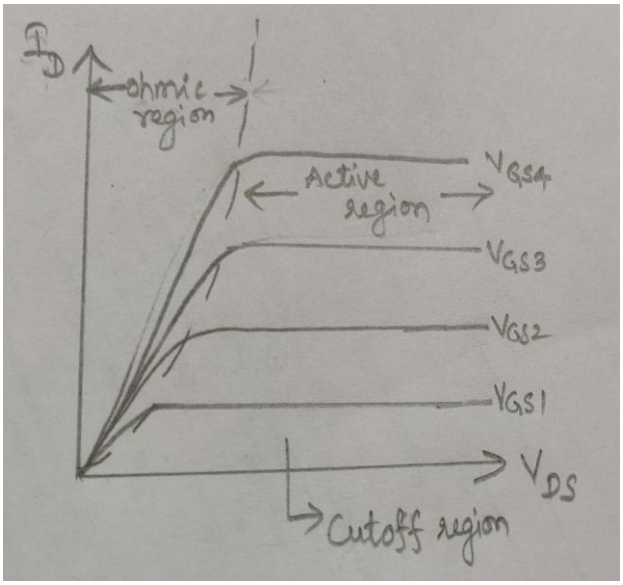
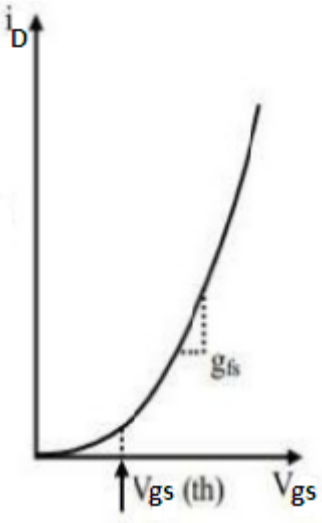
SUMMER – 19 EXAMINATION

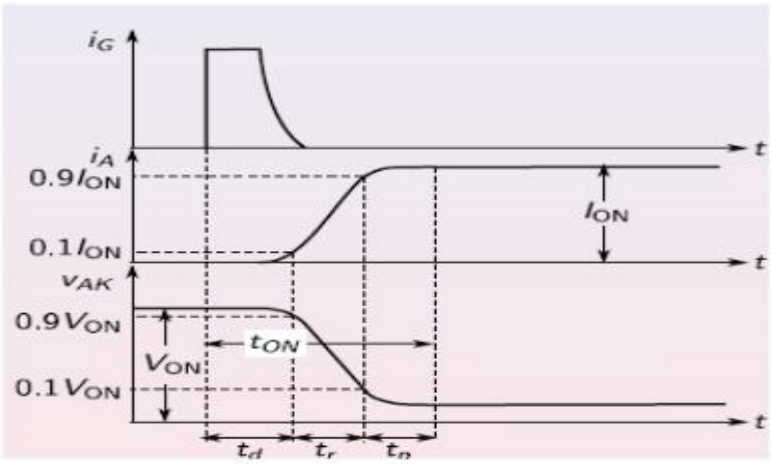
Subject Name: Power electronics **Model Answer** **Subject Code:** 17444

Important Instructions to examiners:

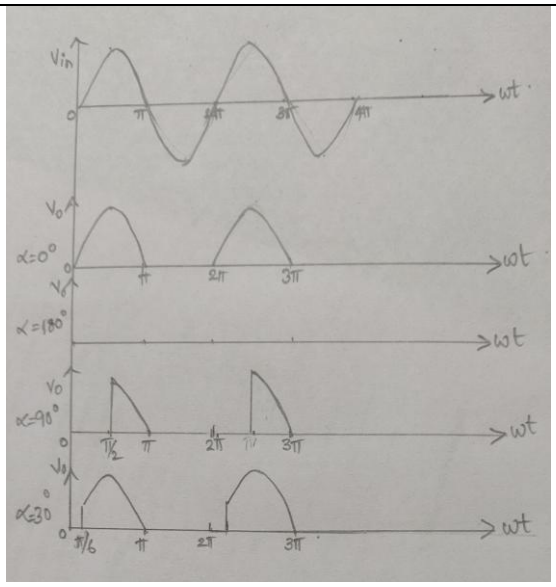
1) The answers should be examined by key words and not as word-to-word as given in themodel answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may tryto assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given moreImportance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in thefigure. The figures drawn by candidate and model answer may vary. The examiner may give credit for anyequivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constantvalues 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.

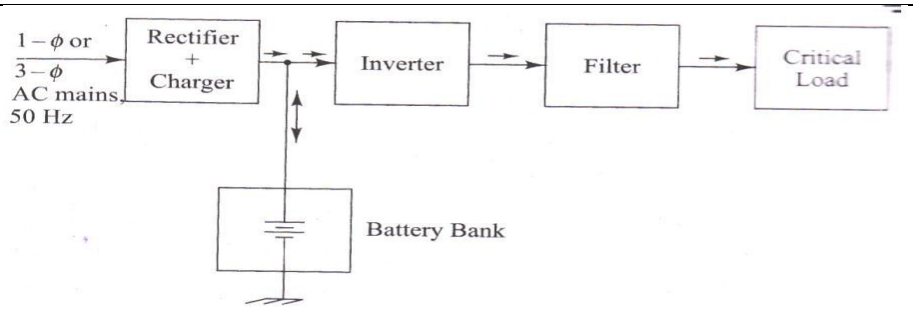
Q. No.	Sub Q. N.	Answers	Marking Scheme
1	**(A)**	**Attempt any SIX of the following:**	**12- Total Marks**
	(i)	**State any four applications of SCR.**	**2M**
	Ans:	• Controlled rectifiers (½ mark for each) • Choppers • Voltage controllers • Speed control of DC motors • Temperature controllers • UPS • Inverters etc.,	**Any four can be considered**
	(ii)	**Draw V-I characteristics of IGBT and label the different regions**	**2M**
	Ans:		**fig one mark, labeling 1 mark**

		Output characteristics:  **Transfer characteristics:**  	
	(iii)	**Classify the following triggering devices for SCR & TRIAC.** **UJT,SBS ,PUT,SUS,DIAC.**	**2M**
	Ans:	**Triggering device for SCR :** UJT,PUT,SUS **Triggering device for TRIAC:** DIAC, SBS	(1mark each)

	(iv)	**State any two applications of each chopper and inverter ckt.**	**2M**
	Ans:	**Choppers:** • Switched mode power supplies, including DC to DC converters. • Speed controllers for DC motors. • Switched capacitor filters. • D.C. voltage boosting. • Battery-operated electric cars. • Battery chargers. • Variable-frequency drives. **Inverters:** • Uninterrupted power supply. • AC motor speed controller. • Centrifugal fans and pumps. • Conveyors. • Induction heating. • Aircraft power supply • High voltage DC transmission lines	**Any two can be considered** (1mark for chopper & inverter)
	(v)	**Draw turn ON characteristics of SCR.**	**2M**
	Ans:	**Current or voltage characteristics can be considered (any one is necessary)**  	
	(vi)	**Define performance parameters of inverter at (i) total harmonic distortion (ii) Distortion factor.**	**2M**

	Ans:	**Total harmonic distortion (THD):** It is a measure of closeness in the shape of the output voltage waveform and its fundamental component. It is defined as the ratio of the rms value of its total harmonic component of the output voltage and the rms value of the fundamental component. **Distortion factor (DF):** It indicates the amount of harmonics that remain in the output voltage waveform after the waveform has been subjected to second order attenuation.	**(1 mark each)**
	(vii)	**State two applications and advantages of poly phase rectifier.**	**2M**
	Ans:	**Advantages of Poly phase rectifiers:** • It has a large amount of power, usually greater than 2 kW. • Its efficiency is greater than as compared to single phase rectifier. • The ripple factor is reduced in case of poly phase rectifier. • It facilitates higher PIV (peak inverse voltage). • The poly phase rectifier provides highest TUF (transformer utilization factor). **Applications of poly phase rectifiers:** • The poly phase rectifier is used in radio transmitters. • It is used in electro chemical processing such as production of AI and mg. • It is used in telephone exchange. • It is used in electronic heaters. • It is used in electric traction.	**1mark for 2 advantages** **1mark for 2 advantages**
	(viii)	**What do you mean by UPS? State its type.**	**2M**
	Ans:	**UPS:** Uninterrupted supply. Various types of Uninterruptible Power Supplies are classified into three types (1mark) • The Standby UPS • The Line Interactive UPS • Online UPS	**Full form:1M** **Types:1 M**
	(B)	**Attempt any TWO of the following: :**	**08- Total Marks**
	(i)	**Draw load voltage waveform of half wave controlled rectifier with resistive load for firing angle. (i) $\alpha = 0^0$ (ii) $\alpha = 180^0$ (iii) $\alpha = 90^0$ (iv) $\alpha = 30^0$**	**4M**

	Ans:		1mark for each waveform
	(ii)	**Give the four applications of each inverter and chopper.**	**4M**
	Ans:	**Choppers:** • Switched mode power supplies, including DC to DC converters. • Speed controllers for DC motors. • Switched capacitor filters. • D.C. voltage boosting. • Battery-operated electric cars. • Battery chargers. • Variable-frequency drives. **Inverters:** • Uninterrupted power supply. • AC motor speed controller. • Centrifugal fans and pumps. • Conveyors. • Induction heating. • Aircraft power supply • High voltage DC transmission lines	**2marks for any 4 applications** **2marks for any 4 applications**
	(iii)	**Draw a block diagram of ON line UPS system and explain it.**	**4M**
	Ans:	**Block diagram: diagram to be modiifed**	2marks for



Explanation:- Block diagram of the on line UPS systems is as shown where the load is connected to the inverter through the UPS static switch. The UPS static switch is normally ON switch. It turns off only when the UPS system fails. In that case the mains static off switch is used only when UPS is to be bypassed. The various operating modes are,

Mode 1:-When the AC mains is on, the inverter circuit will supply the power to the inverter as well as to the battery. Therefore it acts as a rectifier cum charger .Hence its ratings are usually higher. The inverter o/p is connected to the load via UPS static switch. Battery will be charged in this mode.

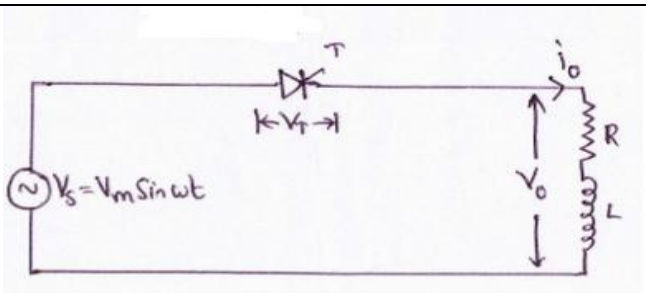
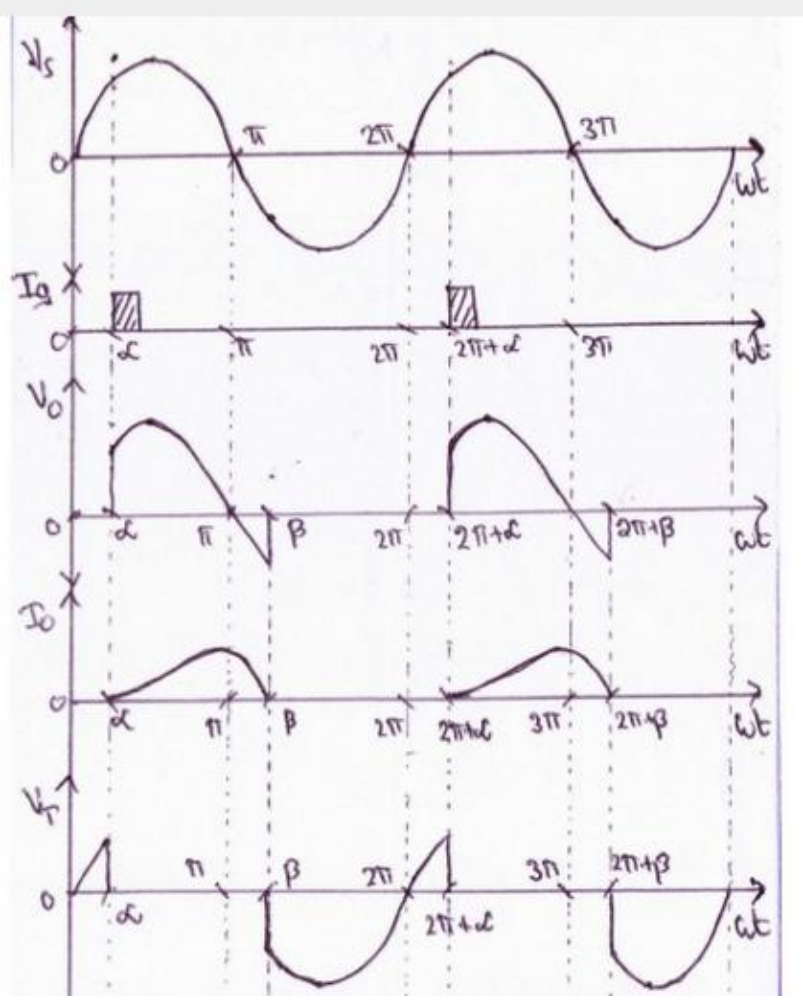
Mode 2:-If the supply fails suddenly, the rectifier o/p will be zero and hence the battery bank now supplies power to the inverter without any interruption and delay. There will not be any inverter as well as the load.

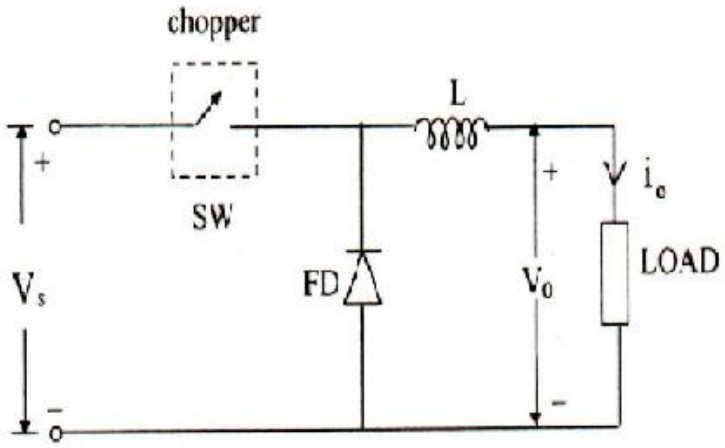
After restoration of the line supply, the charger supplies the inverter and recharges the battery automatically first in constant current mode and then in constant potential mode.

Mode3 :-In case if the inverter /UPS fails, then the normally OFF mains static switch is turned on which automatically transfers the ac line to the load in less than ¼ th of the cycle period with no phase discontinuity.

diagram, 2 marks for explanation

Q. No.	Sub Q. N.	Answers	Marking Scheme
2		**Attempt any FOUR of the following::**	**16- Total Marks**
	(a)	**Draw single phase half wave controlled rectifier with RL load and explain it with waveform.**	**4M**
	Ans:		1mark for circuit, 2marks for operation

		  **Working:** • During positive half cycle of input voltage, thyristor T is forward biased but it does	, 1 mark for waveforms

		not conduct until gate signal is applied to it. • When a gate signal is given to thyristor T at wt = α, it gets turned ON and begins to conduct. • When thyristor is ON the input voltage is applied to the load, but due to the inductor present in the load, current through load builds up slowly. • During negative half cycle of input voltage, thyristor T is reverse biased but current through thyristor is not zero due to inductor. • The current through inductor slowly decays to zero. • So here thyristor will conduct for some time during the negative half cycle and turns OFF at wt = β. • Now the load receives voltage during positive half cycle and for a small duration in negative half cycle. The average value of voltage can be varied by varying firing angle α.	
	(b)	**Explain step down chopper with ckt. diagram. State how output is related to duty cycle.**	**4M**
		Circuit diagram:  **Explanation:** • In this converter Output Voltage is less than input voltage. • This is achieved by switching of a semiconductor device. This switch is called chopper switch, can be implemented using SCR, Power transistor, Power MOSFET and IGBT. In above diagram Power MOSFET is used as chopper switch. • The decrease in output voltage depends on the switch off and on time i.e. duty cycle.	2marks for circuit, 2 marks for operation & wavefor ms optional

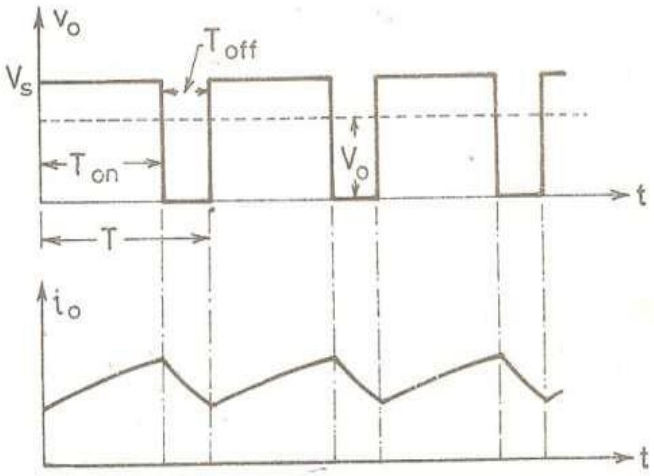
- When device is in off state it means there will not be any contact between load and input so the output voltage will be zero.
- When device is on state there will the output voltage hence the loop continues.
- During the period Ton, chopper switch is ON and load voltage is equal to source voltage Vs.
- During interval T_{off}, chopper switch is OFF, load current flows through freewheeling diode. As a result load terminal are short circuited by freewheeling diode and load voltage is therefore zero during Toff.
- In this manner a chopped dc voltage is produced at the load terminals. During Ton, load current rises, whereas during Toff, load current decays. The average load voltage

of the chopper can be given by:

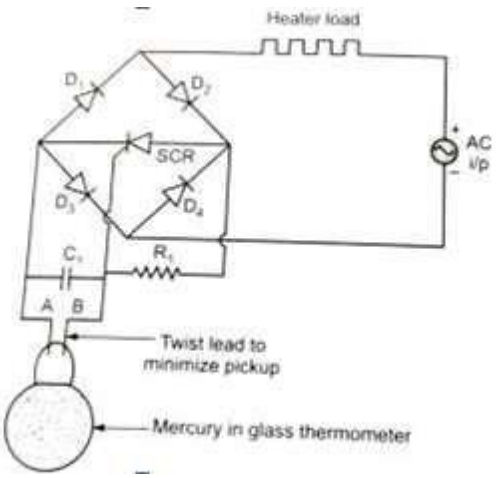
$$V_0 = \frac{T_{ON}}{T_{ON} + T_{OFF}} V_s = \alpha V_s$$

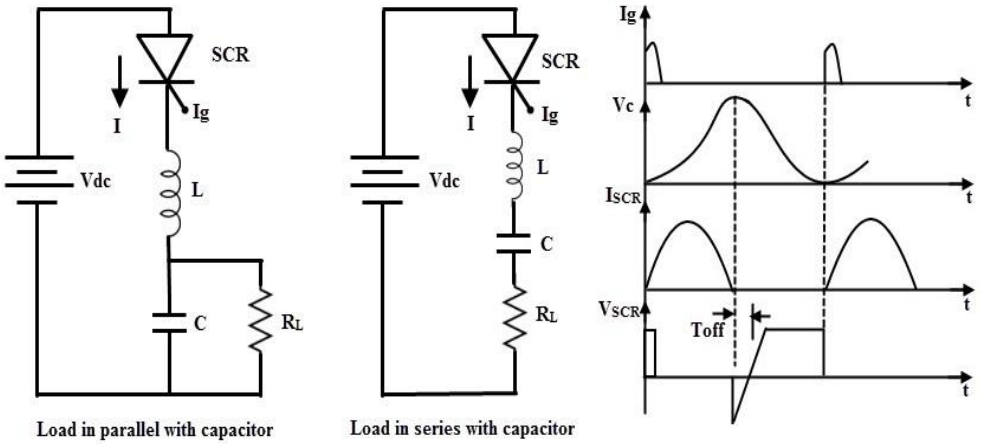
Where "α" is called duty cycle

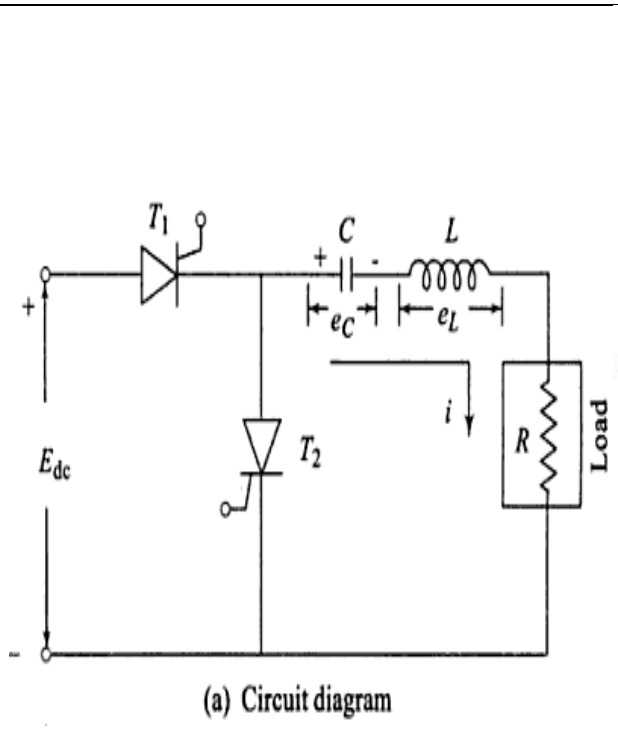
The ideal waveform of a step down chopper are as shown below:



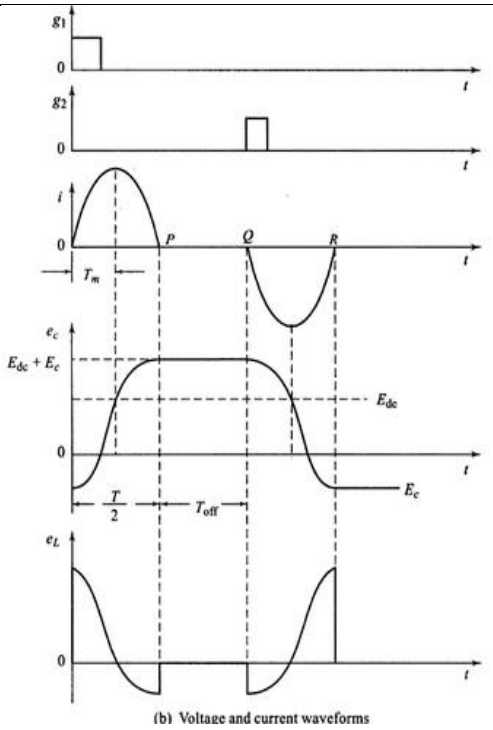
	(c)	**State the components used in temperature controller industrial ckt. ,also draw its ckt. diagram. State any four industrial ckt.**	**4M**
	Ans:	**Components used in temperature controller are:** (i)Heater coil, SCR, Diodes, metal contacts (A & B) Capacitor & resister and mercury in glass	1mark for compon

		thermometer. **(ii) Circuit diagram**  **(iii) Various industrial control circuits are :** • Battery charger • Emergency lighting system • DC flasher • Light dimmer	ents, 2 marks for circuit, 1 mark for industrial circuits
	(d)	**Define:** **(i) Latching current** **(ii) Holding current** **(iii) Firing angle** **(iv) Conduction angle.**	**4M**
	Ans:	**(i) Latching Current(IL) :** It is the minimum on state anode to cathode current required to keep the thyristor in the ON state after the triggering pulse has been removed. **(ii) Holding Current (IH) :** It is the minimum value of the anode to cathode current below which the thyristor stops conducting and returns to its OFF state. **(iii) Firing angle (α)** is the angle of sine wave at which SCR is turned ON.This varies from 0 to 1800 **(iv) Conduction angle (β)** is the angle for which SCR remains on. **β =π-α** As firing angle increase average voltage decreases.	**1M each**

	(e)	**Describe class-A commutation with ckt diagram and waveforms.**	**4M**
	Ans:	 Operation of the circuit Onsce 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. when 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 is negative as the Voltage on capacitor C is higher than the Input supply voltage Vs.	1mark for circuit, 1mark for waveforms, 2 marks for operation
	(f)	**Draw circuit diagram of basic series inverter. Describe its operating principle.**	**4M**
	Ans:	**Working:** • When S1 (T1) is triggered the capacitor starts charging with left side plate positive with respect to right and when the voltage on capacitor is slightly greater than Edc T1 turns off; but there is no discharge path for capacitor hence it holds the charge. • When trigger pulse is applied to T2, T2 start conducting and current starts flowing in opposite direction. • In this way due to charging and discharging of capacitor and switching of T1 and T2 current will flow in RC circuit. Hence sinusoidal current starts flowing in the load.	2marks for circuit, 1mark for operation & 2mark for working principle



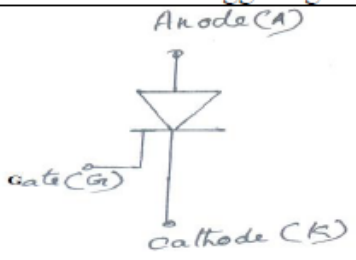
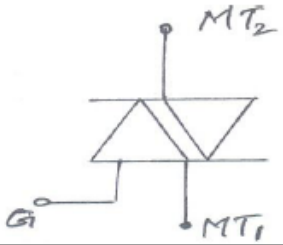
(a) Circuit diagram



(b) Voltage and current waveforms

(Note: Waveform optional)

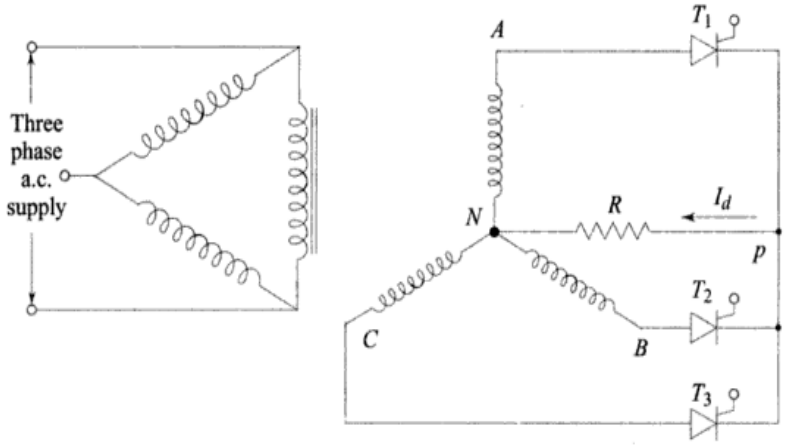
Q. No.	Sub Q. N.	Answers	Marking Scheme
3		**Attempt any FOUR of the following::**	**16- Total Marks**
	(a)	**State four applications of TRIAC. Compare SCR and TRIAC. (four points)**	**4M**
	Ans:	**Applications of TRIAC: (Any four)** 1) Fan speed regulator 2) Flasher circuit 3) Temperature controller 4) Lamp dimmer 5) AC voltage stabilizer **Comparison:** **(Any four)**	**Each Application ½ marks**

Sr No.	SCR	TRIAC
1	Is a unidirectional device	Is a bidirectional device
2	The gate current can only be positive	The gate current can be positive or negative
3	Operates only in the first quadrant	Operates in either Ist or 3rd quadrant
4	Anti parallel SCRs are used for power control of inductive loads	TRIAC is not suitable for power control of inductive loads
5	UJT is used for triggering	DIAC is used for triggering
6		Symbol 

Each point ½ marks

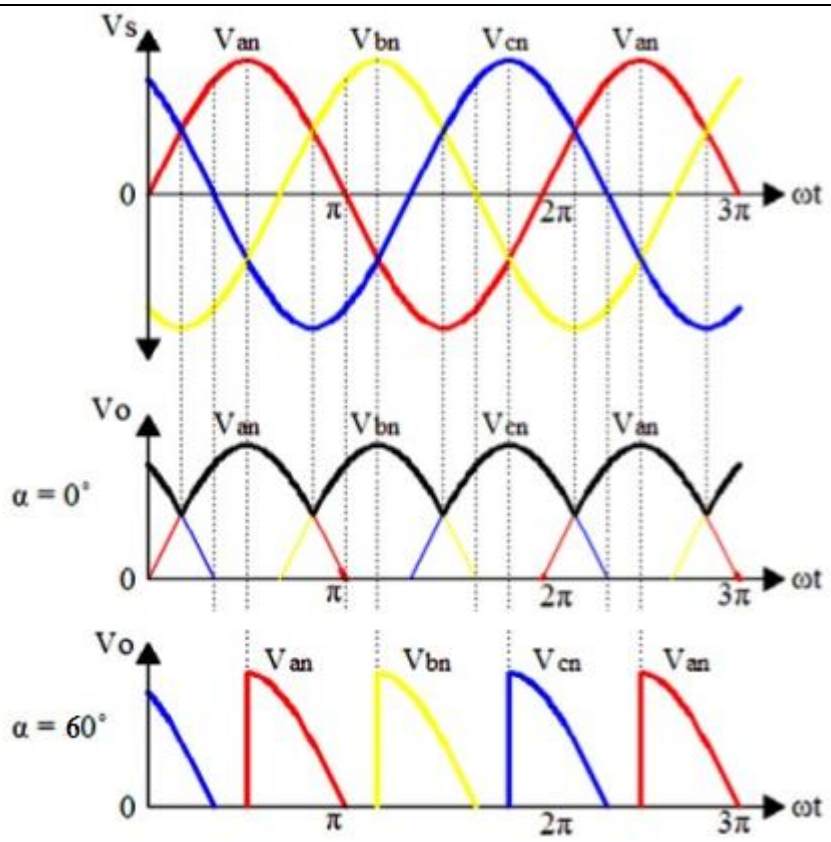
(b) **Draw ckt.diagram of 3ϕ half wave controlled rectifier with resistive load, also draw load voltage waveform for α= 0^0 & α= 60^0.** **4M**

Ans:



Three-phase half-wave controlled rectifier with resistive load

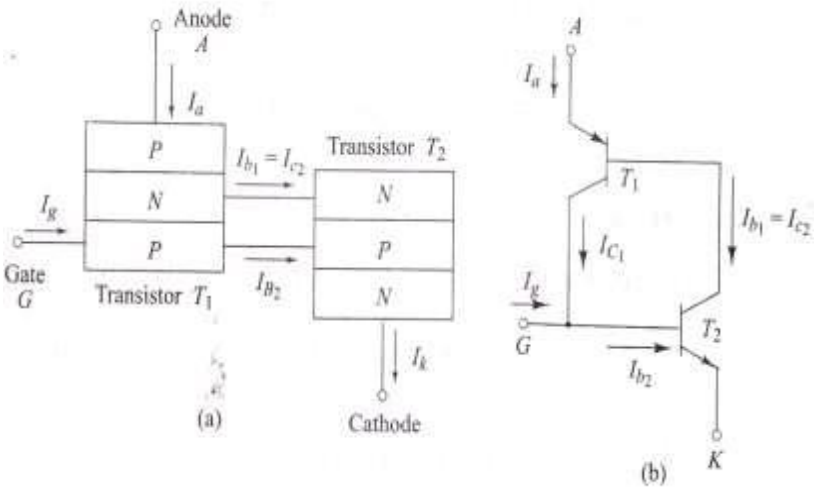
Circuit diagram – 1M



Input Waveform – 1M

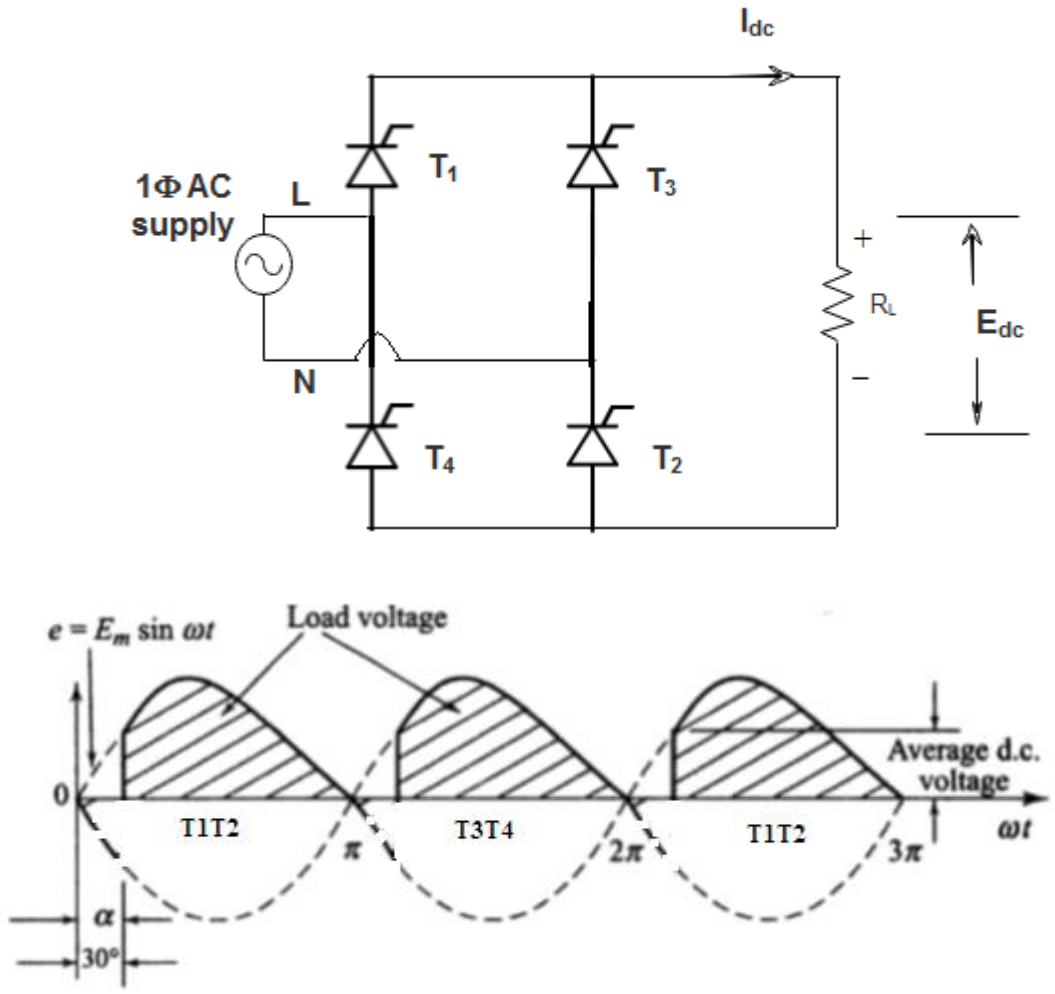
Output waveform – 2M

	(c)	**Draw the transistor analogy of SCR and explain working principle.**	**4M**
	Ans:	**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. • The collector current of transistor T1 becomes the base of transistor T2 & vice versa & Ic1= Ib2 Ib1=Ic2	**Circuit diagram – 2M** **Working - 2M**

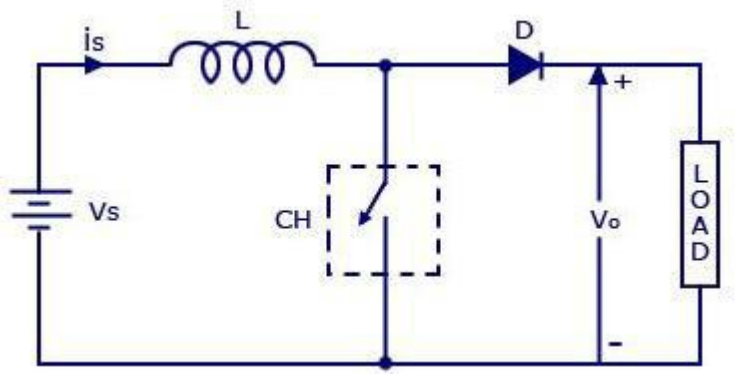


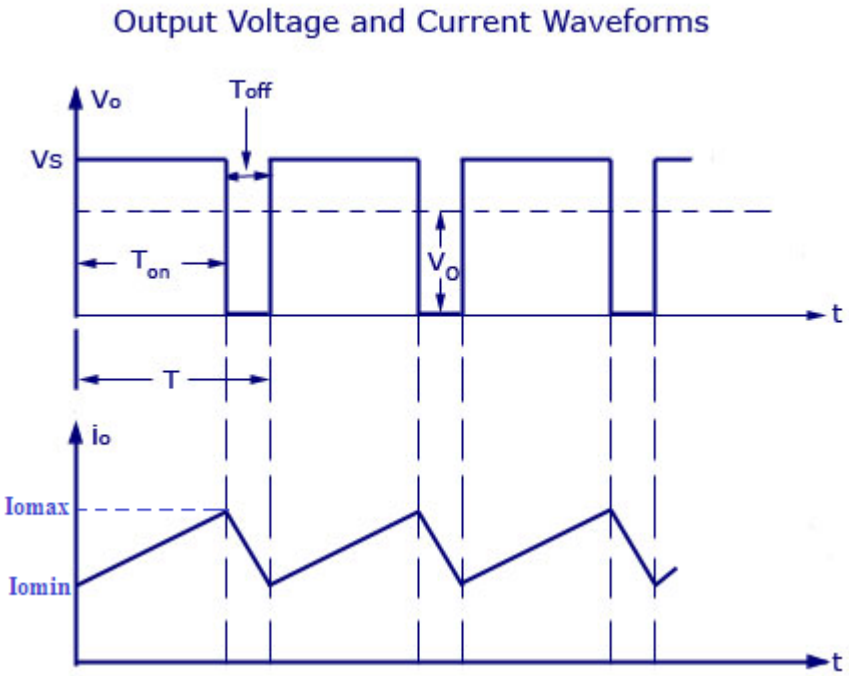
- When the gate current is zero or the gate terminal is open, the only current in circulation is the leakage current, which is very small.
- Under these conditions P-N-P-N device is said to be in its forward blocking or high impedance off state.
- As soon as a small amount of gate current is given of transistor T2 by applying forward bias to its base emitter junction it generates the collector current.
- 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 characteristic of the device is known as its regenerative action.

(d)	**State different operating regions of power transistor. What is primary and secondary breakdown?**	**4M**
Ans:	**Different operating regions of power transistor are:** **1. Cut off** **2. Active** **3. Quasi Saturation** **4. Hard saturation**	**2M**
	➢ **Primary breakdown:-**The breakdown due to the conventional avalanche break down of the collector base junction is known as primary break down. Large power dissipation leads to primary breakdown.	**2M**
	➢ **Secondary break down: -** 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. The second breakdown shown is due to localized thermal runaway.	
	(e)	**Draw ckt diagram of full wave bridge type controlled rectifier with resistive load. Also draw waveform across load and SCR at 30^0 firing angle.**	**4M**
	Ans:		**2M** **2M**
	(f)	**A single phase half wave rectifier is used to supply power to load impedance 10Ω from 230 V,50Hz A.C. supply at firing angle 60^0. Calculate average load voltage.**	**4M**
	Ans:	**Given :** Vm = 2√2 * 230 = 650.53 V R_L = 10 Ω f = 50 Hz	**4M**

		$\alpha = 60^0$ **To find:** Vdc = ? **Formula Used:** $Vdc = \frac{Vm}{2\pi}(1 + cos\ \alpha)$ **Solution:** $Vdc = \frac{Vm}{2\pi}(1 + cos\ \alpha)$ $= \frac{650}{2\pi}(1 + \cos 60)$ = 103.452 (1 + 0.5) = 155.178 V **Vdc = 155.178 V**	

Q. No.	Sub Q. N.	Answers	Marking Scheme
4		**Attempt any FOUR of the following::**	**16- Total Marks**
	(a)	**Explain the working principle of step-up chopper with neat diagram.**	**4M**
	Ans:		Circuit diagram: 2M



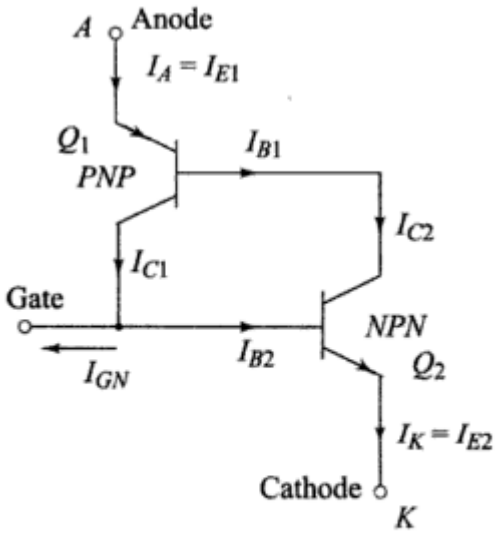
Working Principle :

- When the switch is ON, the inductor L is connected to the supply Vs and inductor stores energy during on period T_{ON}.
- Now the load current will increase from Iomin to Iomax and supply voltage is applied to the load.
- When the switch is OFF, the inductor current is forced to flow through the diode and load for a period T_{OFF}.
- Now the closed circuit path will be Vs+ – L – D – Load – Vs-.
- As the current tends to decrease, polarity of the emf induced in the inductor L is reversed.
- Output voltage here is greater than input voltage as the inductor Voltage adds to the source Voltage to force the inductor current into the load.

(Note: Waveform optional)

Working principle :2M

(b)	**Explain turn -OFF mechanism in GTO.**	**4M**
Ans:	**Two transistor analogy of GTO:**	**2M**



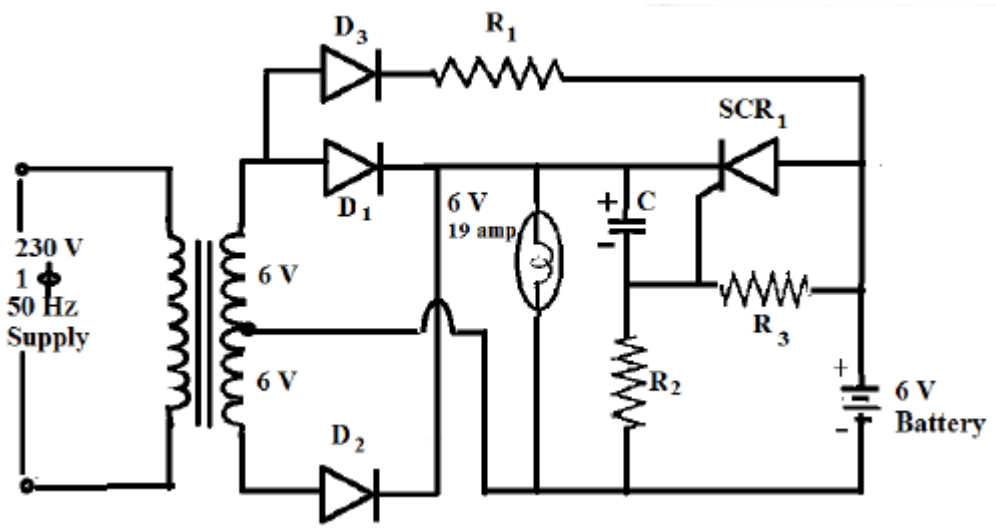
Two-transistor analogy of GTO

2M

Operating Principle:-

- Basic operation of GTO is same as that of the conventional SCR but the major difference between is that the conducting GTO can be turned off by applying a negative gate current to it. Thus positive gate current turns it on and negative gate current turns it off.
- From two transistor model of GTO both transistor Q1 and Q2 are in saturation when the GTO is in its on state.
- If the base current of Q2 could be made less than the value needed for maintaining it in saturation, then Q2 will come out of saturation and will be in active state, this will reduce the regeneration and GTO will begin to turn off.
- In order to reduce the base current of Q2, a negative gate current must flow in the direction as shown in fig., thus, turning off a conducting GTO.

(c)	**Draw ckt. diagram and write the working principle of emergency light system.**	**4M**
Ans:	**Circuit diagram:**	**2M**



Working principle:

- Fig. above shows a simple emergency lighting circuit. The 230v ac supply is applied as input. Supply is stepped down using a Center tapped transformer. The full wave rectifier converts ac to dc voltage.

- When supply is ON, voltage appears across it and the lamp glows. Pulsating current also flows through D3 & R1 to charge the battery. Thus battery charging is carried out.

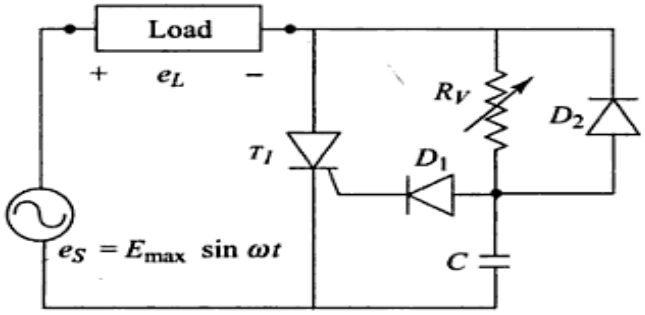
- The capacitor C gets charged with upper plate positive to some voltage less than secondary voltage of transformer. Due to capacitor voltage, gate cathode junction of SCR1 gets reverse biased. The anode is at battery voltage & cathode is at rectifier output voltage, which is slightly higher, hence SCR1 is reverse biased & cannot conduct. The lamp glows due to rectifier output dc voltage.

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

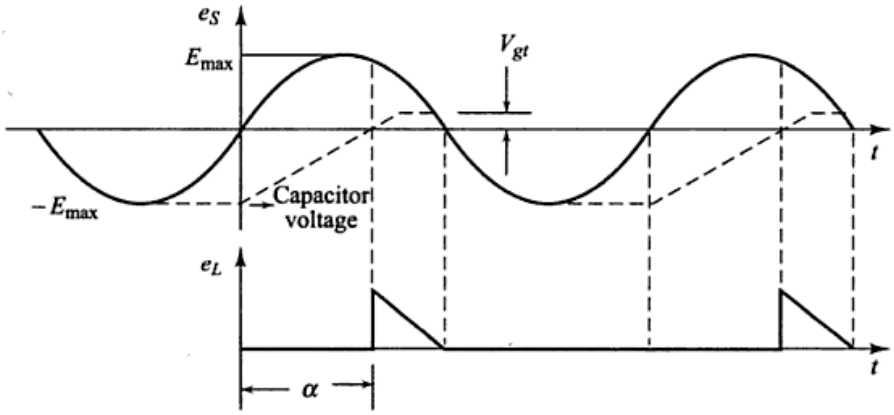
2M

	(d)	**State different triggering methods and describe RC triggering method for SCR with circuit diagram.**	**4M**
	Ans:	**Triggering methods:-** ➢ Forward voltage triggering ➢ dv/dt triggering. ➢ Temperature triggering	**1M**

- Light/illumination /radiation triggering.
- Gate triggering



(a)



(b)

***(a)** RC firing circuit, **(b)** voltage-waveform*

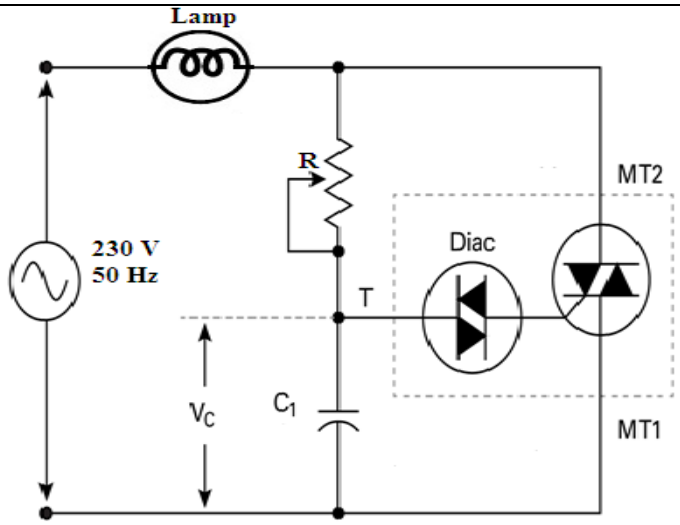
Circuit diagram – 2M

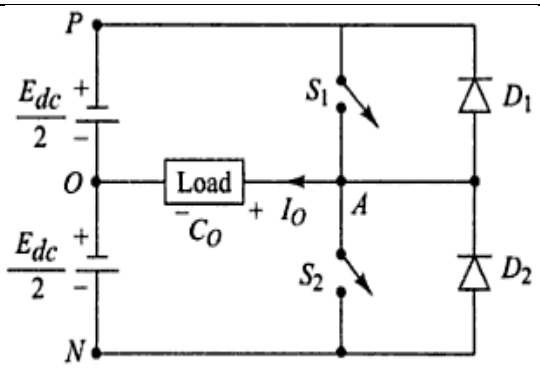
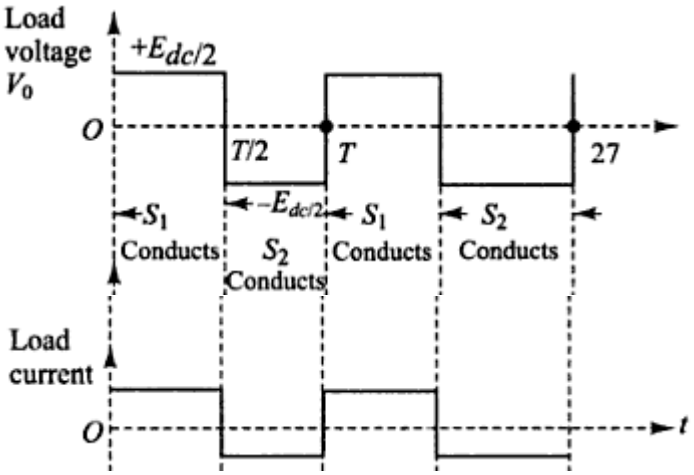
Explanation:- **1M**

- A large value of firing angle (more than 90°) can be obtained from above circuit usually in 0-180° 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 the voltage across the capacitor & if the gate current is sufficient, the thyristor triggers.
- In negative half cycle the capacitor C is charged up 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.

(Note: Waveform is optional.)

	(e)	**Draw light dimmer circuit using DIAC and TRIAC. State relation between light intensity**	**4M**

		and firing angle.	
	Ans:	 **Explanation:** • In the above circuit DIAC is used to trigger TRIAC. • During the positive half cycle, when the voltage across capacitor is above the breakdown voltage of the DIAC, DIAC turns 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. • The charging rate of capacitor C can be changed by varying the resistance R and , hence the firing angle can be controlled. • If firing angle is less, intensity of light is more & vice-versa. • Thus by controlling the firing angle, we can control intensity of light using TRIAC.	**2M** **2M**
	(f)	**Draw ckt. diagram of single phase half bridge inverter and explain.**	**4M**

	Ans :	 *Half-bridge inverter*  Waveforms **Explanation:** • Assume the load is resistive. • When SCR S1 is turned ON, current flows from the upper source, S1 and the load. • When SCR S2 is turned ON, current flows from lower half of the source and S2. • The direction of the load current reverses across the load. • If the load is inductive, then freewheeling diodes are used. **(Note: Waveform optional)**	**2M** **2M**

Q. No.	Sub Q. N.	Answers	Marking Scheme
5.		**Attempt any FOUR of the following:**	**16- Total Marks**
	(a)	**Compare OFF line UPS and ON line UPS.**	**4M**

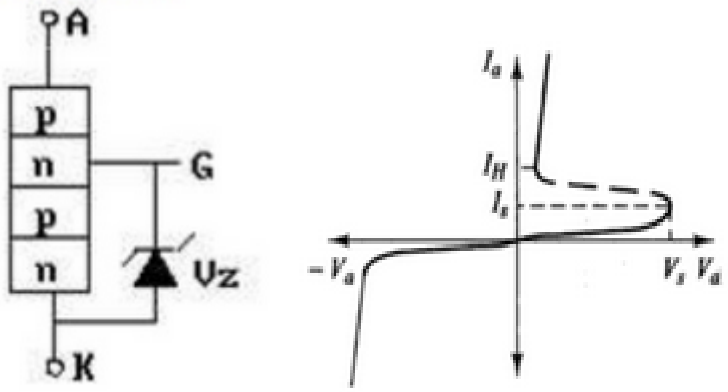
Ans:

Parameter	ON line UPS	OFF line UPS
Output voltage waveform	Sinusoidal	Quasi square
Total harmonic distortion	Low	High
Transfer time	0	< 5ms
Efficiency	Low	High
Cost	Costliest	Less costly
Size and weight	Highest	Low

Any four points : 4M

(b) **Explain SUS with the help of construction and V-I characteristics.** **4M**

Ans:



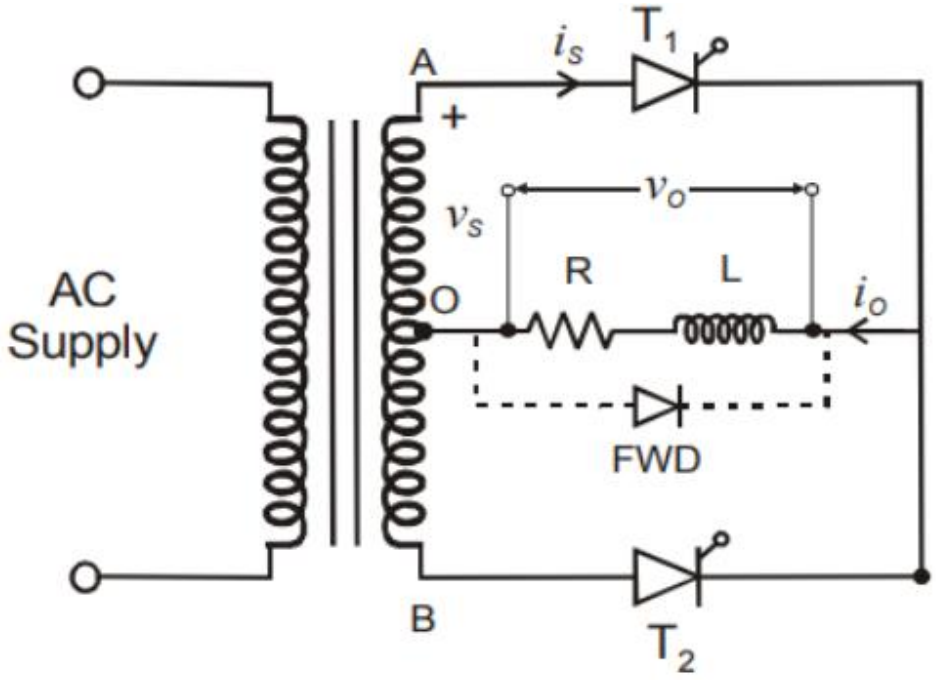
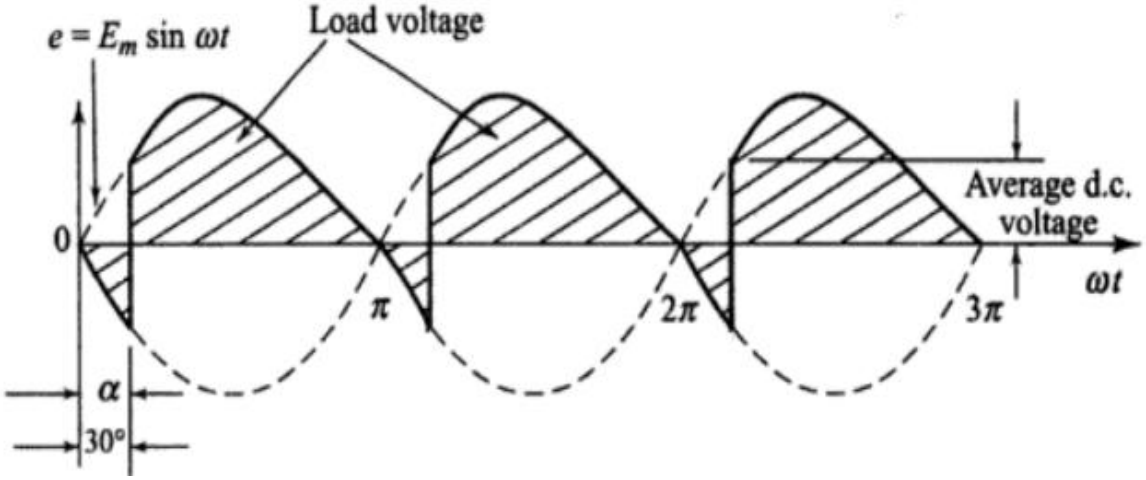
Construction : 1M

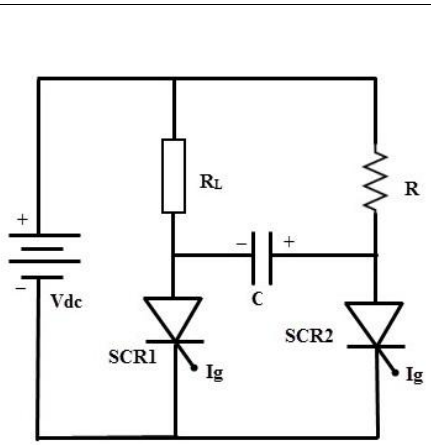
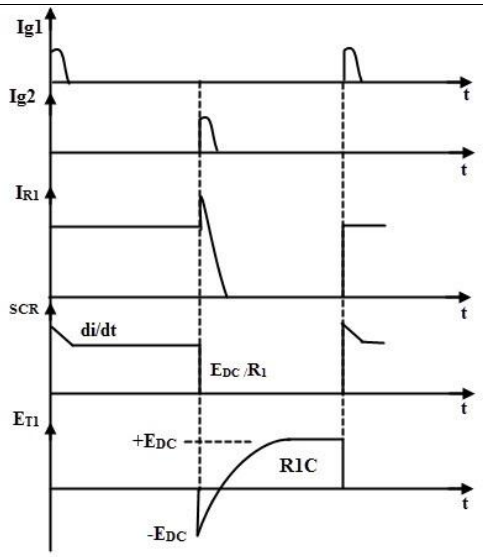
Characteristics : 1M

Explanation : 2M

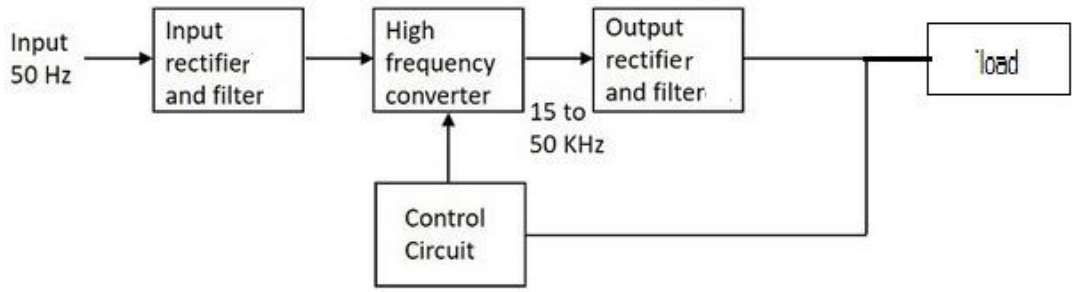
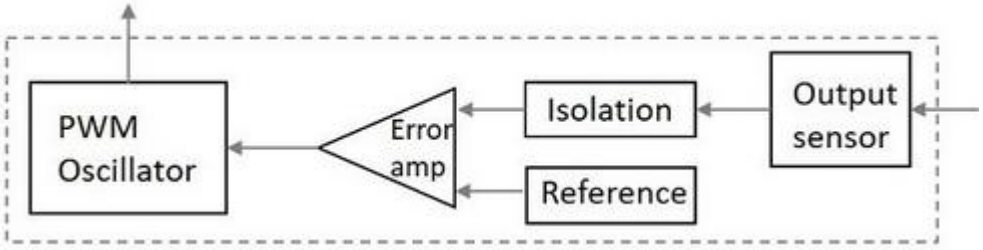
- It has an built in avalanche diode between the gate and the cathode of an SUS.
- The breakover voltage can be reduced to (V_Z + 0.6 V).This is accomplished by connecting Zener diode cathode to the SUS gate and Zener diode anode to the SUS cathode.
- SUS can be fired at a very low anode to cathode voltage . when external voltage is applied and when it becomes equal to zener breakdown voltage, zener diode breaks down and SUS turns ON.
- It it an unilateral device because conduction takes place from anode to cathode.

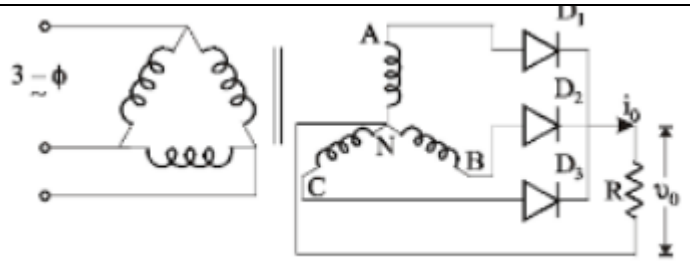
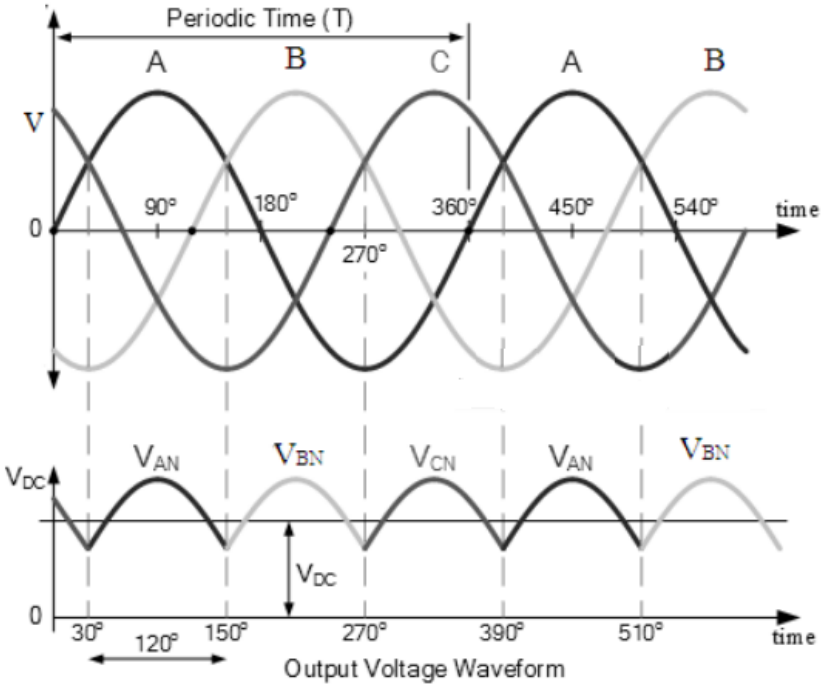
(c) **Draw mid-point converter with inductive load. Draw the waveforms across load, SCR at firing angle 30^0 .** **4M**

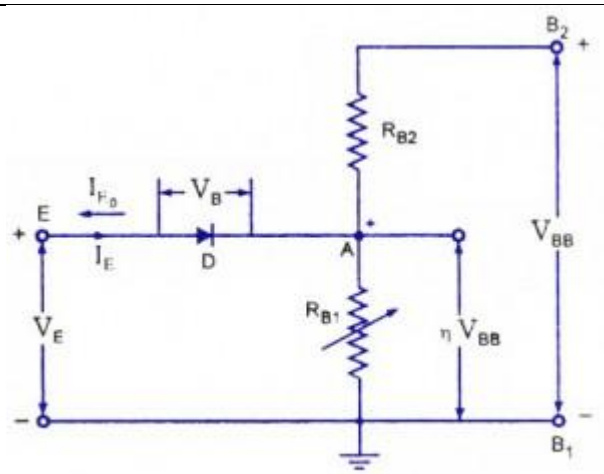
	Ans:	**Circuit Diagram :**  **Load voltage waveform for firing angle α= 30°**  The shaded portion represents load voltage waveform for α = 30°.	**Circuit Diagram : 2M** **Load voltage waveform : 2M**
	(d)	**Draw and explain complementary type commutation with waveforms.**	**4M**

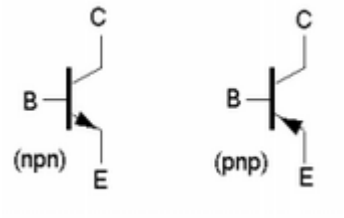
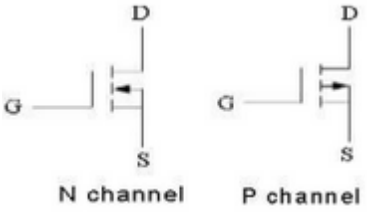
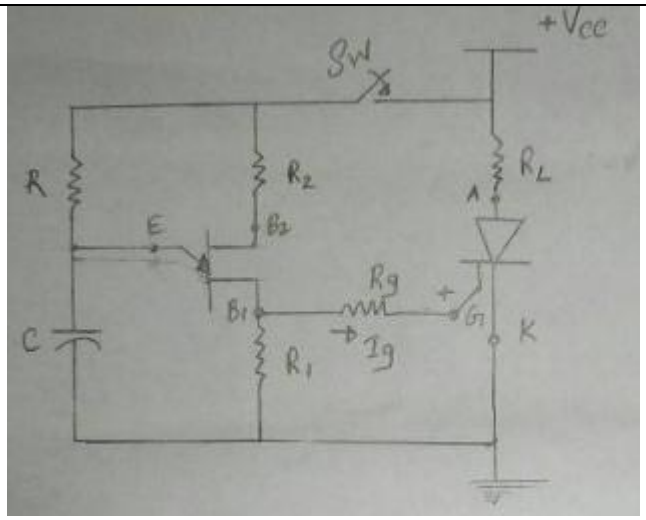
	Ans:	  Working:- • At first the SCR1 is triggered .So it conducts and load current IL (Vdc+, RL, SCR1, Vdc-) starts flowing through it. • The capacitor 'C' will charge through Vdc+, R, C, SCR1, Vdc- with right plate positive. • When it is fully charged to Vs capacitor current becomes zero. • To turn off SCR1, SCR2 is triggered. • When SCR2 is turned ON the reverse voltage across 'C' is applied across SCR1, turning SCR1 OFF. • Now capacitor will start charging through Vdc+, RL, C, SCR2, Vdc- with left plate positive. • Similarly, as SCR1 is turned ON the reverse voltage across 'C' is applied across SCR2, turning SCR2 OFF.	**Circuit diagram : 1M** **Working : 2M** **Waveforms : 1M**
	(e)	**State four applications of IGBT and power transistor.**	**4M**
	Ans:	**Applications of IGBT:** 1. The insulated gate bipolar transistor (IGBT) is used in AC and DC motor drives. 2. The IGBT is used in uninterrupted power supply (UPS) system. 3. In power supplies. 4. The IGBT is used in switched-mode power supplies (SMPS). 5. It is used in traction motor control and induction heating. 6. It is used in inverters.	**Each application : 2M (any 4 Points)**

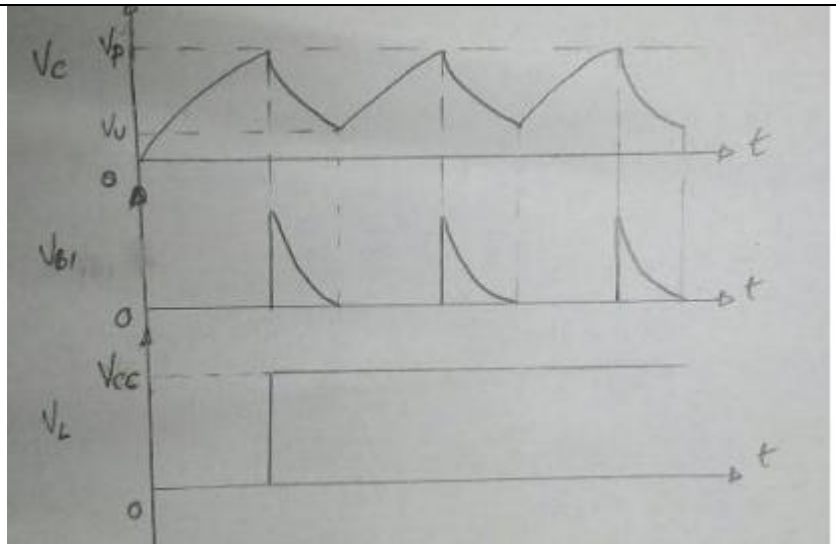
		Applications of power transistor: 1. Switching devices in circuits like inverters. 2. AC motor control applications. 3. In SMPS as series pass transistor. 4. In linear power supplies as a series pass transistor. In UPS.	
	(f)	**Derive the expression of average output voltage and current of single phase half wave controlled rectifier with resistive load.**	**4M**
	Ans:	Average output voltage is given as, $V_0(Avg)=\frac{1}{T}\int_0^T V_0(wt)\,dwt$ Therefore T=2π & Vo(ωt) = Vm sinωt from α to π & for rest of the period Vo(ωt)=0 $\therefore V_0(Avg)=\frac{1}{2\pi}\int_0^{2\pi} V_m sin(wt)\,dwt$ $=\frac{V_m}{2\pi}[-coswt]_\alpha^\pi$ $=\frac{V_m}{2\pi}(1+cos\alpha)$ As load is resistive, Output current is given as, $I_0=\frac{V_0}{R}$	**Derivation : 4M**

Q. No.	Sub Q. N.	Answers	Marking Scheme
6.		**Attempt any FOUR of the following::**	**16- Total Marks**
	(a)	**Draw block diagram of SMPS and describe its working.**	**4M**
	Ans:	 **Control Circuit:**  **Working:** • SMPS converts unregulated AC or DC voltage into a regulated voltage. In case of AC it first converted into unregulated DC. This is fed to a high frequency step-up chopper which switches ON and OFF according to the variations. • It uses a high frequency AC conversion stage to facilitate the use of a high frequency transformer for voltage scaling and isolation. The output of transformer is then rectified and filtered, to get a regulated output. • This is a regulated output voltage which is then given to the control circuit, which is a feedback circuit. The final output is obtained after considering the feedback signal. • The output sensor senses the signal and joins it to the control unit. The signal is isolated from the other section so that any sudden spikes should not affect the circuitry. A reference voltage is given as one input along with the signal to the error amplifier which is a comparator that compares the signal with the required signal level. By controlling the chopping frequency the final voltage level is maintained.	**Block diagram : 2M** **Working : 2M**

		This is controlled by comparing the inputs given to the error amplifier, whose output helps to decide whether to increase or decrease the chopping frequency.	
	(b)	**Draw the circuit diagram of 3ϕ delta –wye rectifier, also draw related waveforms . What is maximum conduction of each diode?**	**4M**
	Ans:	  Output Voltage Waveform Maximum conduction of each diode is 120°	**Circuit diagram : 1M** **Waveform: 2M** **Maximum conduction : 1M**
	(c)	**State turn ON methods of SCR. Explain $\frac{dv}{dt}$ triggering.**	**4M**
	Ans:	SCR can be turned on by any of the following methods: i. Forward voltage triggering ii. Gate triggering	**Methods : 2M** **Explanation : 2M**

		iii. Temperature/thermal triggering iv. Light/radiation triggering v. dv/dt triggering **dv/dt triggering** : In construction of SCR there are four layers and three junctions J1,J2& J3. 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 turns ON. If V = voltage applied across the device CJ = junction capacitance Then the instantaneous current is due to suddenly applied voltage is I_C = CJ dv/dt If dv/dt is large the device may turn-ON or trigger ON, even when the voltage across the device is small.	
	(d)	**Draw equivalent ckt of UJT. Define intrinsic stand off ratio. State its range.**	**4M**
	Ans:	 *Equivalent Circuit of a UJT* **Intrinsic standoff ratio** (η) : It is the ratio of R_{B1} to the sum of R_{B1} and R_{B2}. It can be expressed as $\eta = R_{B1}/(R_{B1}+R_{B2})$ or $\eta = R_{B1}/R_{BBO}$. The typical range of intrinsic standoff ratio is from 0.4 to 0.8	**Equivalent Circuit: 2M** **Definition : 1M** **Range : 1M**

	(e)	**Compare power BJT and power MOSFET with respect to (i) Symbol (ii)SiO_2 layer (iii) switching speed (iv) ON state loses.**			**4M**
	Ans:	**Parameter**	**power BJT**	**power MOSFET**	**4 points : 4M**
		Symbol			
		SiO_2 layer	Not present	Present	
		switching speed	Switching speed slow(µs)	Switching speed fast (ns)	
		ON state loses	On state losses are less	On state losses are more	
	(f)	**Explain UJT triggering circuit for SCR with the help of diagram and waveforms.**			**4M**
	Ans:				**Circuit diagram : 1M** **Working : 2M** **Waveform : 1m**



Workimg:

- When the supply voltage (V_{CC}) is switched ON, the capacitor charges through resistor (R), till the capacitor voltage reaches the voltage level (VP) which is called as peak point voltage. At this voltage the UJT turns ON. As a result of this, the capacitor (C) discharges rapidly through resistor (R1). When that capacitor voltage drops to level Vv (called valley- point voltage) the uni- junction transistor switches OFF allowing the capacitor (C) to charge again. In this way because of the charging and discharging of capacitor the exponential sweep voltage will be obtained at the emitter terminal of UJT.
- The voltage developed at base 1(VB1) terminal is in the form of narrow pulses commonly known as trigger pulses. The first pulse at B1 occurs at T seconds after the switch is closed, for which the SCR will be turned ON. Once the SCR is ON subsequent pulses have no effect.