**

Diagram:-

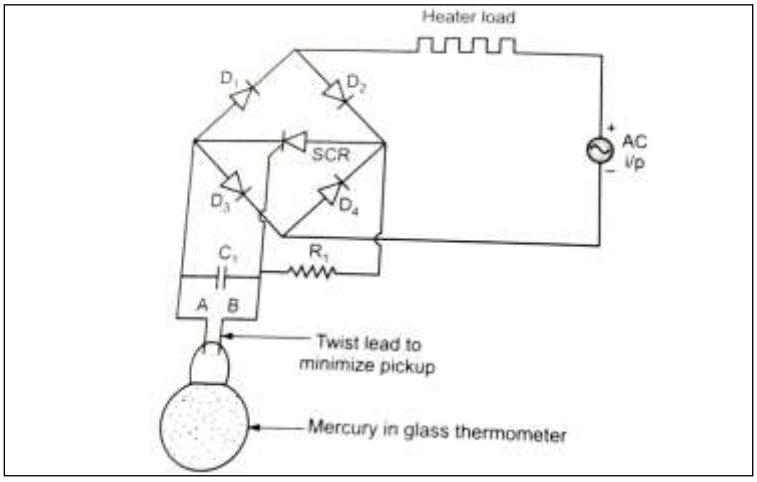


Figure:- Temperature controller

Explanation:-

The temperature control circuit is used to regulate the temperature. Figure shows the temperature control circuit using thermostat as temperature detector and SCR as a switching device. The mercury in glass thermostat is extremely sensitive temperature measuring instrument which is capable of sensing changes in temperature of the order of $0.1^{o}C$.

Working:

Mode I:

When the temperature is less than the desired value the mercury in the glass thermostat is not able to short the electrodes A & B. Therefore the SCR receives the gate signal in both the half cycles & it will be triggered. Hence the heater will be connected in the AC circuit.

Mode II:

As the temperature increases , the mercury level increases and when it reaches the desired value, the electrode A and B are short circuited through mercury. This will short circuit the gate supply to the SCR and will not get the trigger pulse. Hence it is OFF and heater will be disconnected from the circuit.

(iv) Draw labelled V-I characteristics of SCR & define (a) Holding current (b) Latching current.

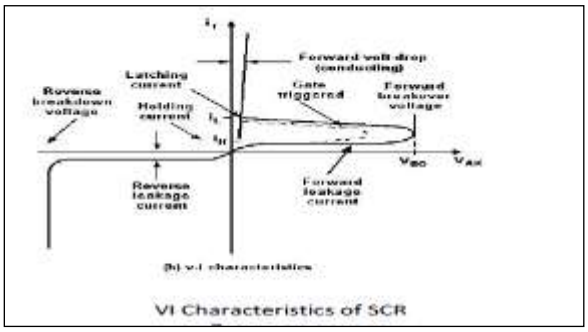
Ans} **(VI characteristics 2M,definition 1M each)**

Definition:-

(a) Holding Current: It is the minimum anode current required to hold the SCR in the ON state. When the anode current goes below the holding current ,the device will go to OFF state.

(b) Latching Current: It is the minimum anode current required to maintain the thyristor in the ON state, immediately after the thyristor has been turned ON and Gate signal has been removed.

Diagram:-



VI Characteristics of SCR

(v) Draw class C commutation circuit. Describe its working with waveform.

Ans} **(circuit 1M,W/F 1M,working 2M)**

Diagram:-

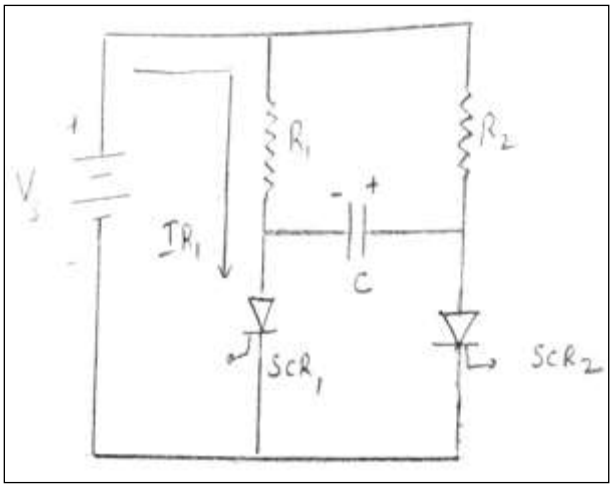


Figure:- Class C commutation circuit

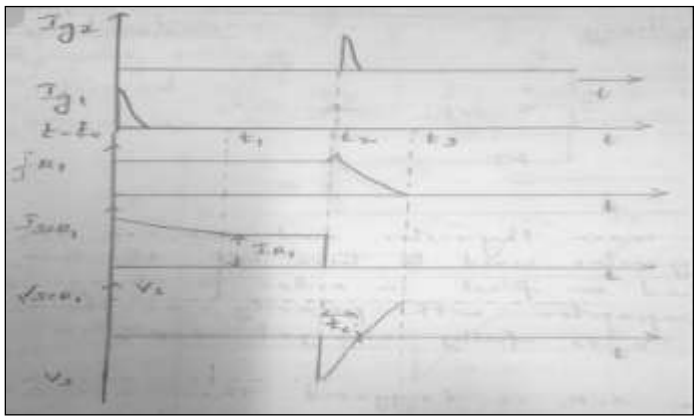


Figure:- waveforms

Working:-

At first the SCR1 is triggered .So it conducts and load current starts flowing through it.The capacitor 'C' will charge through Vs+,R2,C,SCR1,Vs- with right plate positive. When it is fully charged to Vs capacitor current becomes zero.

To turn off SCR1,trigger SCR2.When SCR2 is turned ON the reverse voltage across 'C' is applied across SCR1,reverse biases it and SCR1 is turned OFF. Capacitor will start charging through R1,C, SCR2 with left plate positive. To turn OFF SCR2,turn on SCR1.

(vi) Draw 1 ϕ HWCR with inductive load. Draw i/p and o/p waveforms. Describe its operation.

Ans} **(circuit 2M,W/F 1M, operation1M)**

Operation:-

In single phase half wave controlled rectifier with inductive load the load voltage is positive as well as negative but the load current is always positive. Hence in this power flow can be source to load as well as from load to source. The quadrant of operation is first and fourth.

Diagram:-

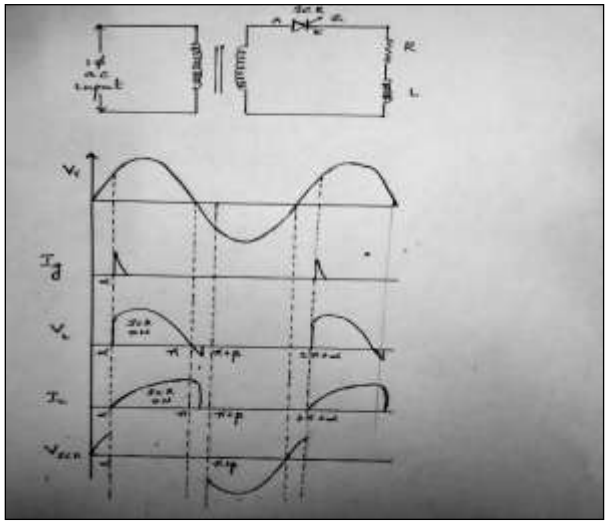


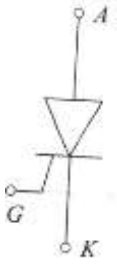
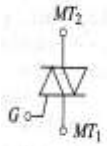
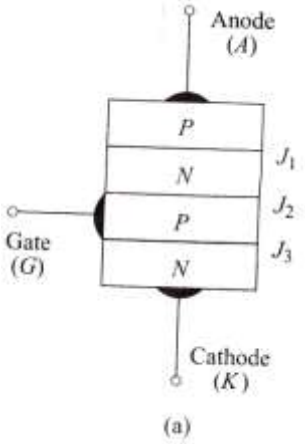
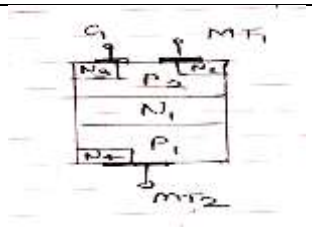
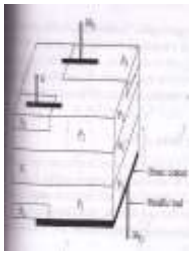
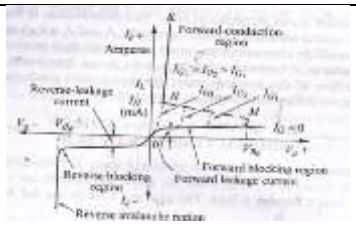
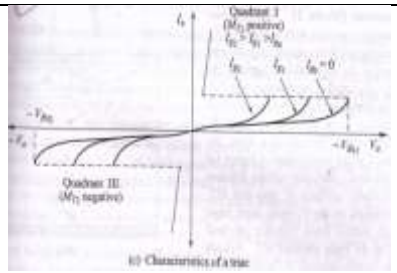
Figure:- Single phase HWCR

Q3) Attempt any Four:-

i) Differentiate between SCR & TRIAC w.r.t a) symbol b) layer diagram c) static characteristics d)applications.

Ans} Any (four) **01M each**

Differentiation:-

Parameters	**SCR**	**TRIAC**
Symbol		
Layer diagram	 (a)	 OR 
Static characteristics		
Application	Controlled rectifier, converters – chopper inverters, cyclo converters, UPS, Battery charger, emergency lighting system, static circuit breaker, flasher.	Light dimmer, speed control of fan , power switches.

ii) Draw 1Φ FW bridge controlled rectifier with resistive load. Draw waveforms at a) I/P b) Load.

Ans}Circuit diagram 02M , i/p & o/p waveform 1M each

Diagram:-

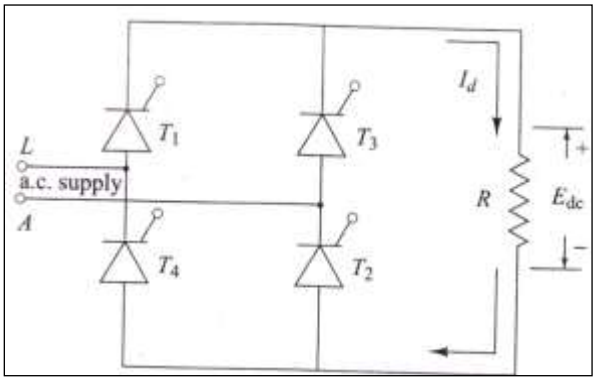


Figure:- Fully –controlled bridge rectifier with resistive load

Wave form:-

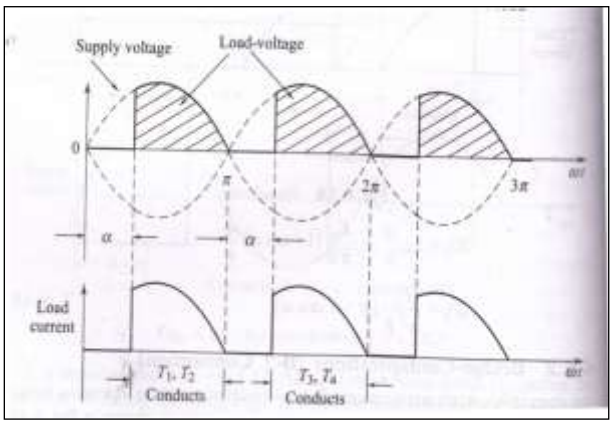


Figure:- Waveform of Fully controlled rectifier

iii) Draw Equivalent circuit of SCR using BJT. Describe its working principle.

Ans} Diagram 02M, Working 02M

Diagram:-

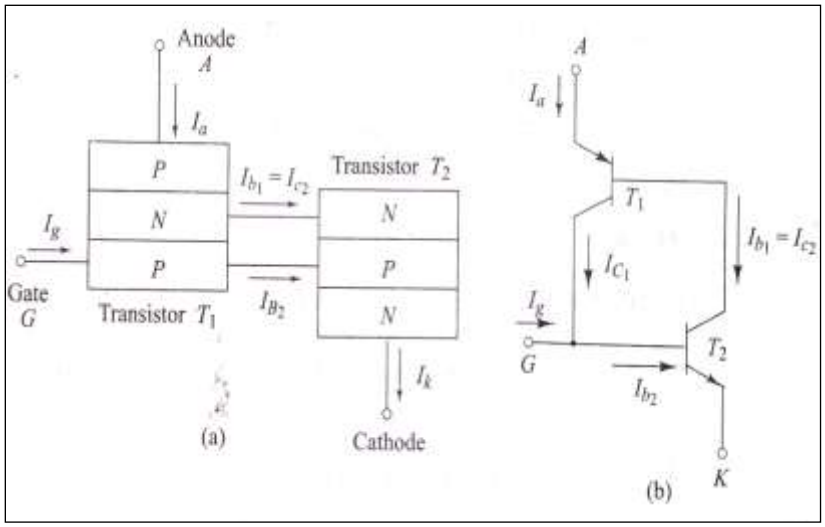


Figure:- Equivalent circuit of SCR using BJT

Working:-

The operation of an SCR can be explained in a very simple way by considering it in terms of two transistors.

The SCR can be considered as an npn & pnp transistor , where the collector of one transistor is attached to the base of the other & vice versa. This gives net gain of loop circuit as β1xβ2 are where β1xβ2 are current gains of two transistors respectively.

The collector current of transistor T1 becomes the base of transistor T2 & vice versa

&

Ic1= Ib2

Ib1=Ic2

When the gate current is zero or the gate terminal is open , the only current in circulation is the leakage current , which is very small. Under these conditions P-N-P-N device is said to be in its forward blocking or high impedance off state .

As soon as a small amount of gate current is given of transistor T2 by applying forward bias to its base-emitter junction it generates the collector current as β2 times the base current. This collector current of T2 is fed as input base current toT1 which is futher multiplied by β1 times the base current i.e collector current of transistor T2 .

In this way both transistors feedback each other and the collector current of each goes multiplying . This process is very quick & soon both the transistors drive each other into saturation.

Now the device is said to be in on-state from the OFF-state.

This characteristics of the device is known as its regenerative action.

iv) Draw the V-I characteristic of power transistor and show different operating regions in it , also state what is primary and secondary break down in it.

Ans}

Diagram:- **02M**

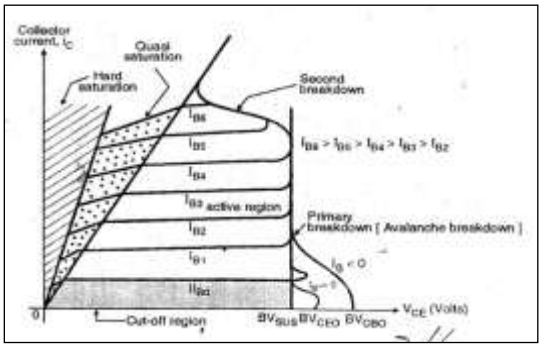


Figure:- V-I characteristic of power transistor

Explanation:-

- **Primary breakdown:-** **01M**

The breakdown due to the conventional avalanche break down of the collector base junction is known as primary break down.

- **Secondary break down:-** **01M**

  As a large values of collector currents the collector emitter voltage decrease . Therefore the collector current increases & there is a rise in power dissipation. Thus at higher levels of collector currents the allowable active region is further restricted by a potential failure mode called secondary breakdown.

V) Draw the circuit diagram of 1Φ half controlled bridge rectifier with resistive load . Sketch I/P & O/P waveforms. Explain its operation.

Ans} **Any one Diagram 02M, Waveform 01M, Explanation 01M**

Diagram :-

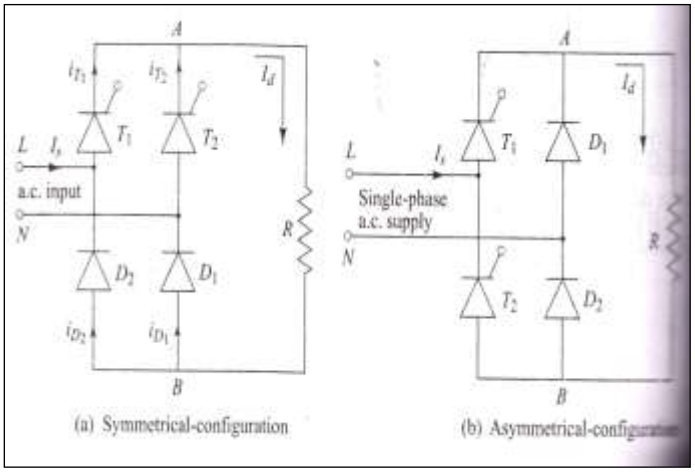


Figure:- Half controlled bridge rectifier

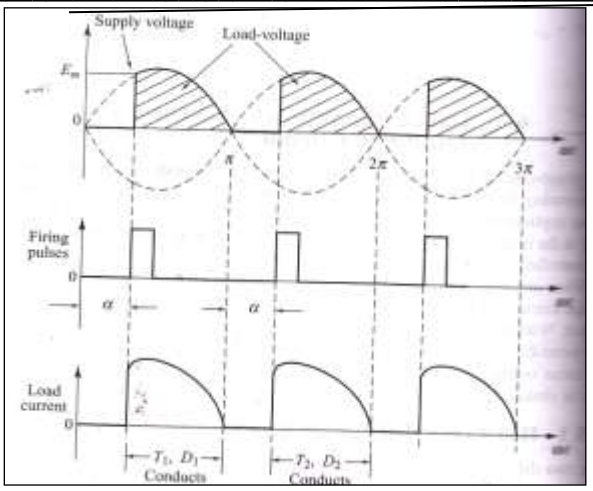


Figure:- waveform of symmetrical configuration with resistive load

Explanation :-

Ina symmetrical configuration,

During the positive half cycle of the ac supply , thyristor T1 & Diode D1 are forward biased & are in the forward blocking mode. When the SCR T1 is triggered , at a firing angle α , the current flow through the path L-T1-R-D1-N, the load current will flow until it is commutated by reversal of supply voltage at wt=T1.

During negative half cycle of the a.c supply , thyristor T2 & diode D2 are forward biased . When SCR T2 is triggered at an angle ($\pi+\alpha$), the current would flow through the path N-T2-A-R-D2-L. This current is continuous till angle 2 π , when SCR T2 is turned OFF.

vi) A 1Φ FWCR is supplied with a voltage V=230 sin 314 t. If forming angle 'α' is 30^0 find a) Avg. dc O/P volt. B) Current for the load resistance of 100Ω.

Ans} Solution:-

Given

For 1 ϕ FWCR

$V = 230 \sin 314t = E_m \sin \omega t$ $[\therefore E_m = 230\ V]$

$\alpha = 30°$

(i) Avg. dc output Voltage = ?

(ii) I = ? For R = 100 Ω

Solution :- Avg. dc o/p voltage =

$$E_{dc} = \frac{E_m}{\pi}[1 + \cos\alpha] \quad \text{—— (1 M)}$$

$$E_{dc} = \frac{230}{\pi}[1 + \cos 30]$$

$$E_{dc} = 136.6\ V \quad \text{—— (1 m)}$$

Voltage load current

$$I_{dc} = \frac{E_m}{\pi \cdot R}[1 + \cos\alpha]$$

OR

$$I_{dc} = \frac{E_{dc}}{R} \quad \text{—— (1m)}$$

$$I_{dc} = \frac{136.6}{100}$$

$$I_{dc} = 1.366\ A \quad \text{—— (1 m)}$$

Q4) Attempt any FOUR:-

i) Draw the neat circuit diagram of step-up chopper . Describe its working with waveforms.

Ans}

Diagram :- **02M**

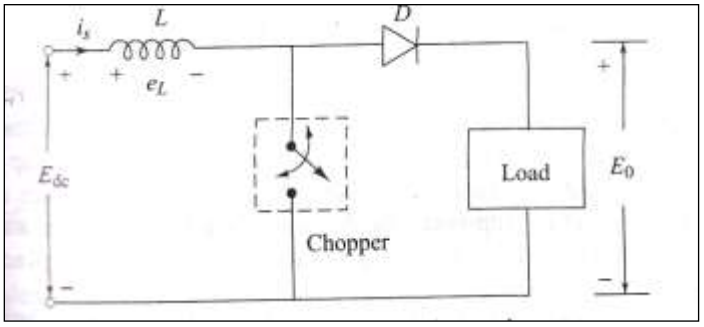


Figure :- Step-up chopper

Explanation:- **02M**

When chopper is ON, the inductor L is connected to the supply Edc, & inductor stores energy during on-period Ton. When the chopper is OFF, the inductor current is forward to flow through the diode & load for a period T_{off}. As the current tends to decrease , polarity of the emf induced in inductor L is reversed to that of shown in figure & as a result voltage across the load E0 becomes

$$E0=Edc + L \frac{di}{dt}$$

i.e the inductor voltage adds to the source voltage to force the inductor current into the load . In this manner, the energy stored in the inductor is used to the load

$$E0= \frac{Edc}{1- \alpha}$$

For $\alpha = 0$, E0=Edc

$\alpha=1$, E0= α

Hence for the variation of a duty cycle α in the range $0<\alpha<1$, the O/P voltage .E0 will vary in the range $Edc<E0<\alpha$.

ii) Draw the layer diagram of PUT. With neat circuit diagram describe its working as relaxation oscillator.

Ans}

Diagram:- **01M**

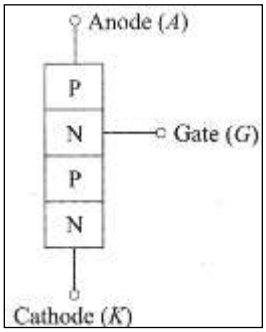


Figure:- Layer diagram of PUT

Circuit Diagram:- **02M**

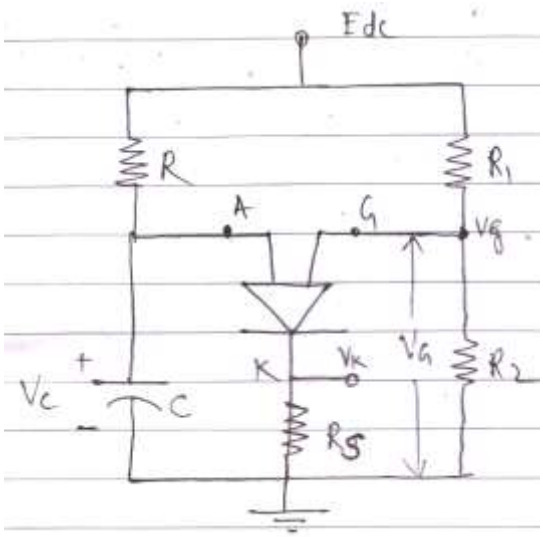


Figure:- PUT relaxation oscillator

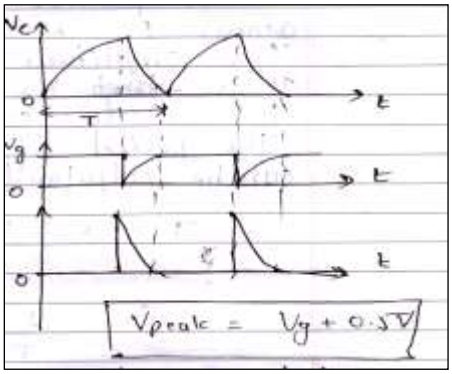


Figure:- Waveforms of PUT relaxation oscillator

Explanation:- **01M**

As soon as biasing voltage Edc is applied to the circuit , capacitor starts charging towards Edc voltage through resistance R. As soon as capacitor voltage reaches up to Vp voltage , the PUT turns on & the capacitor discharges . The Vp voltage is set by the voltage divider consisting of the two resistors R1 & R2 which Vg voltage.

The voltage at G remains at Vg volts, while the capacitor charges & the PUT is OFF when PUT turns ON Vg drops to approximately zero. After the capacitor discharges , the PUT turns OFF & Vg returns to Vg volt. This results in a negative going pulse at G.

A positive going pulse is produced across Rs resistor as the capacitor discharges . The amplitude of the pulse is slightly lower than the capacitor peak voltage due to anode cathode 'ON' voltage of 1V .

The period of oscillator waveforms can be calculated from

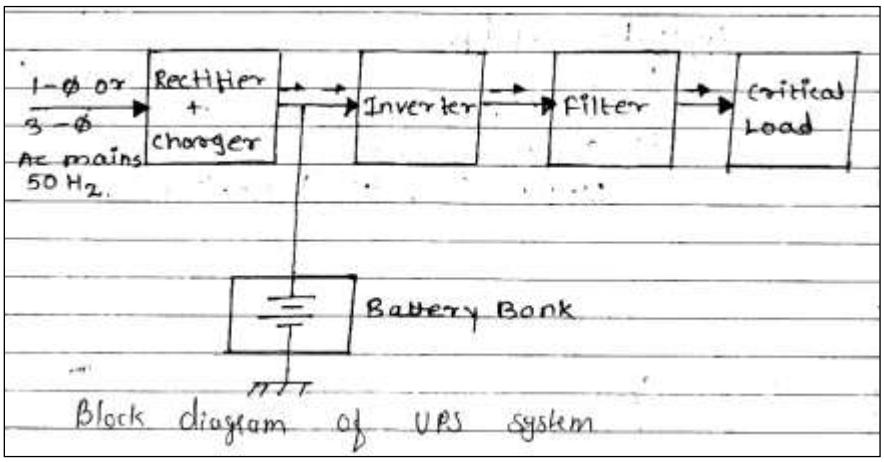
$$T = R.C \log_e \left[\frac{Edc}{Edc - Vp} \right]$$

$$F = 1/T$$

iii) Draw the block diagram of UPS. Explain its working principle in brief.

Ans}

Diagram:- **02M**



Block diagram of UPS system

Explanation:- **02M**

UPS is used to provide an interrupted free supply of power to the ac load.

A rectifier converts a single-phase or three – phase ac voltage into dc, which supplies power to the inverter as well as the battery bank (to charge it).

The inverter gets a dc input voltage from the rectifier when the ac mains is ON , and from the battery bank when ac mains is OFF.

Inverter converts this dc voltage into ac voltage and through a suitable filter applies it to the load .

A static switch will connect or disconnect the battery from the input of the inverter depending on the status of ac mains.

vi) State different triggering methods of SCR . Describe RC triggering method with circuit diagram.

Ans} **Triggering methods 01M, Ckt 02M, Explanation 01M.**

Triggering methods:-

- **Forward voltage triggering**
- **dv/dt triggering triggering.**
- **Temperature triggering**
- **Light/illumination /radiation triggering.**
- **Gate triggering**

Circuit diagram:-

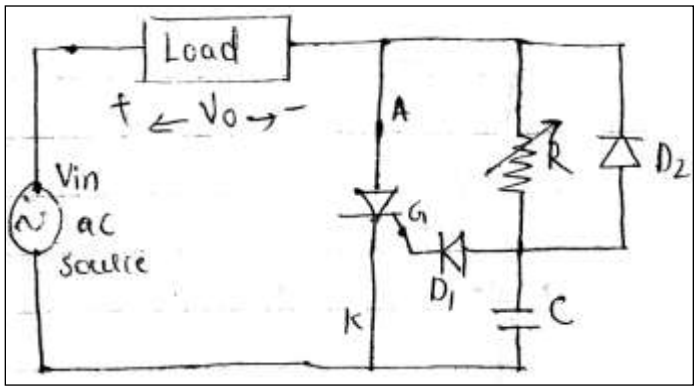


Figure:- R-C triggering circuit

Explanation:-

A large value of firing angle (more then 90^0) can be obtained from above circuit usually in 0-180^0 range .

In the positive half cycle the capacitor is charged through the variable resistance R up to the peak value of applied voltage . The charging rate of the capacitor can be controlled by the variable resistance R . Depending on tbhe voltage across the capacitor & if the gate current is sufficient , the thyristor triggers. In neagive half cycle the capacitor C is charged upto to the negative peak value through the diode D2.

Diode D1 is used as a safe guard against the reverse breakdown of the gate – cathode junction in the negative half cycle .

v) Draw and describe the operation of light dimmer using DIAC & TRIAC.

Ans}

Diagram:- **02M**

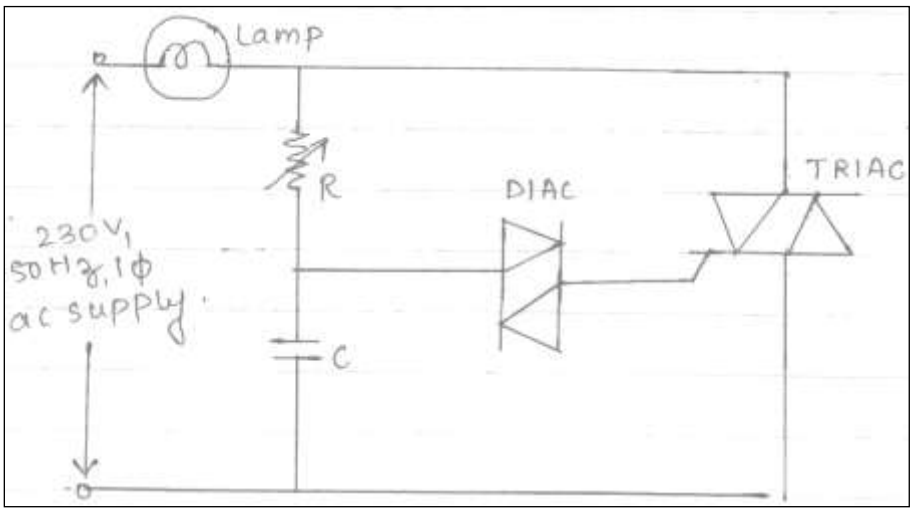


Figure:- Light dimmer using DIAC & TRIAC

Explanation:- **02M**

In the above circuit DIAC is used to trigger TRIAC. During the positive half cycle (when P is positive) the TRIAC requires a positive gate signal for turning it on . This is provided by the capacitor C , when the voltage across the capacitor is above the breakdown voltage of the DIAC . DIAC turn ON & the capacitor discharge through the TRIAC gate i.e positive gate signal is given to the TRIAC & thus TRIAC turns ON. So current starts flowing through load.

A similar operation takes place in the negative half cycle, & a negative gate pulse will be applied when the DIAC breaks down in the reverse direction . The charging rate of capacitor C can be changed by varying the resistance R and , hence the firing angle can be controlled.

Thus if firing angle is less intensity of light is more & if firing angle is more . Intensity of light is less. Thus by controlling the α we can control intensity of light using TRIAC.

vi) Show how the O/P volt of step-down chopper can be varied . State its O/P voltage expression and draw its input output waveforms.

Ans} **Voltage expression 1 ½ M, waveform 01M , Explanation 1 ½ M**

Output voltage :-

Average load voltage V_o is given by

$$\therefore V_o = \frac{T_{ON}}{T_{ON} + T_{OFF}} \cdot V_s$$

$$= \frac{T_{ON}}{T} \cdot V_s$$

$$\boxed{V_o = \alpha \cdot V_s}$$

Where, T_{ON} = on time ; T_{OFF} = off time

$T = T_{ON} + T_{OFF}$ = chopping period

$\alpha = \frac{T_{ON}}{T}$ = duty cycle.

Thus the load voltage can be controlled by varying duty cycle α.

α is changed by changing opening & closing period of semiconductor switch.

The various methods for varying duty cycle α are as follows.

1) Time ratio control
2) Current limit control.

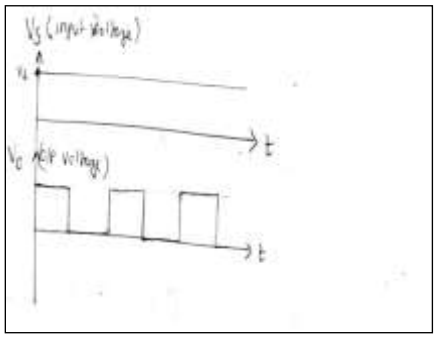


Figure:- I/P & O/P waveform of step –down chopper

Q5:- Attempt any four :-

i) Draw neat circuit diagram of battery charger using SCR. Describe its working.

Ans} **Circuit diagram 02M, Explanation 02 M**

Diagram:-

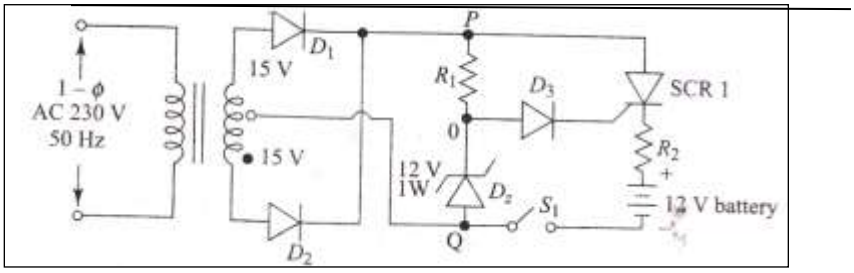


Figure:- Battery charger using SCR

Explanation:-

A 12V discharged battery is connected in the circuit . When Switch S_1 is closed , the single-phase 230V supply is stepped down to (15-0-15)V by a center-tapped transformer. Diodes D1 and D2 forms full-wave rectifier. Due to this, the pulsating dc supply 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 O rises to sufficient level so as to provided to SCR1 and it is turned –ON.

When SCR1 is turned-ON, the charging current flows through battery. Thus , during each positive half-cycle of pulsating dc supply voltage across P-Q, SCR1 is triggered and charging current is passed till the end of that half-cycle. Due to the zener diode D_z, the maximum voltage of point O is held at 12V. Due to the charging process, the battery voltage rises and finally attains full-value of 12V. Thus, when the battery is fully charged , the cathode of SCR1 is held at 12V. Therefore diode D3 and gate-cathode junction of SCR1 cannot be forward biased , since the potential of point O can reach up to 12V. Hence , no gate –current is supplied and SCR1 is not triggered . In this way , after charging further charging is automatically stopped.

ii) Draw V-I characteristics of PUT & describe the role of its operating regions.

Ans} **Characteristic 02M , Exp 02M**

Diagram:-

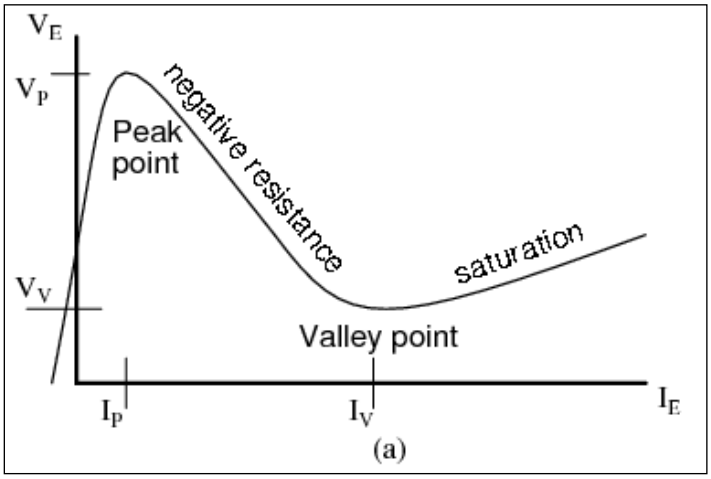


Figure:- V-I characteristics of PUT

The VI characteristic consist of three regions:-

i) cut off region

ii) negative resistance region

iii) saturation region

In the cut off region only a small amount of leakage current flows. PUT is operated as oscillator in the negative resistance region. The region beyond valley point is called saturation region. In this region the device is in its ON position, voltage remains almost constant with increase in current.

iii) Elaborate the term polyphase rectifier. Describe its need.

Ans}

Poplyphase Rectifier:- **02M**

In polyphase rectifier the number of phases are more due to that the average output can be more. Polyphase rectifier have less ripple so small filters can be used. More DC power can be generated in motor control operation.

Need:- **02M**

The average output voltage that can be obtained from single phase full wave rectifier is 0.636Vm and can support power of the order of 1.5KW.To obtain higher power polyphase rectifier are used. The efficiency can be increased to 97%. Increase in number of phases increases the smoothness of output DC

iv) Draw and explain SCR triggering using UJT with the help of pulse transformer . List its advantages.

Ans} **Diagram 02M, Explanation 01M , Advantages 01M**

Diagram:-

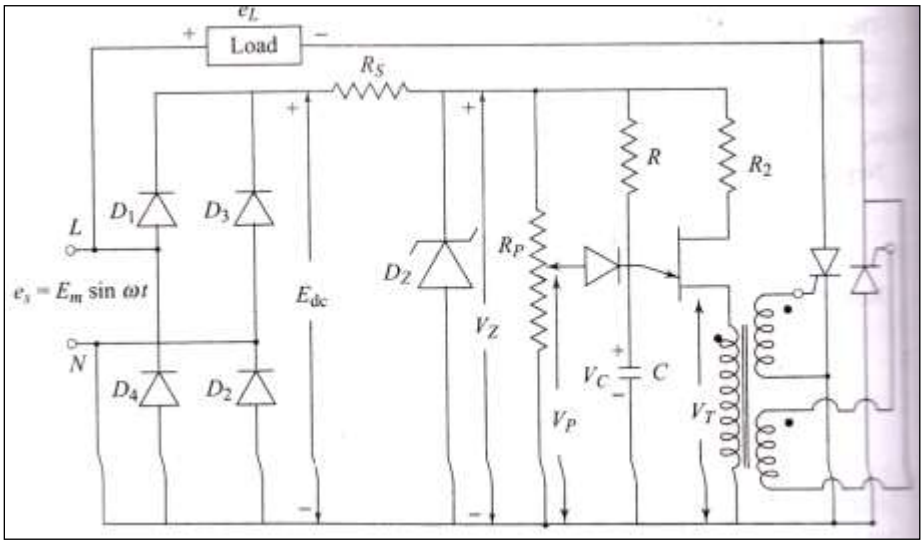


Figure:- SCR triggering circuit using UJT with pulse transformer

Explanation:-

The bridge rectifier converts AC into Dc voltage. The resistor is used to lower the voltage to a suitable value

For the zener diode and the UJT. The zener diode is used to clip the rectified voltage to a fixed voltage. This voltage V_z is applied to the charging circuit RC. Capacitor charges through R with RC time constant. When the voltage across capacitor reached the pewak point voltage UJT turns on and capacitor discharges through UJT. At the secondary a pulse transformer is used for isolation of trigger circuit and power circuit . Pulse at the secondary winding is given to the gate of SCR.

Advantages:-

- Isolation
- Synchronization

v) Draw labelled layer diagram of n-ch IGBT. Draw its V-I characteristics.

Ans} **Layer diagram 02M, V-I characteristic 02M**

Diagram:-

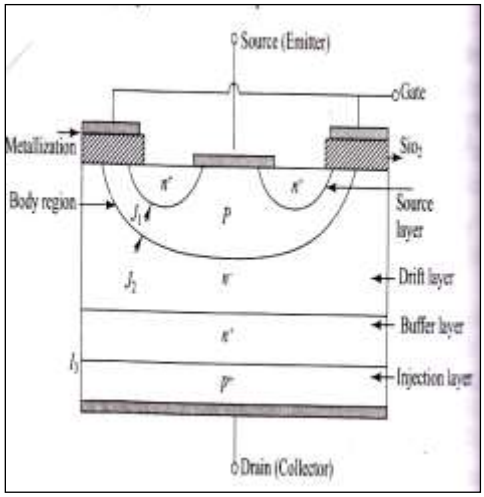


Figure:- Layer diagram of IGBT

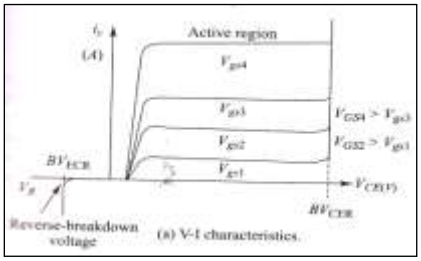
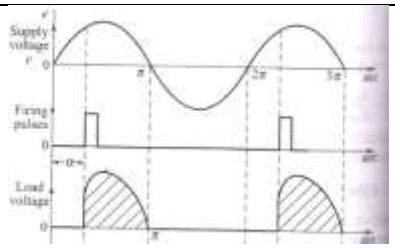
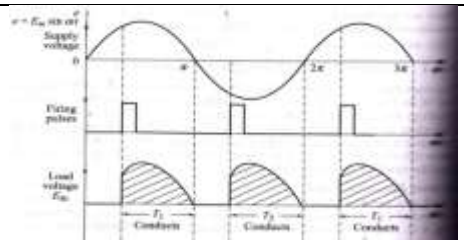


Figure:- V-I characteristic of IGBT

vi) Compare 1Φ HWCR & 1Φ FWCR on the basis of a) No. of SCR diode used, b) O/P waveform, c) firing circuit complexity, d) application.

Ans} **01M for each point**

Comparison:-

Parameters	**1Φ HWCR**	**1Φ FWCR**
No. of SCR diode used	1 SCR	2 SCR or 4 SCR
O/P waveform		
Firing circuit complexity	Easier	Complicated
Application	In small battery chargers	In DC motor speed control

Q6) Attempt any four :-

i) Describe the working principle of controlling the speed of fan using TRIAC.

Ans} Diagram 02m ,Explanation 02M

Diagram:-

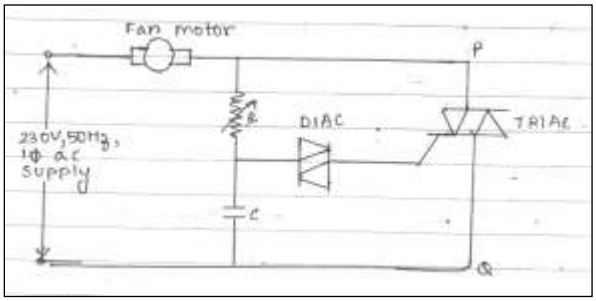


Figure:- Speed control of fan using TRIAC

Explanation:-

IN the above circuit DIAC is used to trigger TRIAC. During the positive half cycle (when P is positive) the TRIAC requires a positive gate signal for turning it on . This is provided by the capacitor C , when the voltage across the capacitor is above the breakdown voltage of the DIAC . DIAC turn ON & the capacitor discharge through the TRIAC gate i.e positive gate signal is given to the TRIAC & thus TRIAC turns ON. So current starts flowing through load.

A similar operation takes place in the negative half cycle, & a negative gate pulse will be applied when the DIAC breaks down in the reverse direction . The charging rate of capacitor C can be changed by varying the resistance R and , hence the firing angle can be controlled.

Thus if firing angle is less speed of fan motor is more & if firing angle is more speed. Fan motor is less. Thus by controlling the α we can control speed of fan using TRIAC.

ii) Describe the effect of freewheeling diode in controlled rectifiers.

Ans}

Diagram:- **anyone diag 02M**

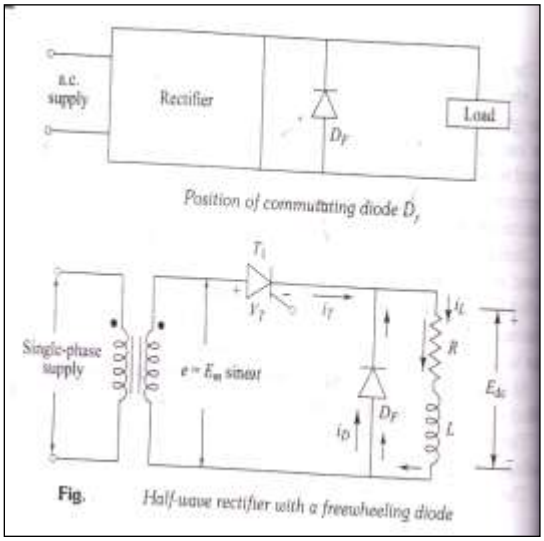


Fig. *Half-wave rectifier with a freewheeling diode*

Explanation:-

The diode which is connected across inductive load is called as flywheel diode , commutating diode or bypass diode. The function of this diode are :-

- It prevents reversal of load volte except for small diode voltage drop.
- It transfer the load current away from the main rectifier , thereby allowing the thyristor to regain its blocking state .

With diode thyristor will not be able conduct beyond $180^{0.}$ After 180^{0} the load current will freewheel through the diode and a reverse voltage will appear across a thyristor . The power flow from the input takes place only when the thyristor is conducting . No power will be returned to the source. This improves the input power factor .

iii) Draw labelled circuit diagram of class A & class B commutation circuit for SCR.

Ans} 02M for each diagram

Diagram:-

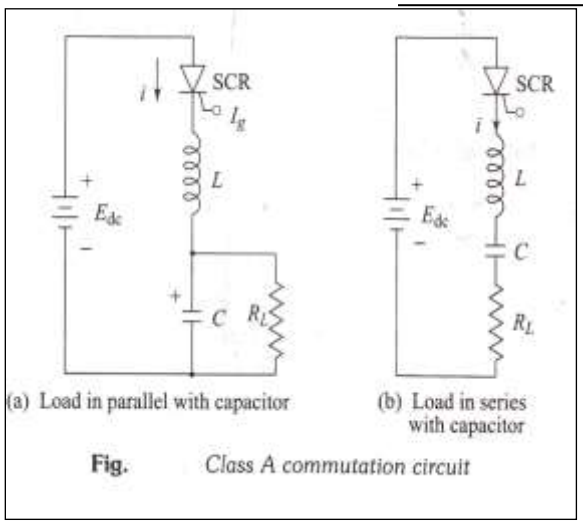


Fig. Class A commutation circuit

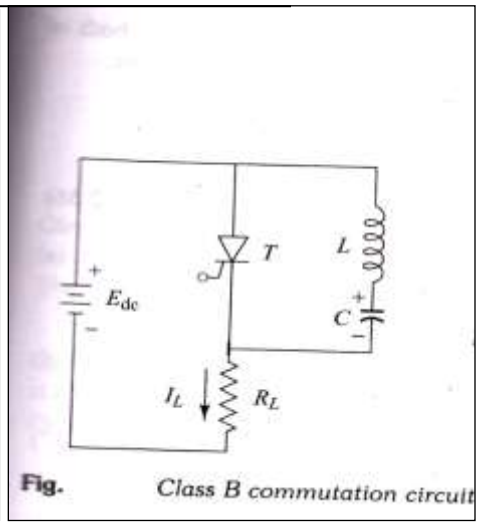


Fig. Class B commutation circuit

iv) Draw (layer) constructional diagram of GTO. Describe its operating principle.

Ans} **Diagram 02M, operating principle 02M**

Diagram:-

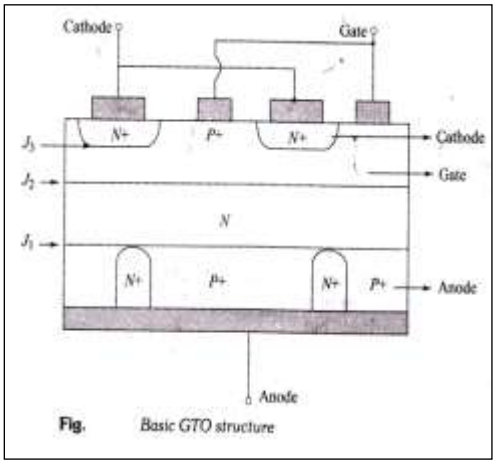


Fig. Basic GTO structure

Explanation:-

GTO is a pnpn device that can be triggered into conduction by a small positive gate current pulse and can be turned off by a negative gate current pulse.

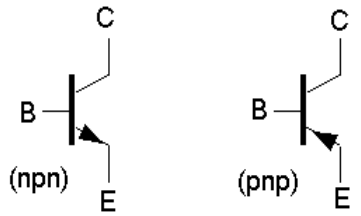
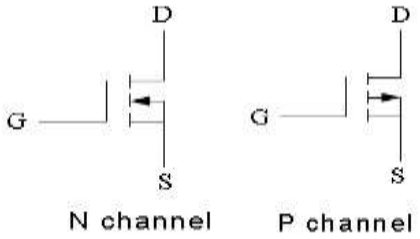
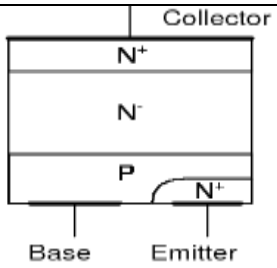
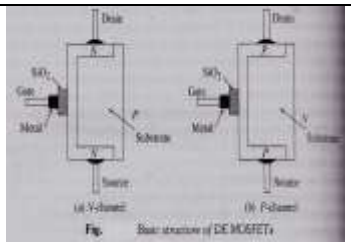
The structure of GTO consist of four layers pnpn similar to that of SCR .The equivalent circuit consist of two transistors one npn and one pnp. When a negative bias is applied at the gate excess carriers are drawn from the base region of npn transistor , and collector current of pnp transistor is diverted into the external gate circuit . Thus the base drive of npn transistor is removed and this in turn removes the base drive of p-np transistor and stops conduction. The V-I characteristics of GTO are similar to that of SCR .

v) Compare power transistor and power MOSFET on the basis of

a) Symbol, b) Layer diagram , c) SiO_2 layer, d) Switching speed.

Ans} **01M each point**

Comparison:-

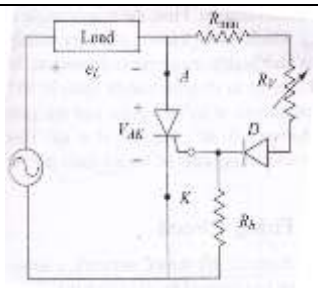
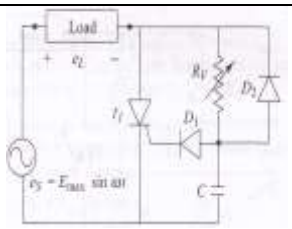
Parameter	**Power transistor**	**Power MOSFET**
Symbol		
Layer diagram		
SiO_2 layer	Not present	Present
Switching speed	More	Less

vi) Compare R-triggering and RC- triggering of SCR on the basis of

a) Circuit diagram , b) Firing angle'α' , c) Cost, d) Avg.O/P volt.

Ans} **Each point 01M**

Comparison:-

Parameters	R-triggering	RC- triggering
Circuit diagram		
Firing angle'α'	$0\text{-}90^0$	$0\text{-}180^0$
Cost	Less	more
Avg.O/P volt	More	Less