

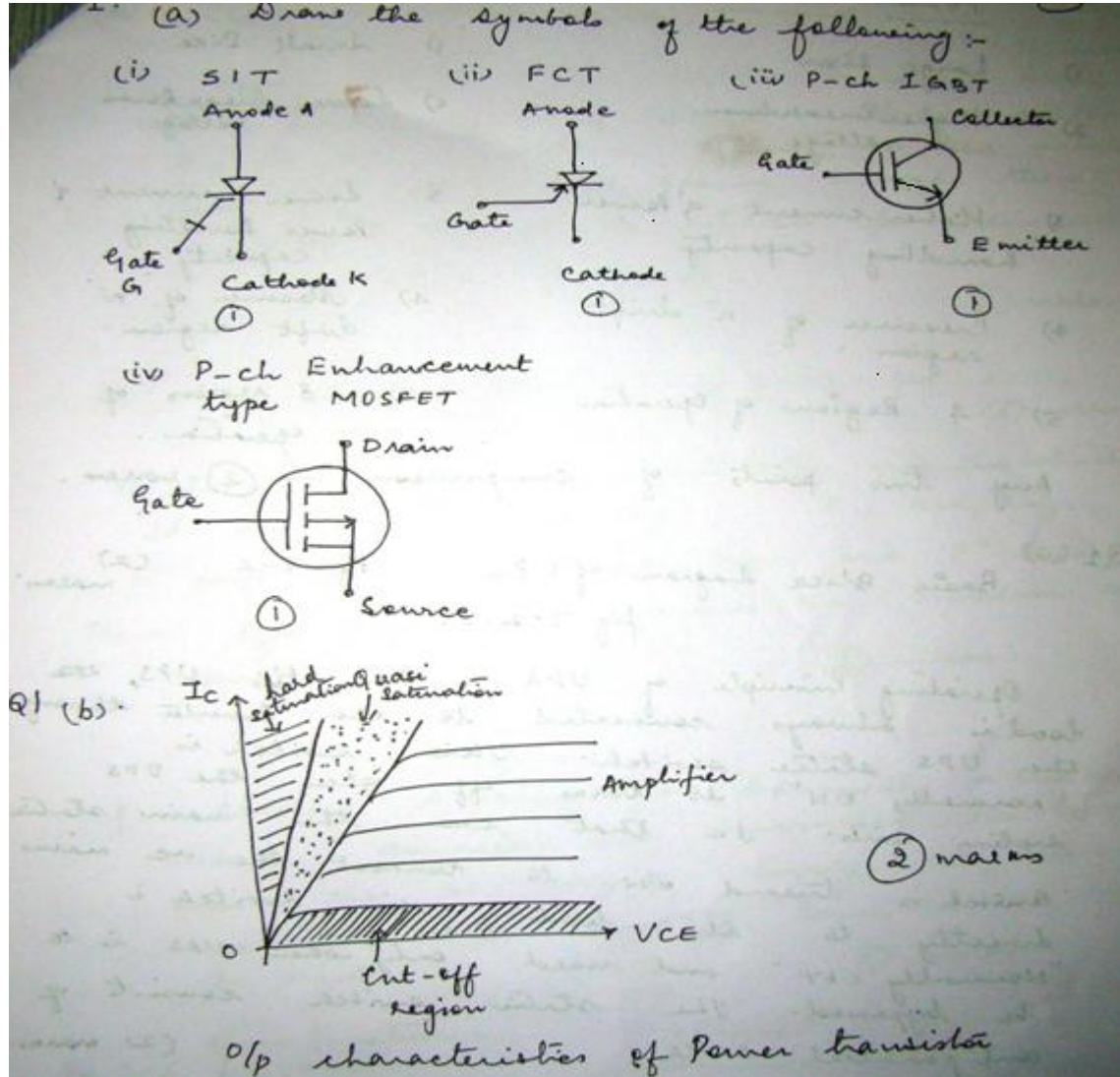
WINTER – 12 EXAMINATION

Subject Code : 12195

Model Answer

Page No : ____/ N

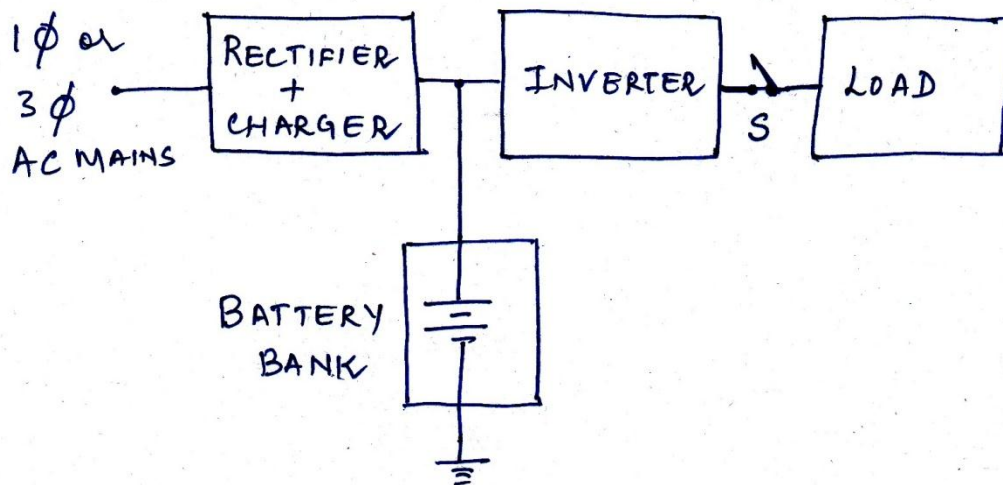
Q. 1. Attempt any FIVE. (20 marks= 5x4)



Power transistor	Low power transistor.
Large size	Small size
Higher break down voltage	Lower break down voltage
Higher current & power handling capacity	Lower current & power handling capacity
Presence - n drift region	Absence of n drift region.
4 regions of operation	3 regions of operation.

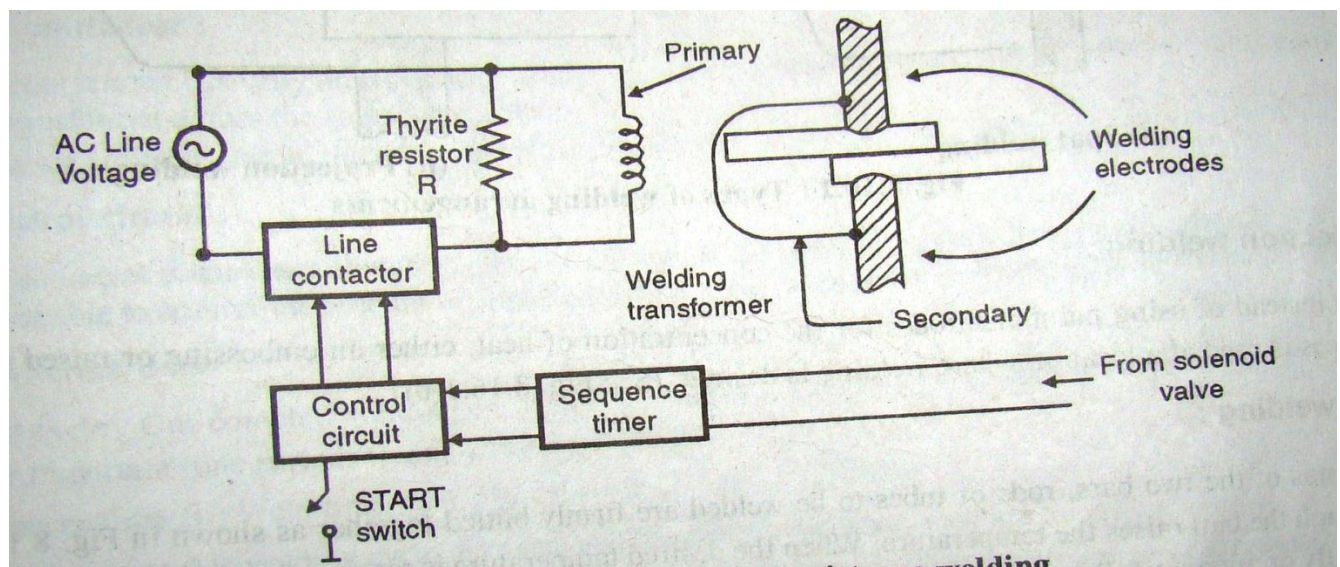
(Any 2 point of comparison – 2 marks)

c) Basic block diagram of UPS (2 marks)



Explanation: [2 marks] In the presence of ac mains, the ac supply is rectified and the battery bank charges. In the event of mains failure the switch S closes and the battery discharges and the inverter converts dc to ac and supplies power to the load

d) Resistance welding diagram (2 marks)



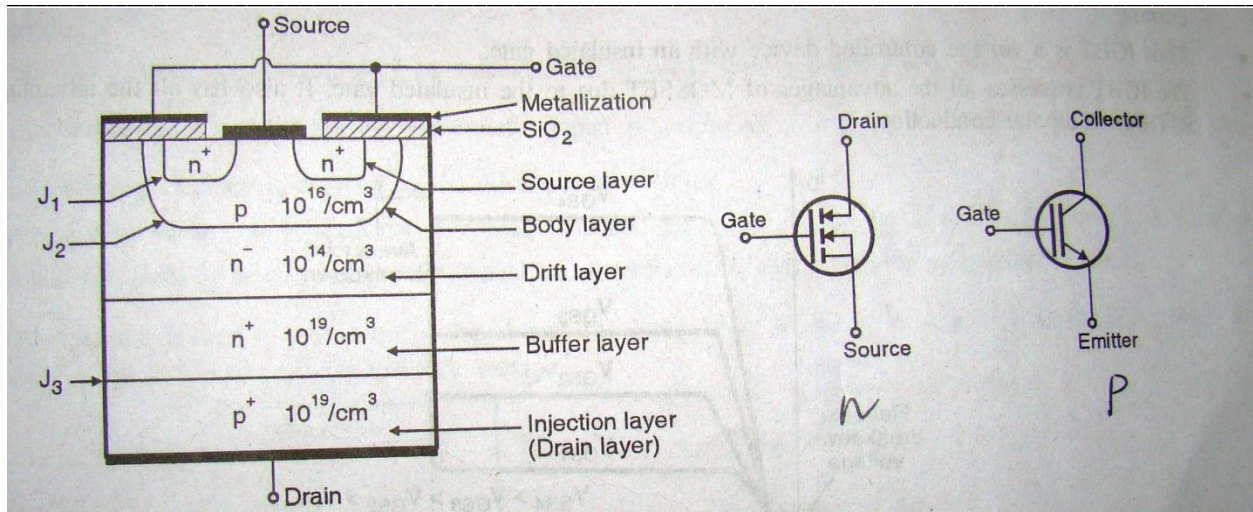
Operating principle:- [2 marks]

the operating principle is based on heating effect of current. Heat is produced due to the resistance offered by the metals sheets to the current passing through them.

Heat produced is utilized for welding and

$$\text{Heat} = \int i^2 R \, dt$$

e) N – channel IGBT (2 marks for the structural diagram showing the layers)



Explanation: 2 marks:

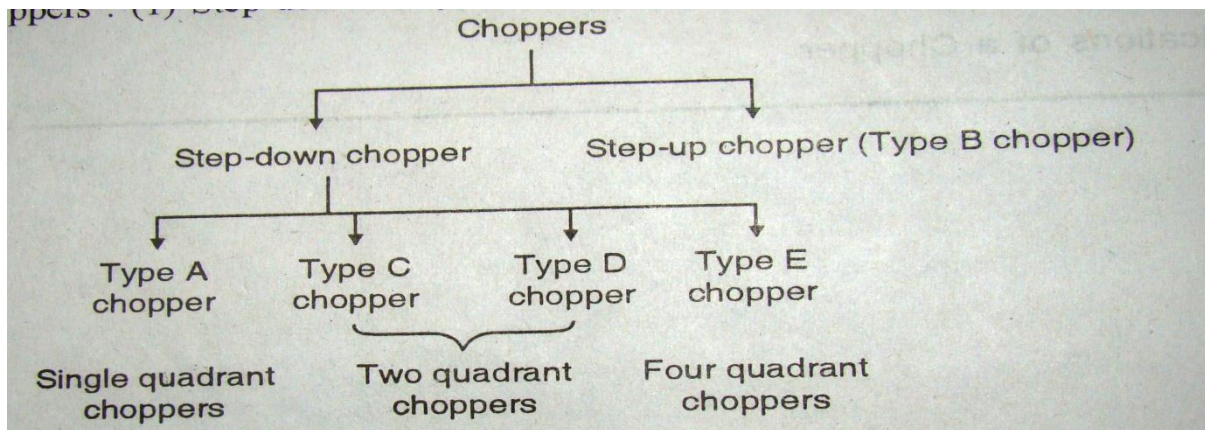
N – Channel IGBT has vertically oriented structure. It has n+ source layer, P – Body layer, n- drift layer and P+ drain layer.

The n-drift layer improves the breakdown voltage capacity. (2 marks)

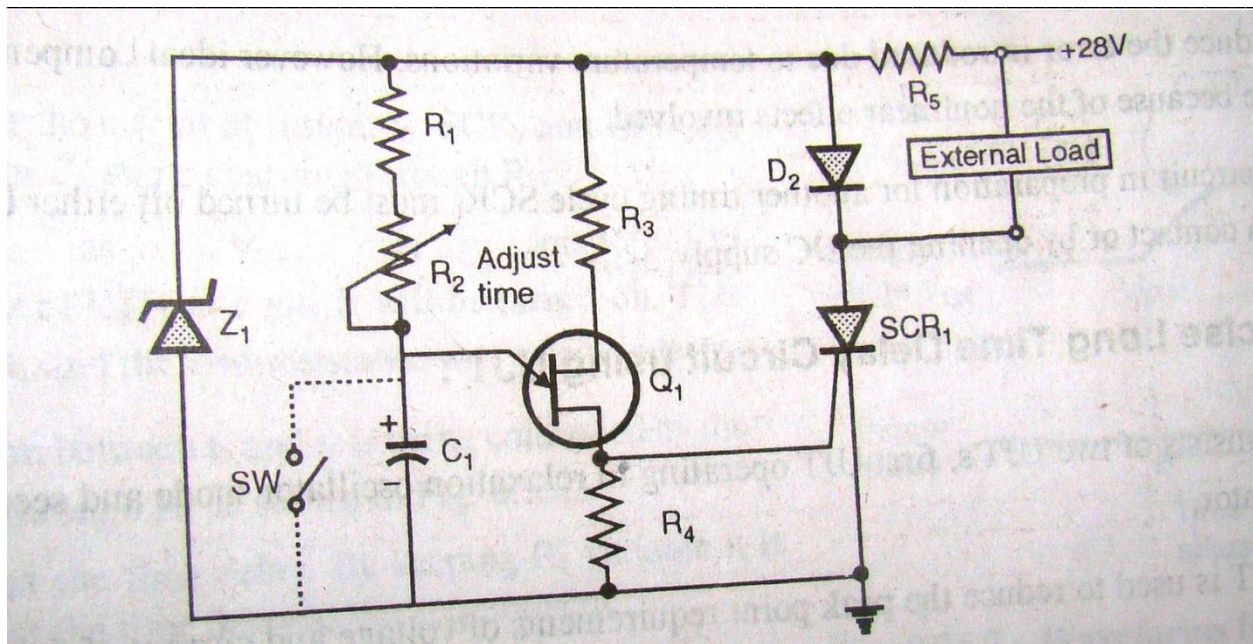
f) Definition [2 marks]

Chopper :- A chopper is a basically a switch which connects and disconnects the load across the DC in put supply. Any switching devices like SCR, Power BJT, and Power MOSFET can be used.

Classification:- (2 marks)



g) Time delay circuit using SCR and UJT. Diagram-2 marks



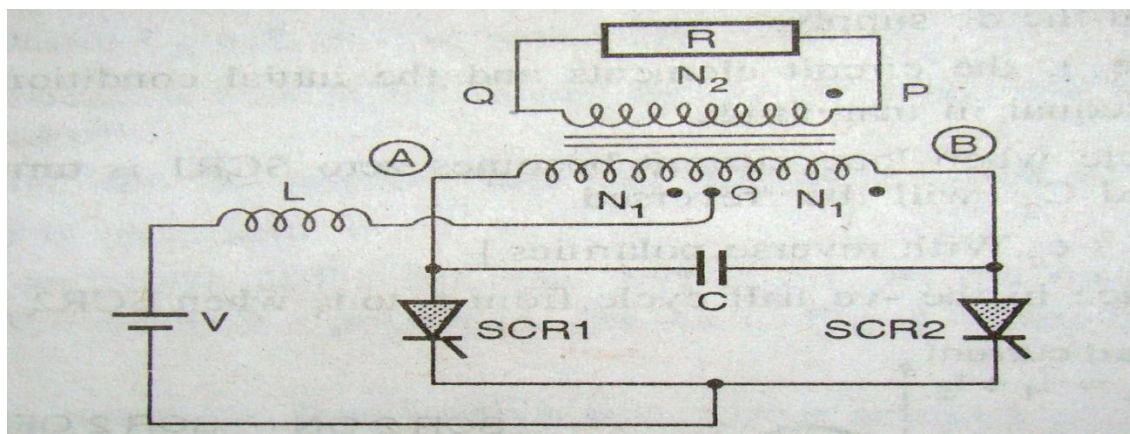
Explanation :- (2mmarks)

1. Initially SCR1 is OFF and there is no voltage to the load.
2. By opening or shorting contact SW across C1 timing is initiated.
3. C1 is charged through R1 and R2 and C1 reaches peak point voltage of UJT and UJT triggers generating a pulse across R4 which triggers SCR1.

Q. 2. Attempt any FOUR.

(16 marks – 4x4).

a) Parallel inverter (2 marks)



Explanation :- (2 marks)

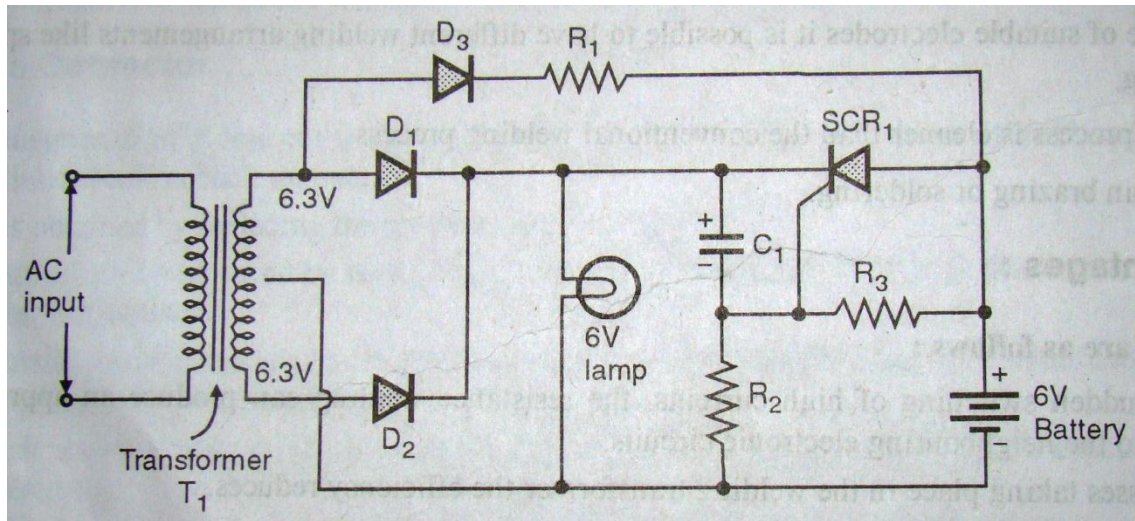
1. SCRs, SCR₁ and SCR₂ are switched alternately to connect the input DC source V across the half of the transformer primary. C is commutating capacitor.
2. When SCR 1 is turned ON the DC voltage appears across the left half of primary OA.
3. Due to transformer action voltage across AB is 2volts. Hence the capacitor is charged to 2V. The load voltage and current is positive.

4. The firing of SCR_2 turns off SCR_1 . The input voltage gets connected across OB .
5. The load voltage changes polarity and direction of load current is reversed.
6. Square o/p waveform is observed.

b) (any 4 points can be considered 4 marks)

ON line UPS	OFF line UPS
Inverter preferred	Line preferred
Main static switch is normally OFF	Main static switch is normally ON.
UPS static switch is normally ON	UPS static switch is normally OFF.
Total harmonic distortion is low	Total harmonic distortion is high
Operation is continuous	Operation is only during the absence of mains.
Critical load	General purpose load
Very reliable	Not so reliable.

c) Emergency light system:- (2marks)

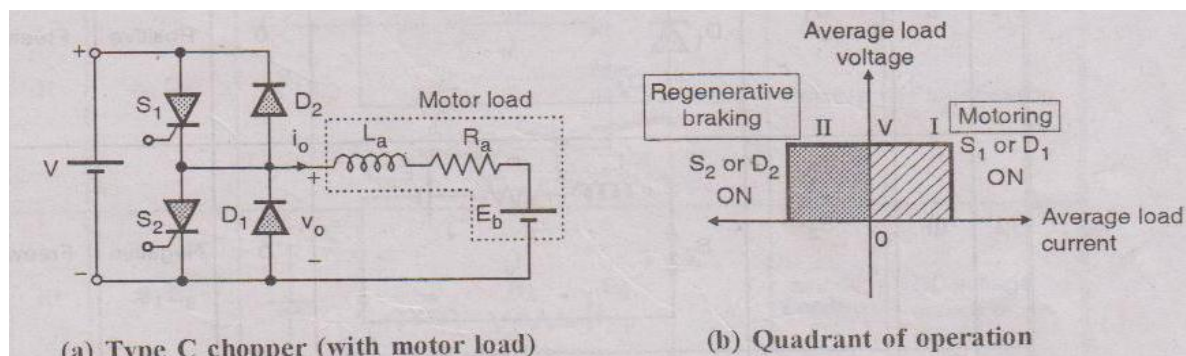


Explanation:- (2 marks)

1. Diode D1 and D2 form full wave rectifier along with center –tap transformer.
2. They supply DC voltage for the lamp when AC supply is ON.
3. Diode D3 and R1 supply the battery charging current.
4. The cathode of SCR1 is kept at a higher potential by C1.
5. When AC supply is interrupted the o/p of rectifier is zero.

6. The cathode potential falls below battery voltage and gate current is supplied to SCR1 is triggered.

d) Class C Chopper : (diagram 2 marks)



Explanation: 2 marks

Mode 1: S_1 is turned on and the DC supply is connected across the load making load voltage positive. The load current flows from dc supply to the load. Load voltage and load current is positive.

Mode 2: S_1 is turned off due to change in load current and -ve self induced emf appears across the load. D_1 is forward biased and freewheeling takes place.

Then the freewheeling current reduces to zero and D_1 turns off. Load voltage is zero and load current is positive.

Mode 3: S_2 turn on after D_1 turns off. Load voltage is zero and load current becomes negative.

Mode 4: D_2 turns on and S_2 turns off. Stored energy is returned back to the supply. Load voltage is positive and load current is negative.

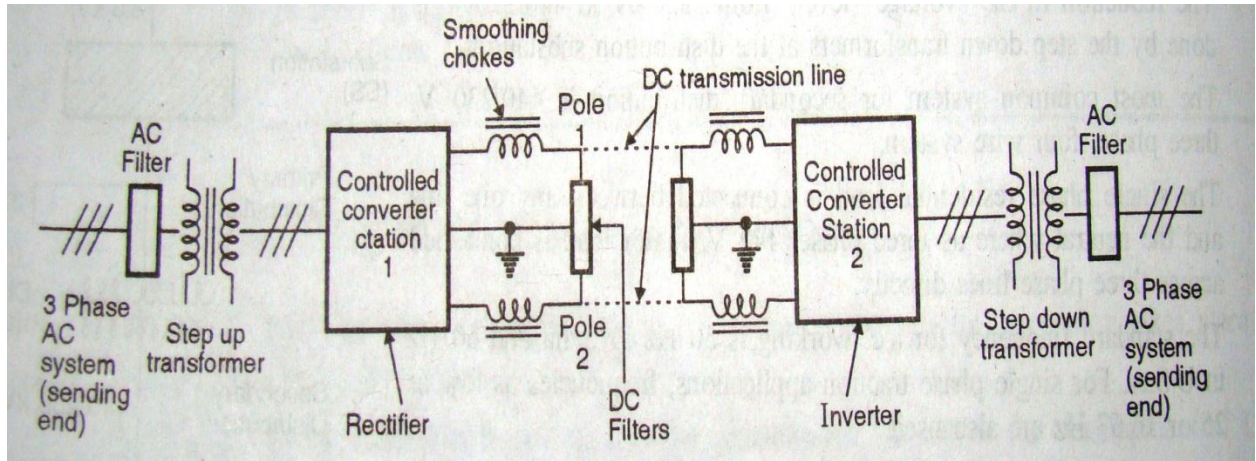
e) Different PWM technique :- (any 4 technique – 2 marks)

1. Single pulse width modulation.
2. Sinusoidal pulse width modulation.
3. Multiple pulse width modulation.
4. Phase displacement control.
5. Modified sinusoidal PWM.

f) Application :- (any 2 application 2 marks)

1. Inverter.,
2. Chopper.
3. Motor control.

g) HVDC diagram:- (2marks)



Explanation:- (2 marks)

1. HVDC system connects two AC systems.
2. Converter station 1 is operated in rectifier mode and AC is converted into DC.
3. The DC travels over the DC transmission line.
4. The transmission system required only two conductors.
5. The DC voltage is again connected into AC by converter station 2 at the receiving end which acts as an inverter.

Q. 3. Attempt any FOUR. (4x4 = 16 marks)

a) Compare series and parallel inverter by four points:- (Any four, 1 mark each)

Series inverter	Parallel converter
Commutating components is connected series with load.	Commutating component is connected is parallel with load.
Resonant circuit is necessary	Resonant circuit is not necessary.
Output transformer is not required	Output transformer is essential
Distortion is high	Low Distortion
Used in induction heating	Used in emergency system.

(note : Other relevant point can be consider)

b) Explain working of zero voltage switching with diagram:-

Ans) (02 marks for diagram, 02 marks for Explanation)

Zero voltage switching is switching turn ON and turn OFF at zero voltage.

ZVS circuit is shown below:-

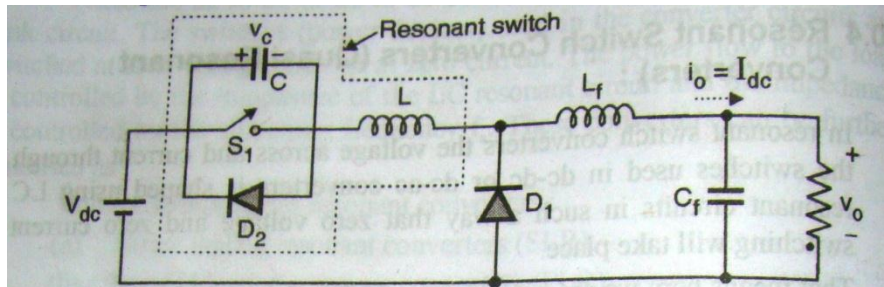
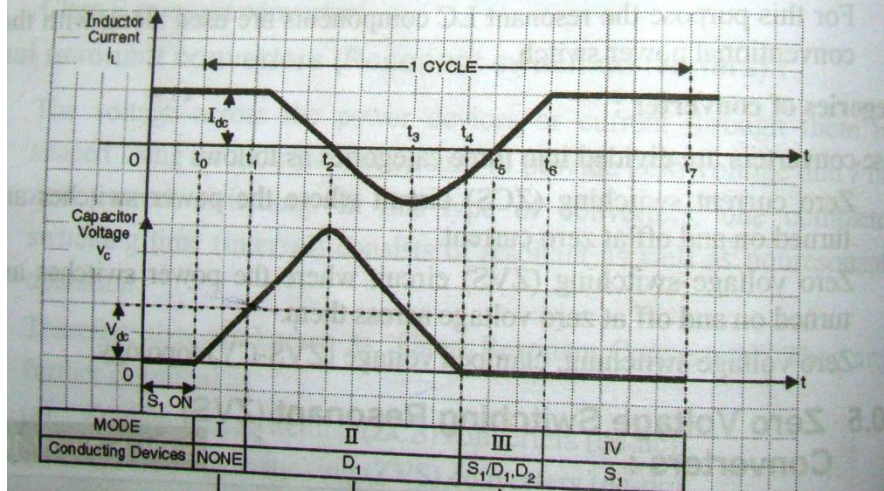


Fig. 4.10.1(a) : ZVS resonant switch dc-dc converter



Explanation:-

Mode 1 :- (t₀ - t₁)

when DC input V_{dc} is applied capacitor C_r gets charge through path $V_{dc} - C - C - L - L_f - RL - V_{dc}$ at a constant load current I_o . The capacitor charging voltage is $V_c = (I_o / C) t$.

At the edge of mode $V_{cr} = V_{dc}$.

Mode 2:- (t₁ - t₄)

During this period diode D_1 turn ON and L and C start resonating.

The current i_L start decreasing as the capacitor voltage rises at the end of this mode $i_{Lr} = 0$ and $V_{cr} = V_{dc}$ peak from $t = t_2$, capacitor discharges through the input supply V_{dc} the path of the discharges current is through V_{dc} D_1 , L back to C .

Therefore during the interval t_2 to t_3 i_L is -ve.

At $t=t_2$, $V_c = V_{dc}$ and i_L continuous to conduct in the same direction and V_c continuous to decrease.

Mode 3:- (t_4 to t_6)

At $t=t_4$, $V_c = 0$ and voltage across S_1 is clamped to zero as the a load D_2 conduct the inductor current i_L .

At $t = t_5$ the inductor current goes to zero D_2 , D_3 turn off and S_1 turn ON, i_L increase towards I_{dc} .

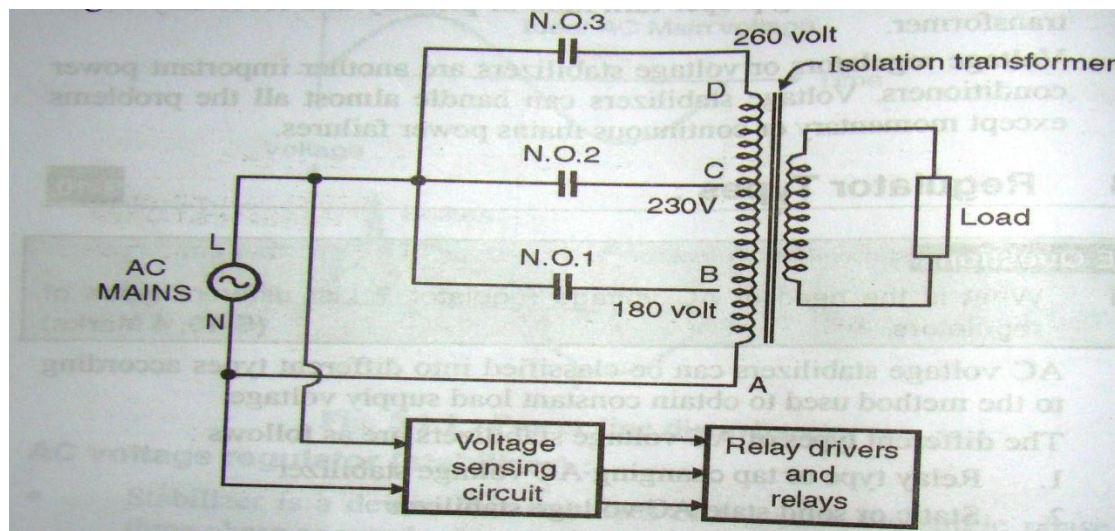
Mode 4:- (t_6 to t_7)

Switch S_1 conduct during this interval. $V_c = 0$ and $i_L = I_{dc}$.

c) Draw relay type AC voltage stabilizer and state it two advantages and two disadvantages:-

Ans) Diagram :- (02 marks)

Relay type AC voltage stabilizer:-



Advantages :- (2 advantage. -1 mark)

1. It is simple.
2. Cost effective.

Disadvantages:- (2 disadvantage. – 1mark)

1. Dynamic response is poor.
2. Voltage regulation is poor.
3. Efficiency is low, about 70 %.



d) Compare power BJT and power MOSFET (Any four point-1 mark each)

parameter	Power BJT	Power MOSFET
Gating	Current	Voltage
Voltage blocking	asymmetric	asymmetric
Temp. coeff.of resistivity	- ve	+ ve
Switching frequency	10 KHz	Up to 100 KHz
Turn ON time	1 μ s	100 ns
Turn off time	2 – 5 μ s	150 – 200 ns
snubber	polarized	Polarized
application	Lamp dimming heating control	Motor device UPS system.

(note: other relevant point if any, can be consider)

e) State the need of protection circuit of SCR :-

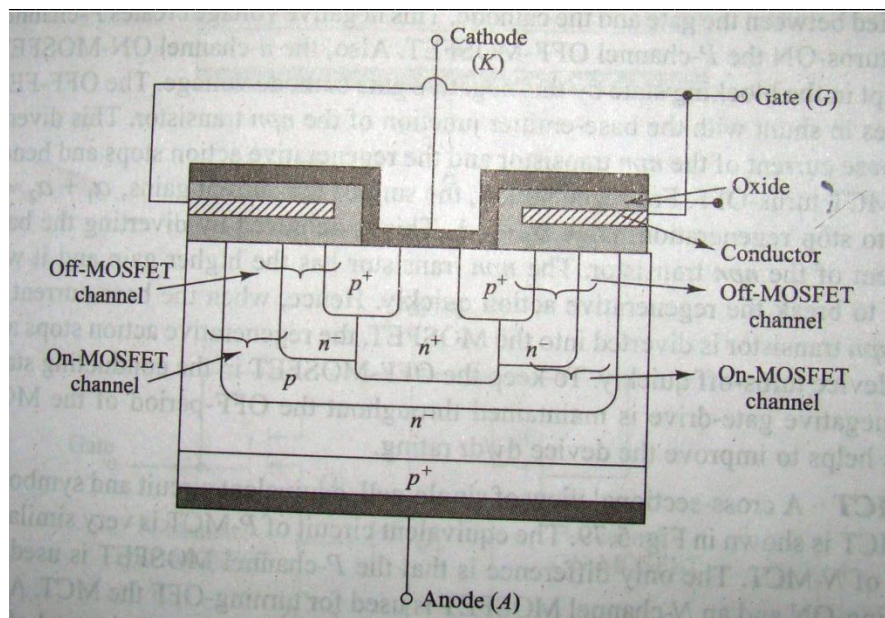
Ans) Need of Protection Circuit in SCR (4marks)

SCR has limited operating capabilities reliable and satisfactory use of it depend on ensuring that the circuit condition imposed on it is always within its capabilities. To achieve this SCR has to be surrounded by component chosen to protect it against the extreme condition. If a SCR experiences over voltage, overload high current or voltages triggers, high junction temperature or other abnormal operating condition, the SCR may be degraded in performance or destroyed permanently. The SCR should be protect against as normal condition for satisfactory and reliable operation.

To operate SCR within its upper temperature limit, the heat produced by 1 uses in a device must be dissipated efficiently and effectively. Therefore protection circuits or cooling arrangement and heat sink are employed.

f) Draw structural diagram for N - MCT and describe its working:-

Ans) Structural diagram for N – MCT (figure: 2 mark)



Explanation 2 mark

N- MCT turn ON:- for an N-MCT the gate voltage is applied with respect to the cathode. There are two MOSFET one for turn on and the other for turn off. If a positive voltage is applied between gate and cathode an N – channel MOSFET turns on and P- channel turns off. If negative voltage is applied between gate and cathode the p –channel MOSFET turns on and N- channel turns off. Hence N- MCT can be turned on by applying positive voltage and turned off by supplying negative voltage.

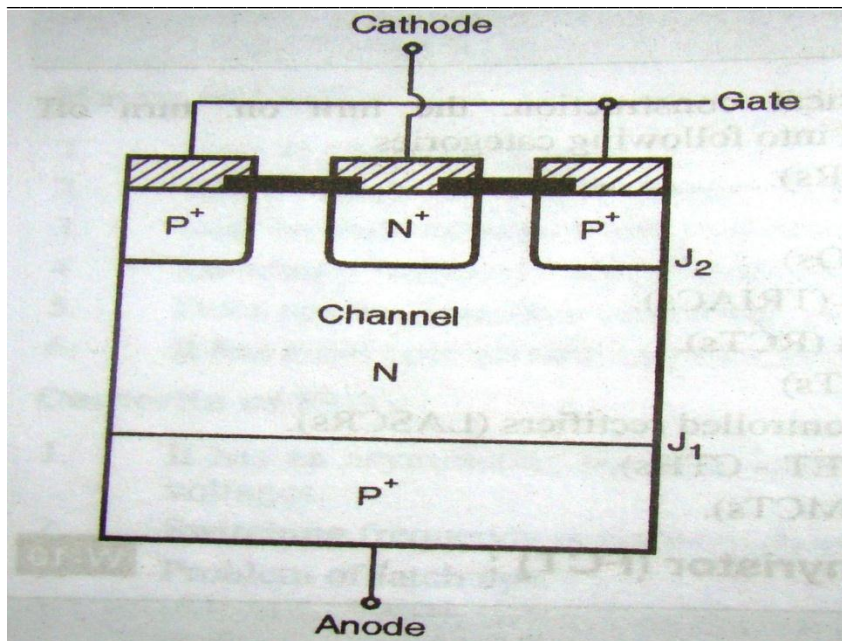
When positive voltage is applied between gate and cathode the anode current flows through the N – channel of the ON MOSFET. Hence ON – FET is activated and will ensure the off FET is driven into its blocking state. The anode current through N channel on MOSFET applies base current to the npn transistor. The collector current of which turns on the npn transistor. The regenerative action starts and the device latches.

N –MCT turn OFF:- in order to turn off the N- MCT a –ve voltage is applied between the gate and cathode. This –ve voltage creates the p – channel and turns on the p channel off MOSFET.

The N –channel ON- MOSFET is kept in blocking state by this –ve gate cathode voltage. The off – FET comes in shunt with the base – emitter junction of the NPN transistor. This diverts the base current of the open transistor and the regenerative action stops and hence the MCT turns OFF.

Q. 4. Attempt any FOUR. (4x4=16 marks)

a) Explain constructional diagram of FCT?



(Figure 2 mark, explanation 2 mark)

Above fig. shows basic structure of FCT.

It is three terminal device anode , cathode and gate.

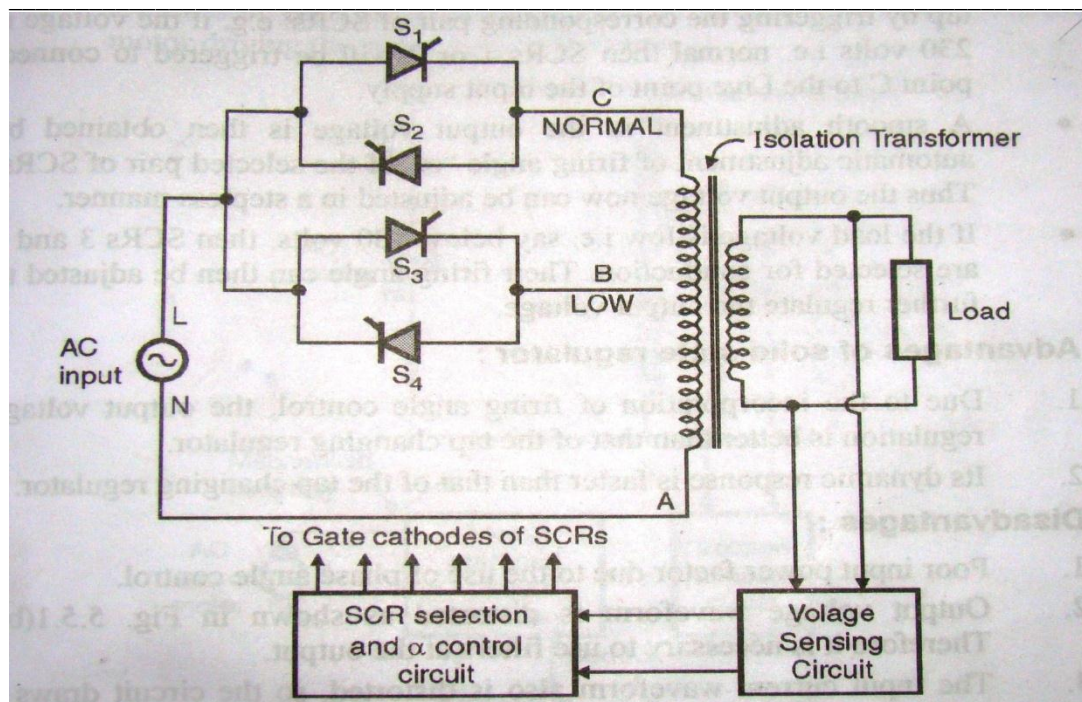
This device can be operated by grounding the cathode and applying bias voltages to the anode and gate with respect to cathode.

It is necessary to forward bias the device for its successful operation with – ve voltage applied to anode the device blocks current because J1 is reverse bias.

With + ve voltage applied to anode the junction J1 is forward biased the device will allow the anode current to pass easily through it.

When the + ve anode voltage is increased above a particular value for each applied VGS the FCT will be turn ON.

b) Draw and explain solid state AC voltage stabilizer



(Figure 2 mark, explanation 2 mark)

As shown in fig. primary winding of the transformer is divided into several taps. Live terminal is connected to the primary winding through back-to-back connected SCRs.

The sensing circuit measures the output voltage and selects a particular tap by triggering the corresponding pair of SCRs.

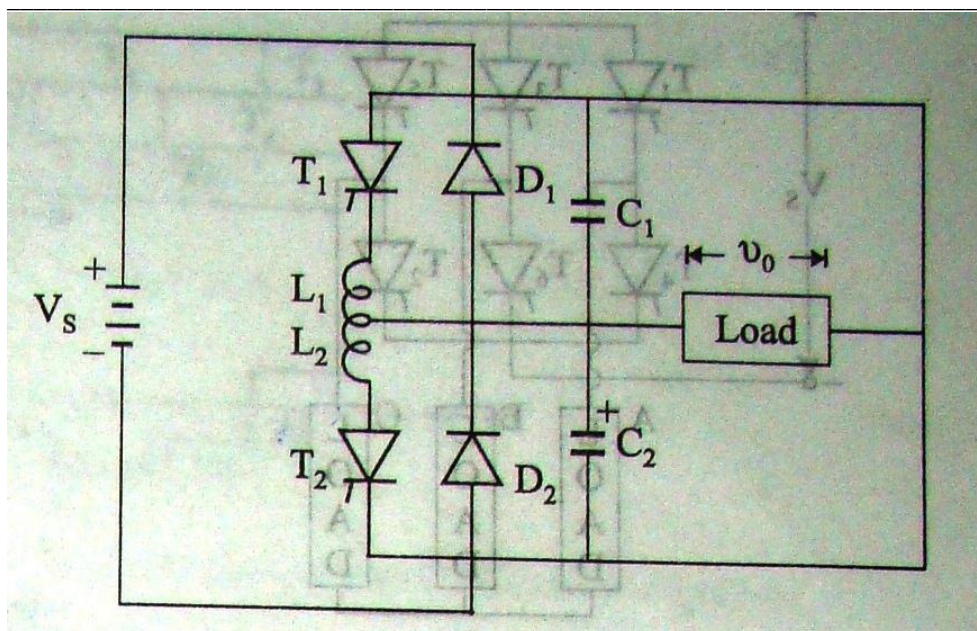
e.g. if the voltage is 230 V i.e. normal, SCR 1 or 2 will be triggered to connect point C, the live point of the supply.

A smooth adjustment in the output voltage is then obtained by automatic adjustment of the firing angle of the selected pair of SCRs. Thus, output voltage can be adjusted in a stepless manner.

If the load voltage is low i.e. below 180 volts, then SCRs 3 and 4 are selected for conduction. Their firing angle can then be adjusted to further adjust the output voltage.

c) Draw and explain Mc-Murray Bed commutation inverter.

Ans: - **(Diagram -2 marks, explanation -2 marks)**



Explanation:- figure shows the ckt arrangement for a McMurry – Bedford inverter. In this inverter the complementary impulse communication method is used in which no auxiliary thyristor is used and the triggering of one main thyristor. Therefore it requires fewer thyristors and diode but large valued commutating components. As shown as figure there are two closely coupled commutating inductors L_1 and L_2 wound on the same core with equal magnitudes and two equal valued commutating capacitors C_1 and C_2 . T_1 and T_2 are the main thyristor which are triggered at 180° intervals and if one thyristor is turned on the other conducting thyristor is turned off.

When the thyristor T_1 is triggered, current flows through the positive terminal of the supply, T_1 , L_1 and the load and flow back to the –ve end of the supply. At this instant capacitor C_1 remains shorted and almost all the total supply voltage V_s appears across the capacitor C_2 thus charging it to V_s with polarity shown in the figure. Capacitor C_2 retains its charge as long as T_1 conducts. As soon as the thyristor T_2 is triggered capacitor C_2 starts discharging through the positive plate of C_2 , L_2 , and T_2 and back to the –ve plate of C_2 . At the same instant the voltage across C_2 appear across L_2 which is then induced across L_1 due to close coupling between L_1 and L_2 . These two voltages then add up and thus reverse bias the thyristor T_1 . When thyristor T_2 is conducting and T_1 is non-conducting the load current flows through the positive terminal of the supply the load T_2 and back to the –ve terminal of the supply.

Thus an AC voltage is obtained across the load and at the same time capacitor C_1 a start charging with the upper plate at a positive polarity and C_2 is totally discharged. When thyristor T_1 is triggered the same step is repeated and T_2 turns off due to the charging of C_1 . Hence by triggering one thyristor the other one is switched off. Diodes D_1 and D_2 are the feedback diodes to feedback the reactive power associated with capacitive and inductive load.

(Note: Mc-murry Bedford half bridge, full bridge also can be consider)

d) Draw and explain Class B type chopper with proper waveform.

Ans: -(figure: 1 mark ,waveform: 1mark, explanation: 2mark)

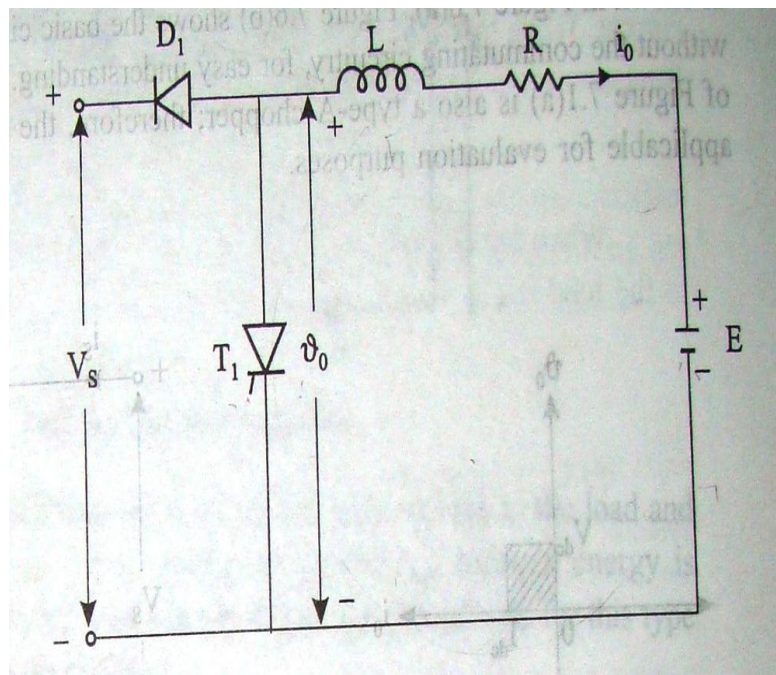


Fig. (a)

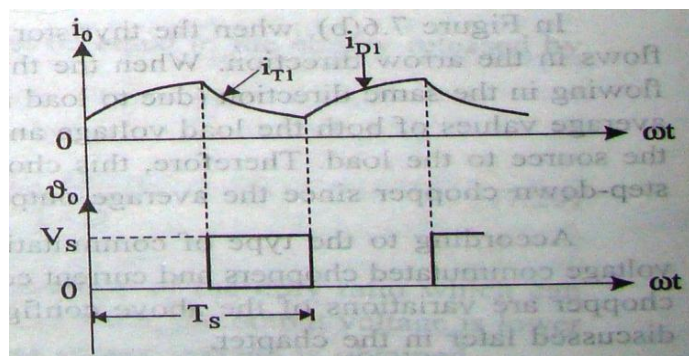


Fig. (b)

This is a second quadrant chopper in which both the load current and load voltage occur only in the second quadrant i. e. the load current flows out of load while the load voltage is positive . the circuit arrangement of such a type of chopper is shown in fig. (a) where the battery E is the part of the load that may be the back emf a DC motor.

When thyristor T1 is triggered the load voltage V_0 becomes zero but the battery E drives the current through the inductor L and thyristor T1. The inductor L stores energy during this period. When the thyristor T1 is turned off the energy stored in the inductor L is returned to the source through the diode D1. Thus when the chopper (T1) is off, the load current i_0 flows in the opposite direction as shown as fig. (b). hence the average load voltage V_{dc} is positive and the average load current I_{dc} is –ve.this means that power can flow from the load to the source by the c=active load. Since the power flows from the load of lower voltage to the source of higher voltage the type – B chopper is also

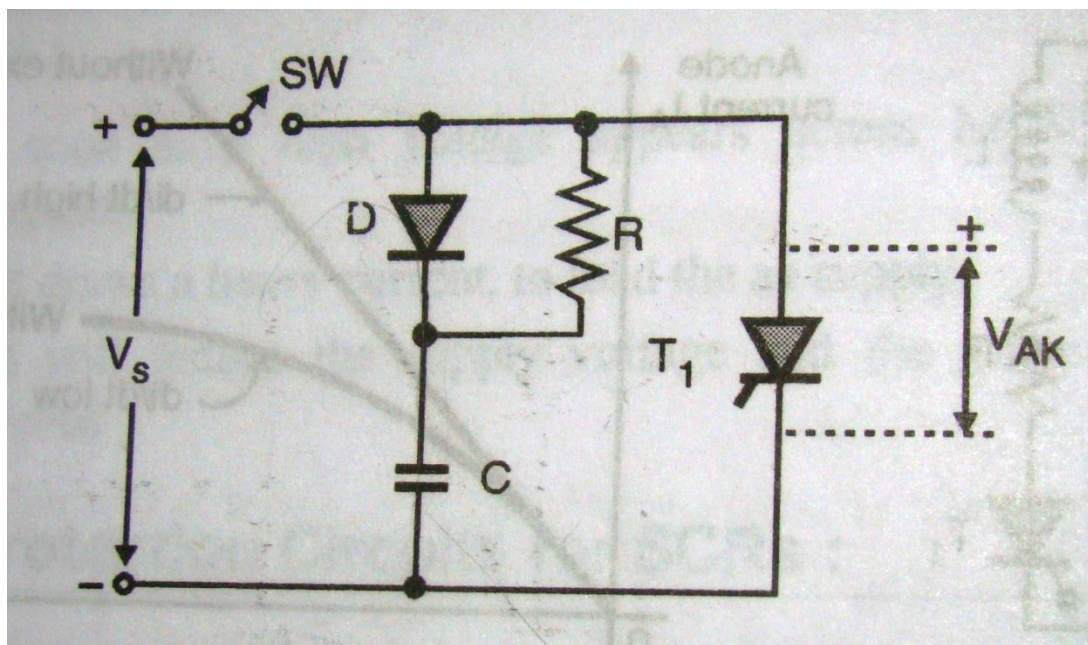
known as a steep chopper. A typical application of this type of chopper is in subway – trains where regenerative braking DC motors are used. The instantaneous ckt waveforms are shown fig. (b).

e) State function of snubber circuit. Explain polarized RC snubber circuit used for SCR.

Ans: - (Function: 1 mark, figure: 1 mark, explanation: 2 mark)

In most proper electronic circuit, protection is necessary against the effects of excessive rate of rise of forward voltage (dv/dt) across the devices, which can cause unintended break over, leading to a malfunction of the circuit and possible to failure of the devices. The tendency to excessive dv/dt may rise from external causes such as the closing of main supply contactor, or from the operation of the circuit itself. Therefore to suppress dv/dt snubber circuit is used.

Polarized RC snubber circuit: -



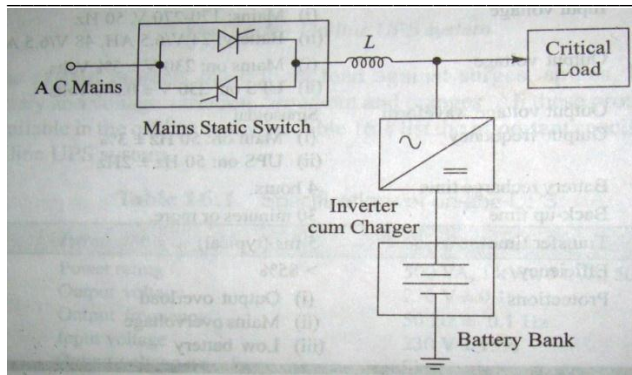
When SCR is in the forward blocking state (off state), the capacitor will charge through diode D. due to low forward resistance offered by diode D, the capacitor is as good as connected across SCR.

Therefore voltage across SCR will increase gradually. Thus rate of change of voltage across SCR is reduced. When the capacitor is fully charged to supply voltage, the diode is reverse biased and stops conducting. When SCR is turned ON, the charged capacitor will discharge through resistance R and SCR. Thus R will limit the discharge current of the capacitor and prevents damage of SCR due to over current.

f) Draw and explain line interactive UPS.

Ans: - (02 marks for diagram, 02 mark for explanation)

The block diagram of line interactive UPS is shown below-

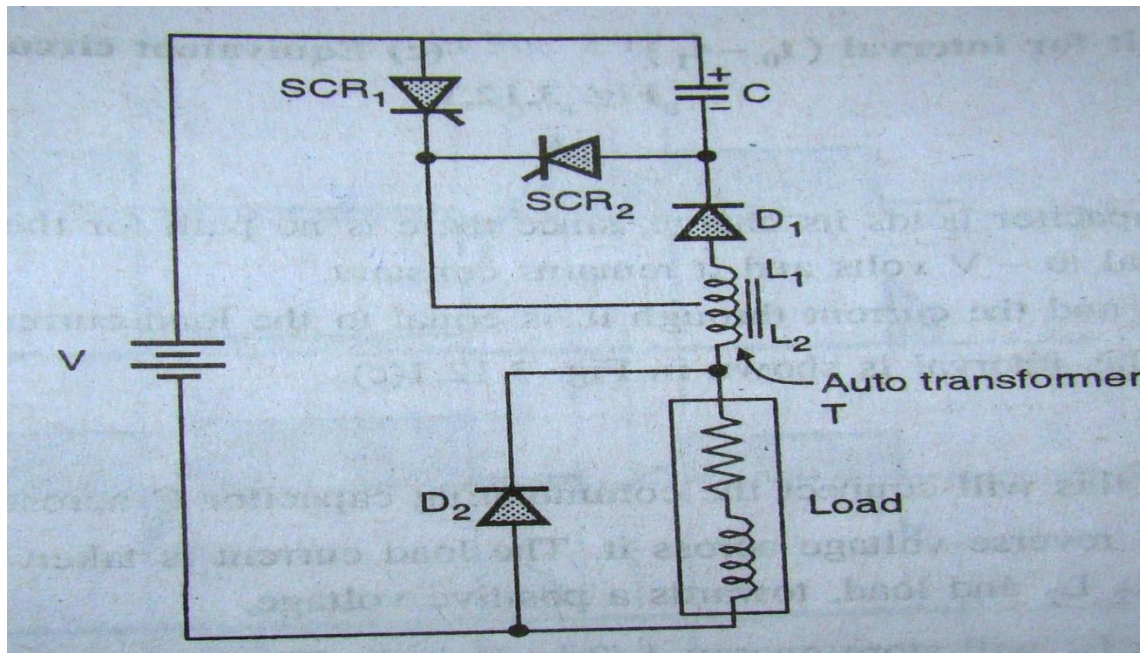


Mode 1: When mains is ON, the static switch is closed and the load gets connected directly to the AC mains through the inductance L. the inverter/charger block operates as a charger and charges the battery back.

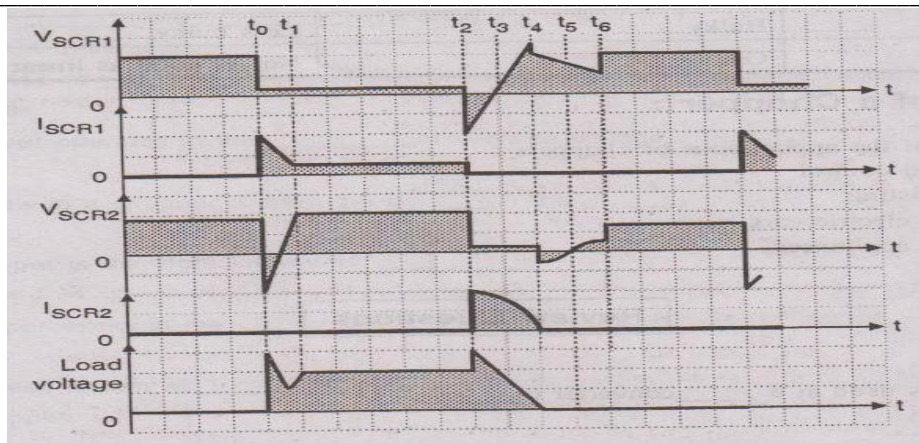
Mode 2: As soon as the mains fails, the static switch is turned OFF and the inverter/charger block operates as a inverter and the battery supplies power to the load through the inverter. The total time taken for sensing and changeover after the failure of mains is less than 5msec. this configuration does not provide any isolation between the load and the AC mains.

Q.. 5. Attempt any TWO. (16 marks – 8x2)

a) Jone's chopper :- (4 marks)



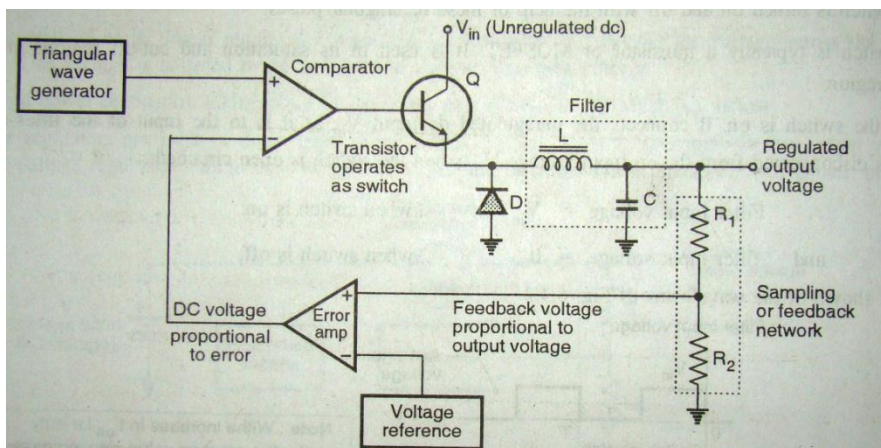
waveforms of Jone's Chopper [2 Marks]



Advantages of Jone's chopper:- (2 marks)

1. Because of tapped auto transformer the capacitor gates sufficient energy to turn off SCR1, efficiently.
2. Voltage commutated chopper.
3. Used in speed control of dc motor

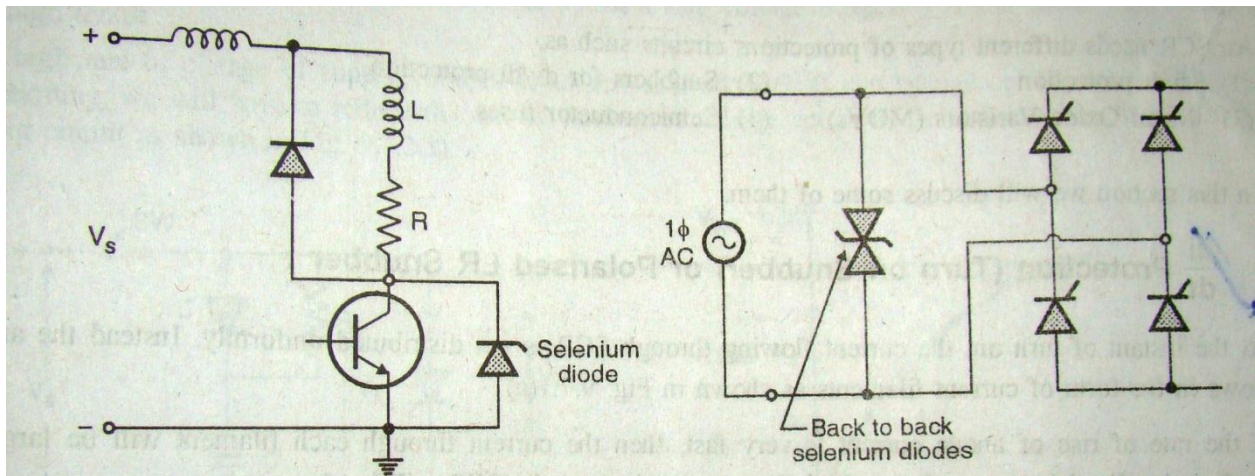
b) Block diagram of SMPS: (4 marks)



Comparison of linear regulator and SMPS:- any 4 points - 4 marks

Parameter	Linear regulator	SMPS
Region	Active	Saturation or cutoff
Switching action	no switching	Transistor acts as switch
Complexity	less	High
efficiency	Less 40%	High 90%
Regulation	excellent	Good
size	large	Small
power	low	High

c) Over voltage protection :- (diagram any one can be considered-4 marks)

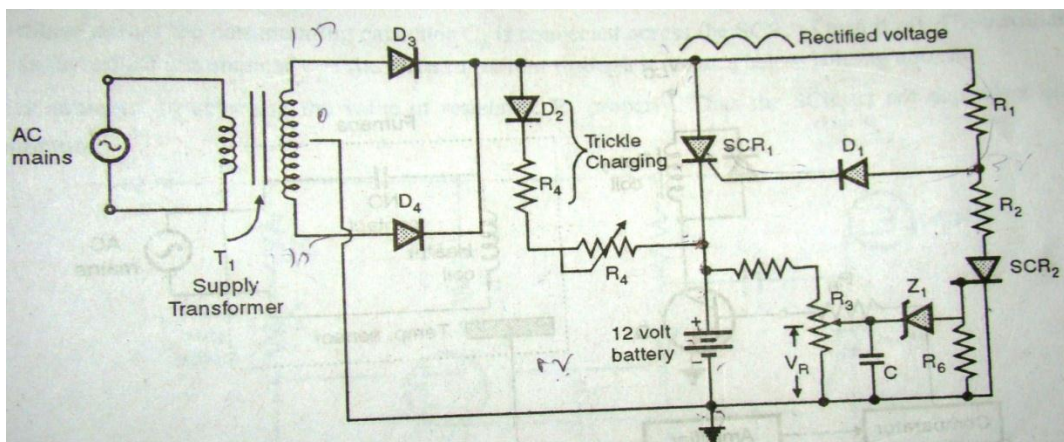


Comparison of over voltage and over current protection:- (4 marks)

Over current	Over voltage
Fuses are need	Selenium diodes or metal oxide varistors are used
It senses over current due to over loads	It senses over voltages due to transients or spikes
Power dependent	Voltage dependent
Complicated circuit	Simple circuit

Q. 6. Attempt any TWO. (16 marks- 2x8)

a) Battery charging regulator:- (diagram 4 marks)

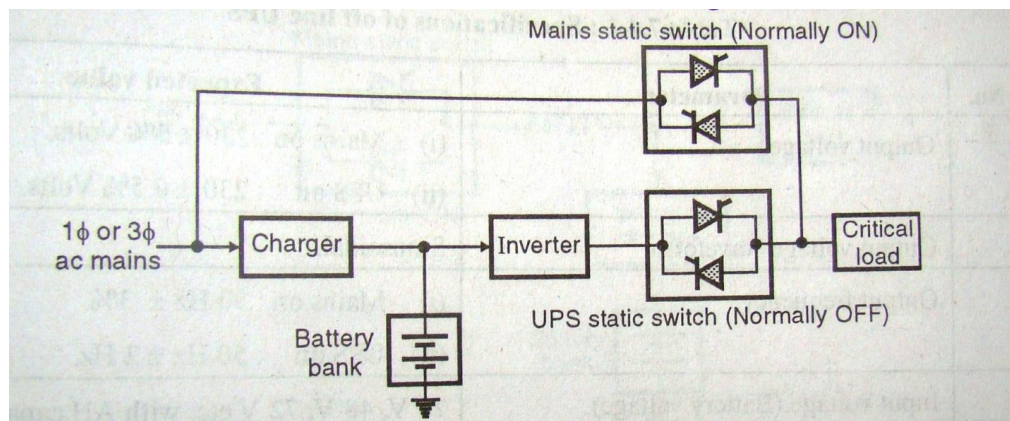


Operation:- (4marks)

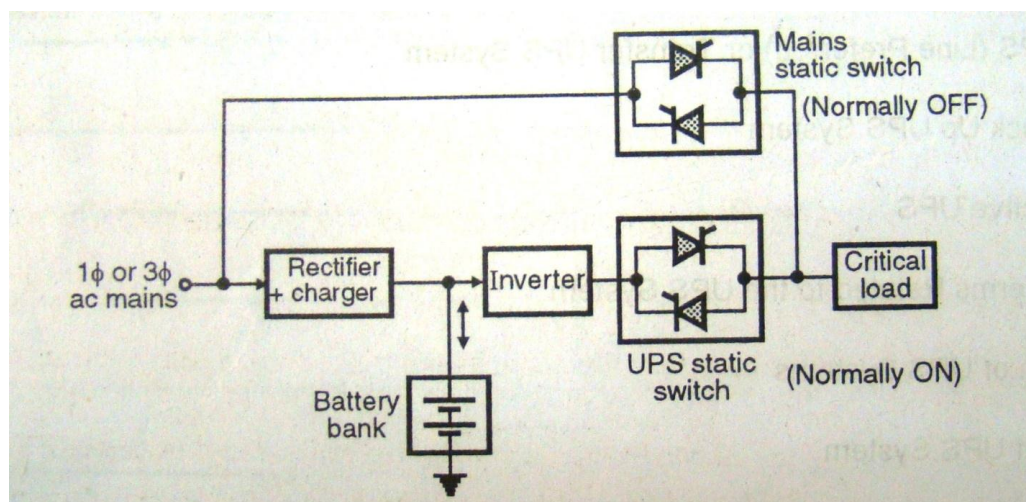
1. The battery voltages are sensed by R3 and C.
2. VR is proportional to battery voltage.
3. 1 ϕ supply stepped down by T1 and rectified by D3 and D4.
4. 12 v batteries to be charged is connected in series with SCR1.
5. When VR is small, then is no gate current for SCR2 and it remains off.
6. SCR1 will get gate current through R1 and D1.
7. The rectified voltages appear across the battery and the battery charges through SCR1.
8. Due to charging the terminal voltages of battery, SCR2 turn ON.
9. This will reverse bias D2 and SCR1 will be turn off.
10. D2 and R4 are used for trickle charging.

b)

i) OFF line UPS: - (2 marks)



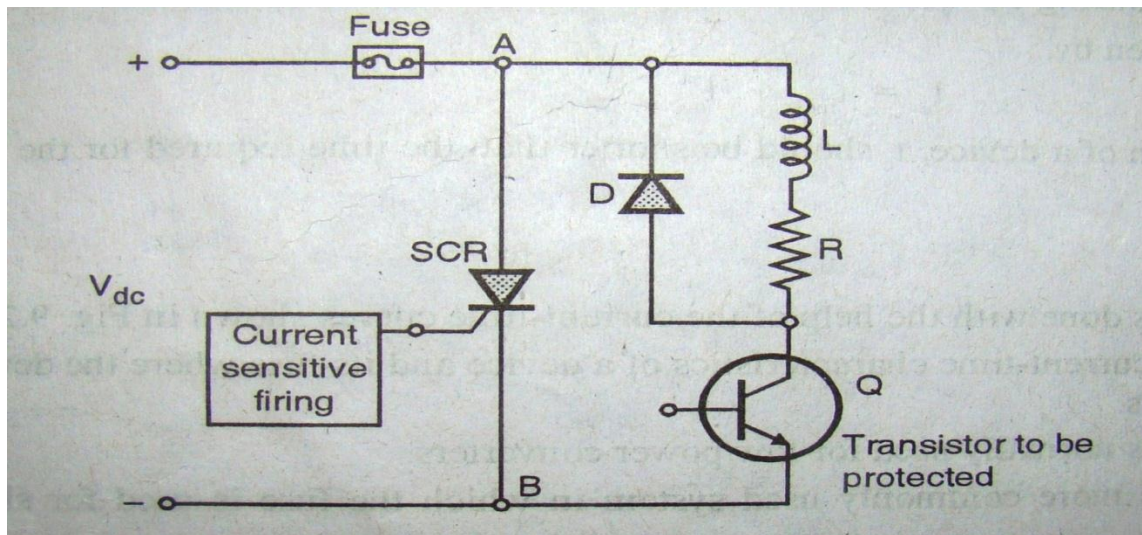
ii) ON line UPS: - (2 marks)



- OFF line UPS application: - 1. General purpose. 2. Domestic / home. (2marks)
- ON line UPS application: - 1. Critical load medical. 2. Computer. (2marks)

c)

i) C ROW BAR PROTECTION :- (diagram- 2marks)



Explanation:- (2marks)

1. SCR is used which is normally in off state.
2. There is a voltages or current sensitive firing circuit.
3. If the current through Q goes above a preset value, then the SCR will be turn ON.
4. The SCR will act as a closed switch and will short circuit points A and B.
5. So in fault condition, SCR turns ON and will below the fuse and the transistor is protected.

ii) Circuit breaker :- (2 marks)

Circuit breakers disconnect the load from the mains in the event of overload or fault.

are used for low voltage motors of high ratings.

Function- (2 marks)

They are used for overload protection, short circuit protection, under voltage, over temperature and unbalanced supply voltage in motors.

