WINTER– 16 EXAMINATION

Model Answer Subject Code: 17444

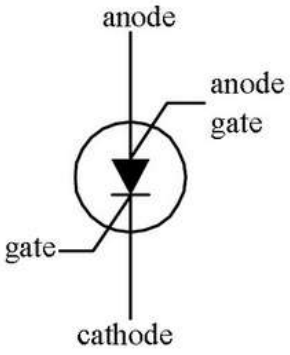
Important Instructions to examiners:

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

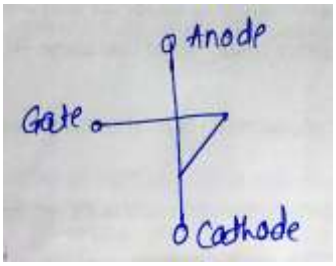
Q 1a) Attempt any six of the following : **12**

(i) Draw the symbol of SCS and SUS .

Ans: [1 M Each]



SCS



SUS

(ii) State any two advantages of power MOSFET.

Ans: [Any 2,1 M Each]

Advantages: a) It is a voltage controlled device so easy to drive.

b) Requires negligible power to hold it in the ON state.

c) The gate drive circuitry is less complex & less costly.

d) Fast switching speed.

e) No additional circuit is required for commutation.

f) No secondary breakdown

g) Small size and less expensive

(iii) Define holding current (I_H) and latching current (I_L) .

Ans: [1 M Each]

Holding Current (I_H) : It is the minimum value of the anode to cathode current below which the thyristor stops conducting and returns to its OFF state.

Latching Current(I_L) : 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.

(iv) Give Classification of inverter.

Ans: [Any 2 methods 2M]

Inverter are classified according as:-

1) According to nature of input source:

- Voltage source inverter
- Current source inverter

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

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

3) According to the type of commutation:

- Line commutated inverter
- Force commutated inverter

4) According to the connection of thyristor and commutation components

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

(v) State importance of pulse transformer in triggering circuit – 2 marks
Ans :

1) Pulse transformers are often used to couple a trigger pulse generator to a thyristor in order to obtain electrical isolation between the two circuits i.e trigger circuit and main power circuit.
2) Due to pulse transformer it is possible to trigger multiple SCR's

(vi) List any two applications of Chopper.

Ans: [Any two ,1 M Each]

Applications of Chopper:(any two)

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

(vii) State need of polyphase rectifier

Ans:[Correct answer 2M]

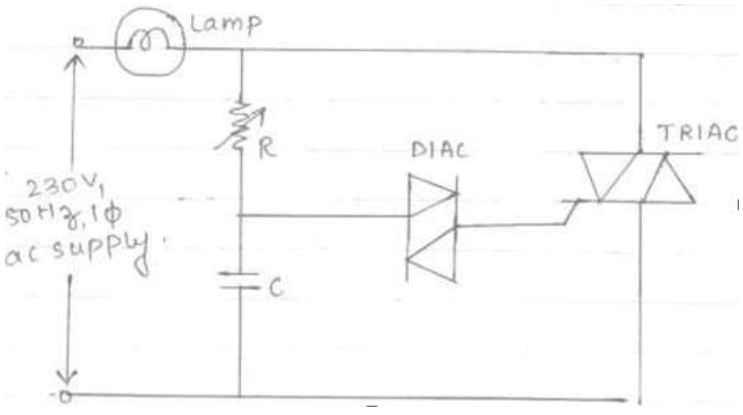
Note: Other point may be considered if conceptually correct.

Need of polyphase rectifiers:

1. The power supplying capacity of the single phase rectifiers is limited 1.5 kW(say upto 2kW).
2. If power higher than 2kW, this has to be delivered to the load, then we have to need the polyphase rectifiers.

viii) Draw circuit diagram of light dimmer using DIAC-TRIAC .

Ans:[circuit diagram 2M]



b) Attempt any TWO of the following : 8M

(i) Compare single phase half wave and three phase half wave uncontrolled rectifier based on

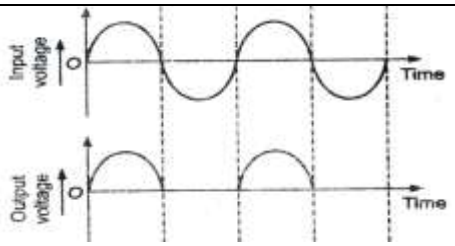
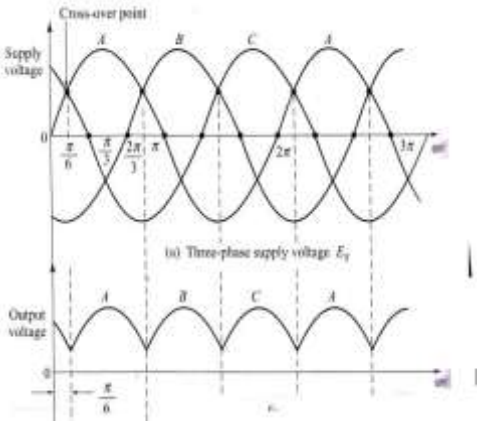
1) No. of diodes

2) Output power

3) Ripple present in output

4) Output voltage waveform

Ans: [Each point 1M]

Parameters	Single phase half wave uncontrolled rectifier	Three phase half wave uncontrolled rectifier
No. of diodes	One	Three
Output power	Less	More
Ripple present in output	More	Less
Output voltage waveform		

(ii) Define performance parameters of an inverter.

Ans: [Any four each for 1M]

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

2. Total harmonic distortion (THD): It is a measure of closeness in a shape between 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.

3 .Distortion factor (DF): It indicates the amount of harmonies that remain in the output voltage waveform after the waveform has been subject to second order attenuation.

4. Lowest order harmonic (LOH): It is the lowest frequency harmonic with a magnitude greater than or equal to 3% of the magnitude of the fundamental component of the output voltage.

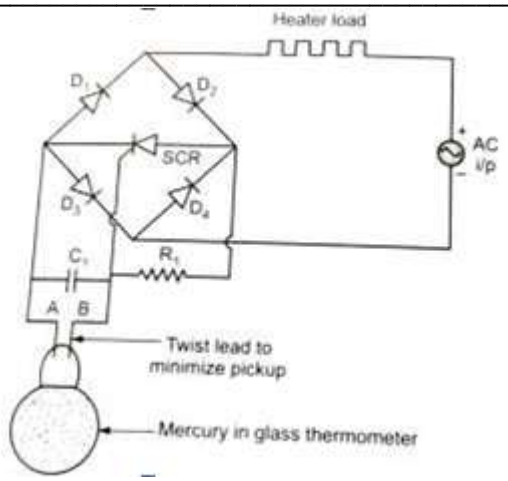
Or equal to 3 % of the magnitude of the fundamental component of the output voltage.

(iii) With the help of neat diagram explain operation of temperature controller using SCR

Ans: (Diagram 2 M Working 2 M) Circuit Diagram of temperature Controller:

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

Circuit Diagram



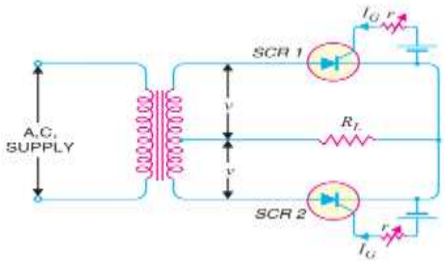
In the temperature controller circuit using thermostat as temperature detector and SCR as a switching device. The mercury in glass thermostat is extremely sensitive temperature measuring instrument which is capable of sensing changes in temperature of the order of $0.1^{O}C$.

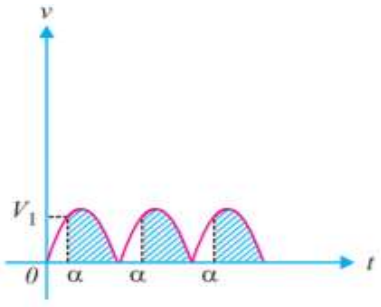
Operation

1) 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.
2) 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.

Q 2: Attempt any FOUR of the following : 16

a)Describe the working of single phase Centre tapped full wave controlled rectifier with Resistive load.
Ans:[Circuit diagram 2M, Working 2M]



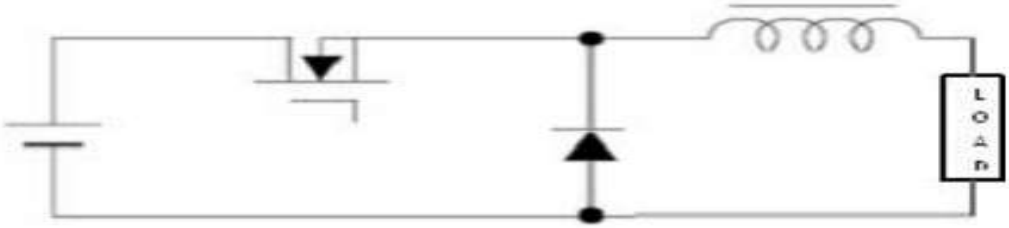


Working: The angle of conduction can be changed by adjusting the gate currents hence it adjust firing angle (α). Suppose the gate currents are so adjusted that SCRs conduct as the secondary voltage (across half winding) becomes V1.

1. During the positive half-cycle of a.c. across secondary, the upper end of secondary is positive and the lower end negative. This will cause SCR1 to conduct. However, the conduction will start only when the voltage across the upper half of secondary becomes V1 as shown . In this way, only shaded portion of positive half-cycle will pass through the load.
2. During the negative half-cycle of a.c. input, the upper end of secondary becomes negative and the lower end positive. This will cause SCR2 to conduct when the voltage across the lower half of secondary becomes V1. It may be seen that current through the load is in the same direction (d.c.) on both half-cycles of input a.c.

a)With the help of circuit diagram and waveforms explain step down chopper using power MOSFET.

Ans[Circuit diagram 2, waveforms 1M, 1M explanation]

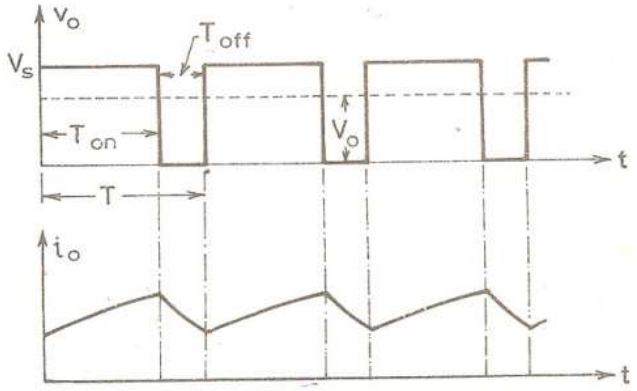


In this converter Output Voltage is less than input voltage. This is achieved by switching of a semiconductor device. This switch is called chopper switch , can be implemented using SCR, Power transistor, Power MOSFET and IGBT. In above diagram Power MOSFET is used as chopper switch. The decrease in output voltage depends on the switch off and on time i.e. duty cycle. While device is off state it means there will not be any contact between load and input so the output voltage will be zero. While 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 Toff, 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:

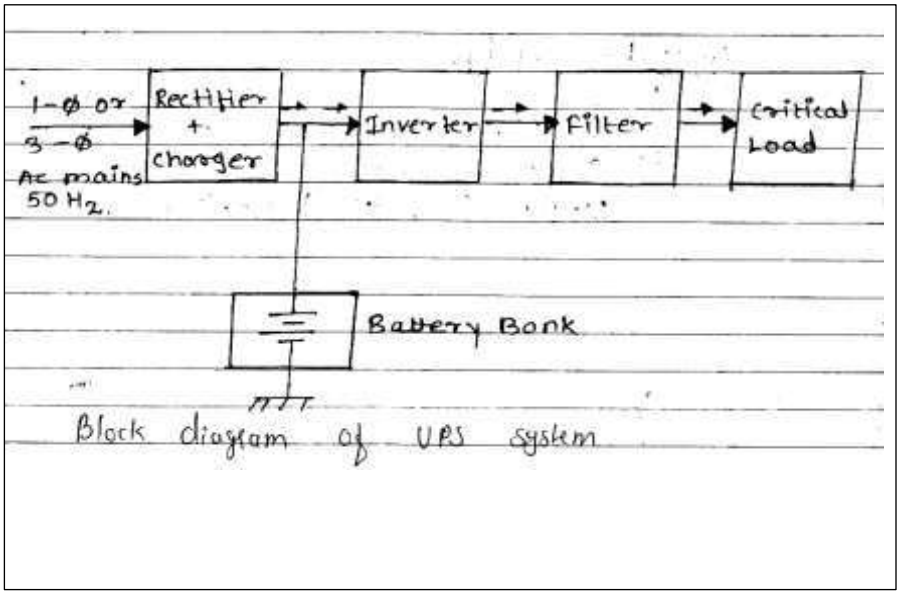
$$V_0 = \frac{T_{ON}}{T_{ON} + T_{OFF}} V_s = \alpha V_s$$

Where α is the duty cycle The ideal waveform of step down Chopper is given by



c) Draw the block diagram of UPS. Explain each block in detail.

Ans:[Block diagram 2M, function of each block 2M]



UPS is used to provide an interrupted free supply of power to the ac load. The function of each block is as follows:

1) Rectifier+ Charger :- 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 .Charger is used to charge battery bank.

2) Inverter :- 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

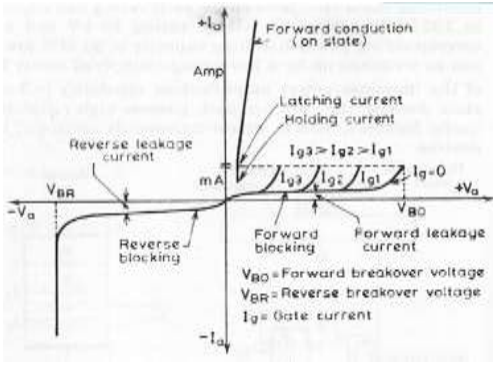
3)Filter :–The output of inverter is A C passes through a suitable filter then applies it to the load

4) Battery bank: – It always charged for emergency i.e. to provide dc power to the inverter when AC mains interrupted .

A static switch is also required connect or disconnect the battery from the input of the inverter depending on the status of AC mains.

d) Draw VI characteristics of SCR . State the effect of increasing gate current of SCR.

Ans: [Neat labeled characteristics 3M, Effect 1M]



Effects of Gate current: As the value of gate current (Ig) increases, the value of Forward

Break over voltage decreases or voltage required to turn ON SCR decreases.

e) What are different Turn ON methods of SCR ? Explain dv/dt triggering.

Ans: [Methods 2M, Explanation of dv/dt 2M]

SCR can be turned on by any of the following methods:

i. Forward voltage triggering
ii. Gate triggering
iii. Temperature/thermal triggering
iv. Light/radiation triggering
v. dv/dt triggering

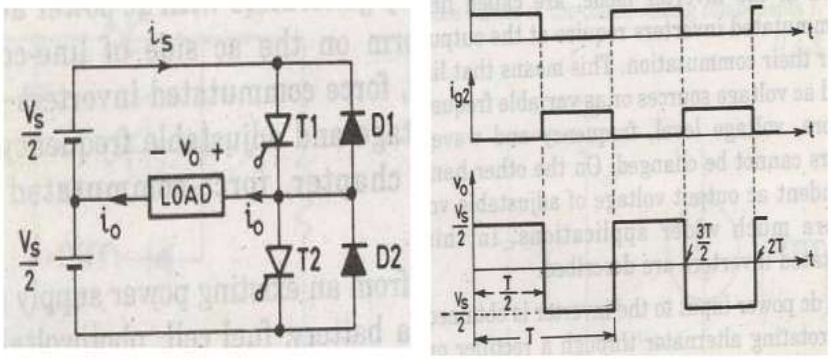
dv/dt triggering : In construction of SCR there are four layers and three junctions J1,J2& J3. Under forward bias condition junction J1 & J3 are forward biased whereas junction J2 is reverse biased. This reverse biased junction J2 behaves as a capacitor. Now if the forward voltage is applied suddenly a charging current will flow through capacitor. Thus device turn on.

If V = voltage applied across the device
CJ = junction capacitance

Then the instantaneous current is due to suddenly applied voltage is IC = CJ dv/dt
If is dv/dt large the device may turn-on or trigger on, even when the voltage across the device is small.

f)Describe working of single phase half bridge inverter with help of circuit diagram and waveforms.

Ans: [circuit diagram 2M, waveforms 1M, explanation 1M]



Circuit diagram **Waveforms**

- Thyristors T1 and T2 are operated as switch
- If transistor T1 is on , T2 is off and vice versa. When is T1 on then output voltage (Vo) is Vs/2 and T2 is on then output voltage (Vo) is –Vs/2
- T1 and T2 shouldn't be turned on at the same time
- Diodes D1 and D2 which are connected parallel carry negative current for inductive loads

Q 3 : Attempt any FOUR of the following : 16

a) Compare UJT and DIAC w.r.t.

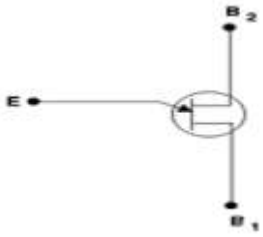
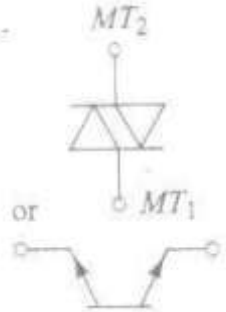
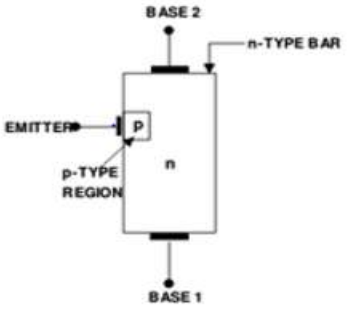
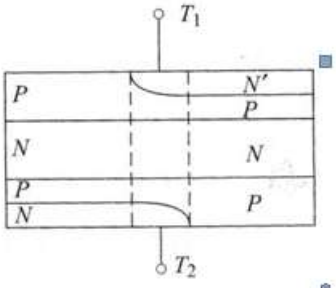
(i) Symbol

(ii) Layer diagram

(iii) Operating quadrant

(iv) Application

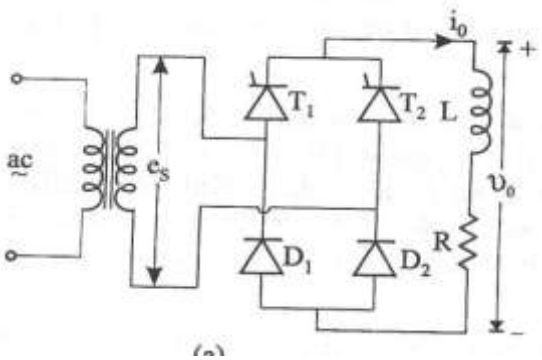
Ans: (Each point 1M)

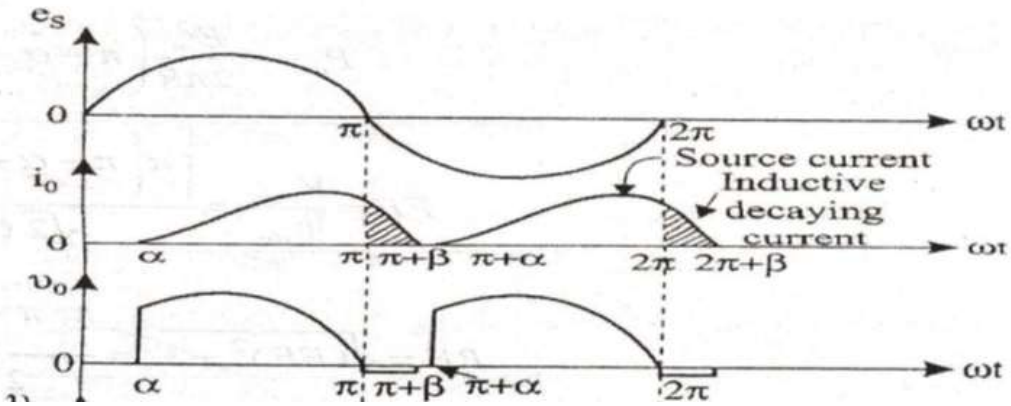
Parameters	**UJT**	**DIAC**
Symbol		
Layer diagram		
Operating quadrant	First quadrant	First and third quadrant
Application	1. Use as a triggering device SCR and TRIAC 2. Used in timer /delay circuit	1. Use as a triggering device of TRIAC 2. In light dimmer/fan speed controller

b) Draw circuit diagram , input and output waveforms for single phase half controlled Rectifier with RL load.

Ans : [Circuit diagram 2M,Input and Output waveforms 2M]

Circuit diagram:





c) Define following w.r.t. GTO

(i) Maximum controllable Anode current

(ii) Turn off gain

Ans: [Each point for 2M]

Note any relevant answer can be consider.

i) Maximum controllable Anode current : In GTO, there always a maximum value of the controllable anode current . If the anode current exceeds this value ,then no value of gate , current can turn off GTO

If the anode current exceeds this maximum controllable anode current , the negative gate current to turn it off also increases . due to this gate cathode junction becomes reverse-biased and will eventually breakdown GTO

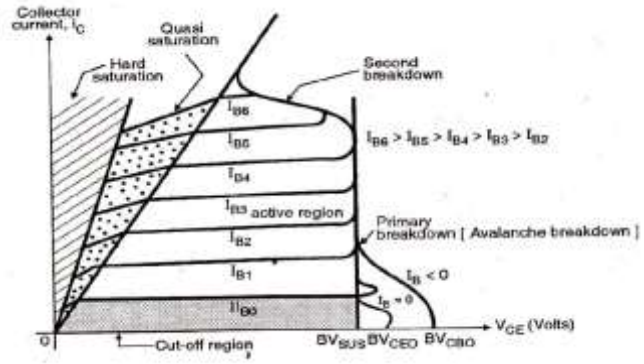
ii) Turn off gain: In GTO β_{off} is known as turn off gain . To turn off GTO , the negative gate current must be greater than the anode current divided by the turn-off gain.

$I_{GN} > I_A / \beta_{off}$ hence $\beta_{off} > I_A / I_N$

The turn off gain of GTO is order of 3 to 5.

d) Draw neat labeled characteristics of power transistor. Show its regions.

Ans:[Labeled Characteristics 4M]



e) Define firing angle (α) and conduction angle (θ) .State the effect of changing firing angle (α) on the output voltage of rectifier.

Ans:[Each definition 1M,Effect 2M]

Firing angle (α) - It is the angle of sine wave at which SCR is turned ON.Thi**s** α varies from 0 to 180^0

Conduction angle (θ) - It is the angle for which SCR remains on.

$\theta = \pi - \alpha$

Effect of changing α : Output voltage of controlled rectifier is inversely proportional to firing angle . As α is 0° then output voltage of rectifier is maximum and when α is 180° then output voltage of rectifier is minimum. As firing angle α increases output DC voltage of rectifier decreases.

f) A single phase full wave controlled Rectifier is supplied with a voltage Vs= 300 sin(314t) . Find average output voltage and current if firing angle is 60°and load resistance is 500Ω.

Ans: [Average output voltage 2M, Average output current 2M]

Given Vs=300 sin(314t) $\alpha = 60°$ $R_L = 500\Omega$.

Find : i) A**verage output voltage(Vdc)**

ii) A**verage output current(Idc)**

But Vs = Vm sin(wt)

Hence Vm=300 Volts

i) A**verage output voltage(Vdc)** $= Vm(1+\cos\alpha)/\pi$

$= 300(1+\cos 60)/\pi$

$= 143.23$ Volts

ii)Average dc load current (Idc)=Vdc/R_L

$=143.23/500$

$=0.28646A$

Q4: Attempt any FOUR of the following. 16

a) With help of circuit diagram and waveform explain step-up chopper.

Ans:[Circuit diagram 2M,waveforms 1M,explanation 1M]

Circuit diagram with waveforms:

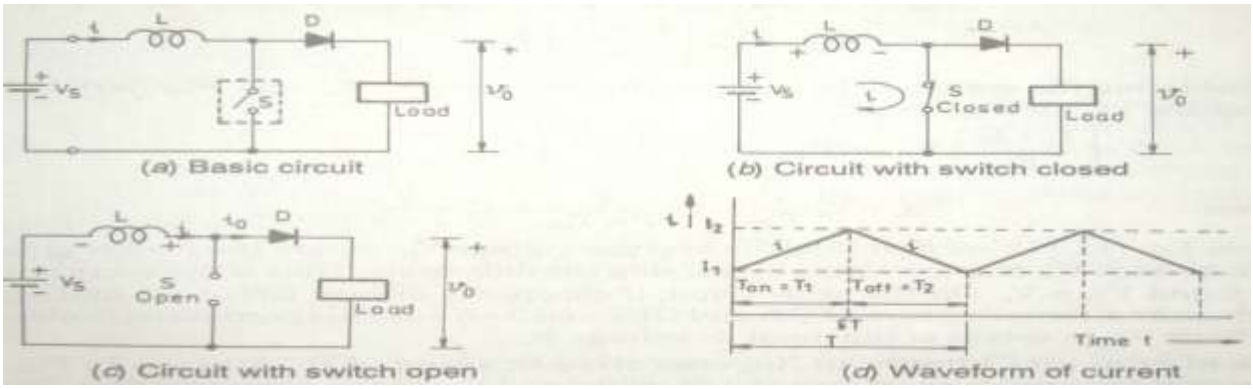


Fig shows basic step up chopper circuit when average output voltage Vdc is greater than dc input voltage Vs then it is called step up chopper.

1) When switch S is closed the current I flow through the closed path including Vs & L as shown in fig current i rises and energy is stored in inductor L during time interval Ton (T1).

2) When switch S is open, the energy stored in inductor L is transferred to the load via diode D and inductor current falls during the interval Toff (T2)

3) During period T1,

VL = L di / dt

4) During period T2, As the current tends to decrease, polarity of the emf induced in L gets reversed so average voltage across the load is given by,

Vdc = Vs + L (di / dt)

This voltage Vdc exceeds the input voltage Vs . So circuit act as step up chopper. As the duty cycle increases, output voltage also increases.

b) Explain four modes of operations of TRIAC with neat constructional diagram.

Ans:[Each mode explanation 1M]

Note : All mode diagrams are needed

Though the TRIAC can be turned on without any gate current provided the supply voltage becomes equal to the breakover voltage of the TRIAC but the normal way to turn on the TRIAC is by applying a proper gate current. As in case of SCR, here too, the larger the gate current, the smaller the supply voltage at which the TRIAC is turned on. TRIAC can conduct current irrespective of the voltage polarity of terminals MT_1 and MT_2 with respect to each other and that of gate and terminal MT_2. There are four different operating modes of TRIAC:

1) MT_2 and gate are positive with respect to terminal MT_1

here terminal MT_2 is positive with respect to terminal MT_1 current flows through path P_1-N_1-P_2-N_2.The two junctions P_1-N_1 and P_2-N_2 are forward biased whereas junction N_1 P_2 is blocked. The TRIAC is now said to be positively biased.

A positive gate with respect to terminal MT_1 forward biases the junction P_2-N_2 and the breakdown occurs as in a normal SCR.

2) MT_2 is positive but gate is negative with respect to terminal MT_1

Though the flow path of current remains the same as in mode 1 but now junction P_2-N_3 is forward biased and current carriers injected into P_2 turn on the TRIAC.

3) MT_2 and gate are negative with respect to terminal MT_1

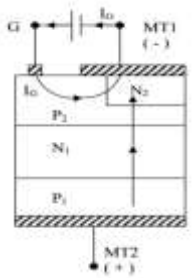
When terminal MT_2 is negative with respect to terminal MT_1, the current flow path is P_2-N_1-P_1-N_4. The two junctions P_2-N_1 and P_1 – N_4 are forward biased whereas junction N_1-P_1 is blocked. The TRIAC is now said to be negatively biased.

A negative gate with respect to terminal MT_1 injects current carriers by forward biasing junction P_2-N_3 and thus initiates the conduction.

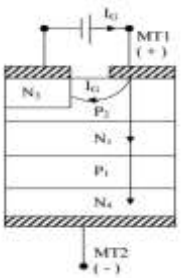
4) MT2 is negative but gate is positive with respect to terminal MT1

Though the flow path of current remains the same as in mode 3 but now junction P_2-N_2 is forward biased, current carriers are injected and therefore, the TRIAC is turned on.

Generally, trigger mode 4 should be avoided especially in circuits where high di/dt may occur. The sensitivity of triggering modes 2 and 3 is high and in case of marginal triggering capability negative gate pulses should be used. Though the triggering mode 1 is more sensitive compared to modes 2 and 3, it requires a positive gate trigger. However, for bidirectional control and uniform gate trigger modes 2 and 3 are preferred.



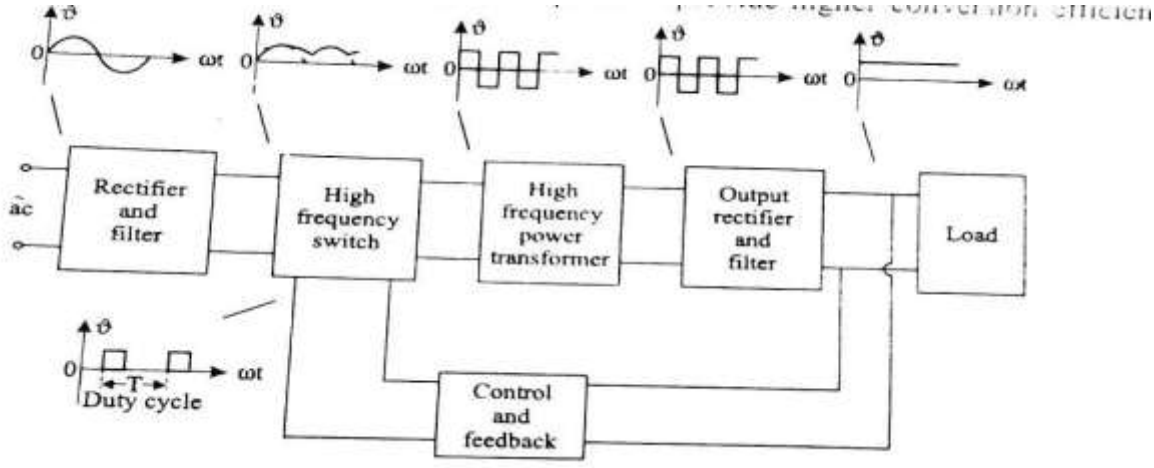
MT2 and gate +ve w.r.t MT1



MT2 and gate -ve w.r.t MT1

c) Draw the block diagram of SMPS. State its advantages over linear regulators.

Ans: [Block diagram 2M, advantages 2M]



Advantages of the switch mode power supply (SMPS):

(i) Small size

(ii) Light weight (20 to 30 % by volume and weight of only linear power supply)

(iii) High efficiency (typically 60 to 70 percent , while linear power only 30 to 40%).

(iv) Strong anti-interference

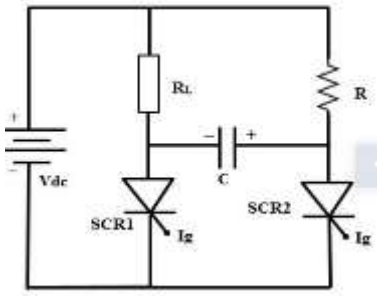
(v) wide output voltage range

d) What is commutation? Explain class C commutation with neat diagram.

Ans:[Commutation explanation 1M,circuit diagram 2M ,explanation of class c 1M]

Commutation: The process to turn off conducting SCR is called commutation .

Circuit diagram of class c commutation:



Initially, both SCRs are in OFF state so the capacitor voltage is also zero.

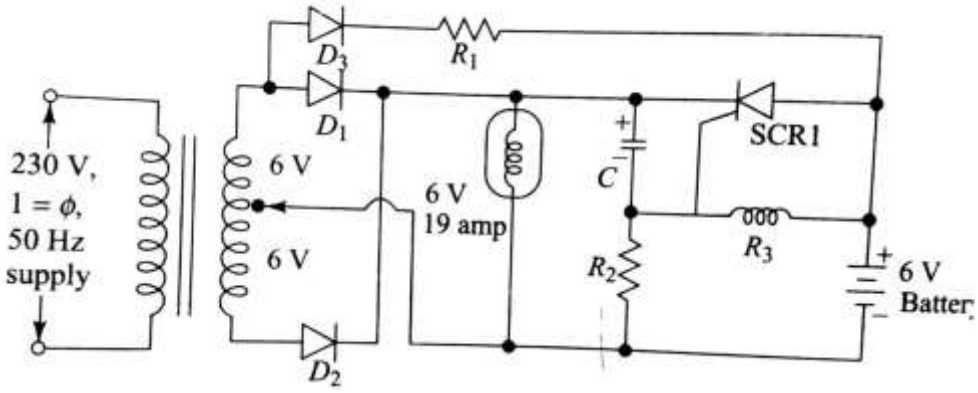
1)When the SCR1 or main SCR is triggered, current starts flowing in two directions, one path is Vdc+ – RL – SCR1 – Vdc- and another path is the charging current Vdc+ – R- C+ – C- SCR1 – Vdc- . Therefore, the capacitor starts charging up to the value of Vdc.

2)When the SCR2 is triggered, SCR2 is turned ON and simultaneously a negative polarity is applied across the SCR1. So this reverse voltage across the SCR1 immediately causes to turn OFF the SCR1. Now the capacitor starts charging with a reverse polarity through the path of Vdc+ – RL- C+ – C- SCR2 – Vdc-. And again, if the SCR 1 is triggered, discharging current of the capacitor turns OFF the SCR2.

e) Describe working of emergency lighting system with neat circuit diagram.

Ans: [Circuit Diagram -2 M, Working -2M]

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



Working:- In this circuit, 230v ac supply is applied as input. This supply is stepped down TO 6-0-6 v ac supply by center tapped transformer. The supply is stepped down full wave rectifier & converts ac to dc volt. When ac supply is available, 6V dc supply appears across lamp and it glows. Pulsating current also flows through D3 & R1 to trickle charge the battery. Thus battery charging is carried out. The capacitor C gets charged with upper plate +VE to some voltage less than 6V.Due to capacitor voltage, gate cathode junction of SCR1 gets reverse biased. The anode is at battery voltage & cathode is at rectifier output voltage, which is slightly higher, hence SCR1 is reverse biased & cannot conduct. The lamp glows due to rectifier output dc voltage.

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

f) Compare step up and step down chopper based on

i) Position of chopper switch

ii) Output voltage

iii) Expression of output voltage

iv) Application

Ans: [Each point 1M]

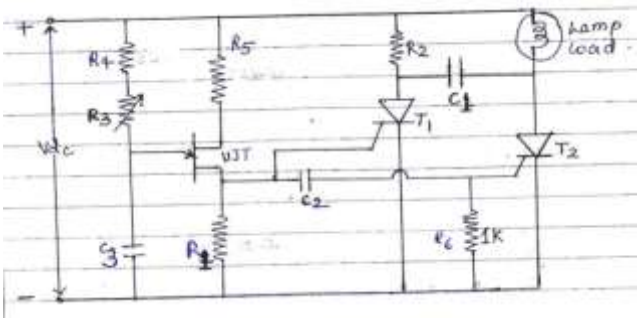
Parameter	**Step up chopper**	**Step down chopper**
Position of chopper switch	In parallel with load	In series with load
Output voltage	More than input voltage	Less than input voltage
Expression of output voltage	Vdc = Vs/(1-D) Volts Where D= Duty Cycle Vs= Input voltage	Vdc = DxVs Volts Where D= Duty Cycle Vs= Input voltage
Application	Battery charging, voltage booster	Motor speed control.

Q5: Attempt any FOUR of the following. **16M**

a) Draw circuit diagram of low power DC flasher. List any two applications.

Ans :[Diagram 3M, Any two applications 1M]

Circuit diagram :



Applications flasher circuit : 1) for voltage indication purpose

2)For decoration purpose

3)For door keyhole finding

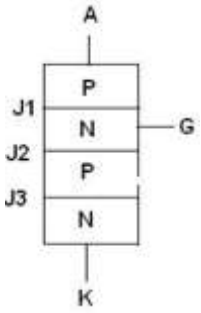
4)In electronics camera

5) Traffic light

b) Describe constructional details of PUT. Why it is called programmable?

Ans: [construction 2M, Construction Explanation 1M, Explanation of programmable 1M]

Construction of PUT:



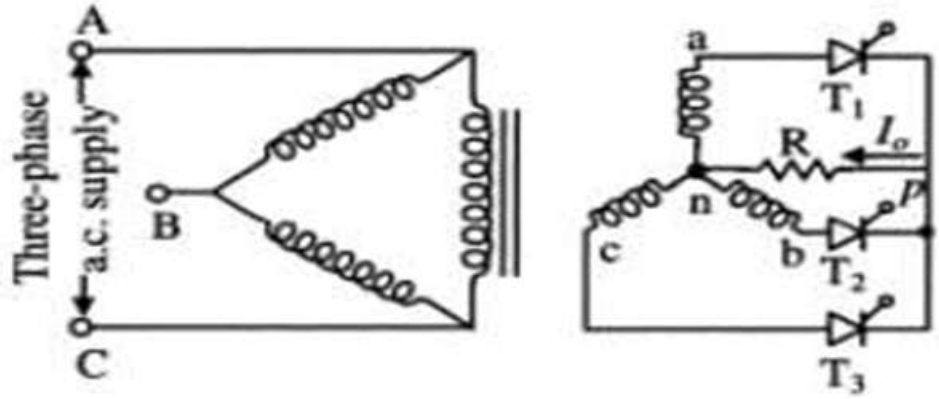
PUTs has a four layered construction just like the SCR and have three terminals named anode(A), cathode(K) and gate(G) and it is four layer of PNPN ,three junctions like the SCR. It called a programmable UJT just because its characteristics and parameters have much similarity to that of the unijunction transistor.

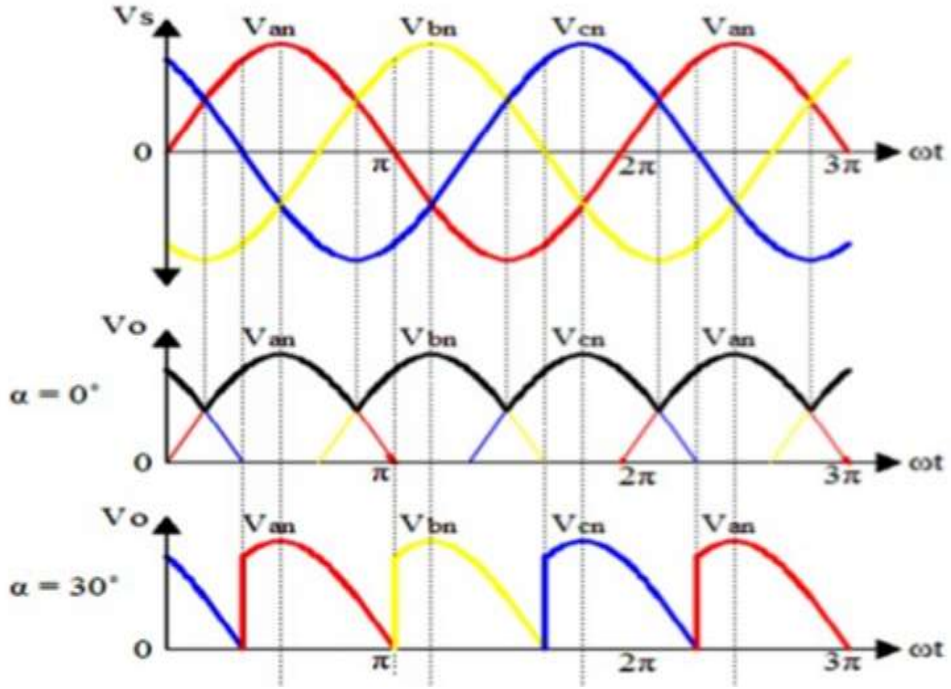
PUT is called programmable because the parameters like intrinsic standoff ratio (η), peak voltage(Vp) etc can be programmed with the help of two external resistors. In a UJT, the parameters like Vp, η etc. are fixed and we cannot change it. The main application of programmable UJT are relaxation oscillators.

c) Draw circuit diagram of three phase half wave controlled rectifier. Draw its input and output voltage waveforms.

Ans:[Circuit diagram 2M,Input and output waveforms 2M]

Circuit Diagram:

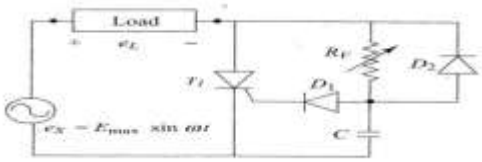


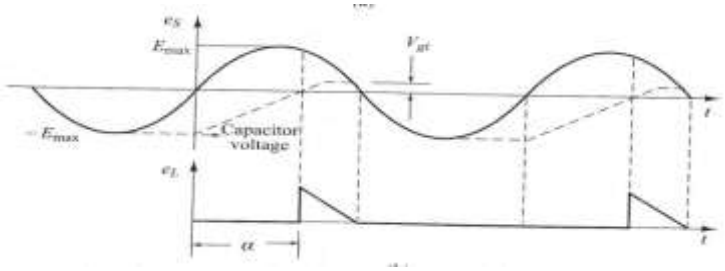


d) Explain RC triggering of SCR with neat circuit diagram.

Ans:[Circuit Diagram 2M,Explanation 2 M ,waveforms optional]

Circuit diagram :





Explanation: The triggering angle control limitation of the resistance triggering circuit (R triggering) can be overcome by the -resistance-capacitance (RC) triggering circuit. The figure shows the RC-half wave trigger circuit. The conduction period can be controlled over the full 180° range. By varying the value of Rv, the trigger can be controlled from 0 toΠ

1. During the positive half cycle, the capacitor C charges to the trigger voltage of the thyristor in a time determined by the RC time constant and the applied anode voltage.

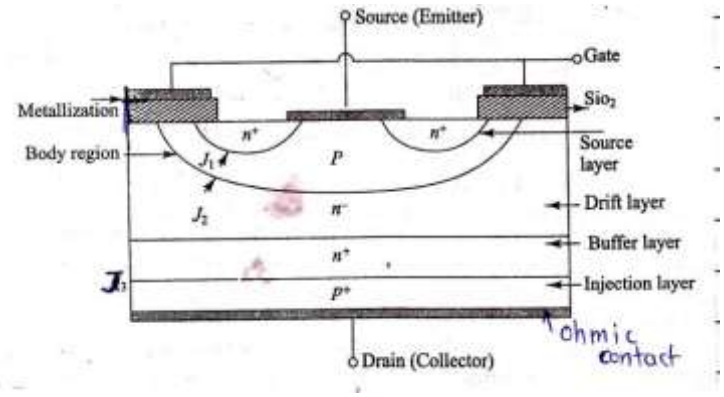
2. During the negative half cycle, the capacitor charges to the peak supply voltage at t = (-Π/2). After this period, the supply voltage decreases and reaches zero at t = 0.During this period the capacitor voltage becomes positive during the positive half cycle of the ac input, the capacitor begins to charge through the variable resistance Rv, in the opposite direction and as soon as it charges to a positive voltage equal to the gate trigger voltage, the thyristor turns ON.

Here the diode D1 is used to prevent the negative voltage between the gate and the cathode through the diode D2 during the negative half-cycle.

e) Draw neat labeled construction of IGBT. State any two advantages.

Ans: [Construction 2M, Any two advantages 2M]

Construction of IGBT:



Advantages of IGBT:

(a) High input impedance
(b) No second breakdown
(c) Low on-state conduction loss
(d) Simple driver circuit
(e) High power, high frequency application
(f) Large safe operation area

f) Compare Uncontrolled and Controlled Rectifiers (Any four points)

Ans : [**1 M each for any 4 points]**

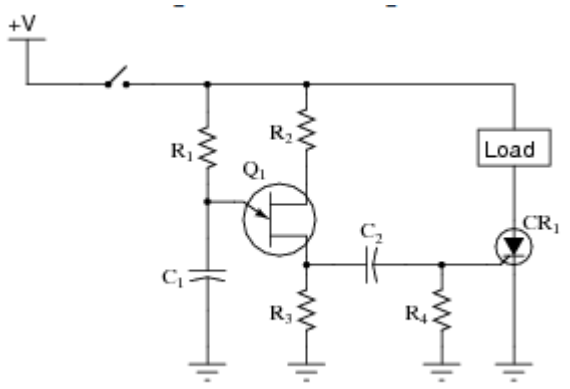
Parameter	**Controlled Rectifier**	**Uncontrolled Rectifier**
Device used	SCR and Diodes	Only Diodes
Control of load voltage	Load voltage can be controlled	Load voltage cannot be controlled.
Direction of power flow	Source to load and some case load to source	Source to load only

Triggering circuit	Required.	Not Required.
Applications	DC motor controller, Battery chargers	Power supply.

Q6: Attempt any FOUR of the following. **16M**

a) Explain operations of Electronic timer using SCR. Give any two applications.

Ans: [Circuit Diagram 2 M, operation 1M, Any two applications 1M]



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

Together, the combination of R_1, C_1, R_2, R_3, and UJT Q_1 form a *relaxation oscillator*, which outputs a triggering pulses for triggering SCR. This circuit perform a simple time-delay for the load, where the load energizes a certain time *after* the switch is closed.

When switch is closed ,capacitor C_1 charges through R_1 at that time load will not energized. Due to charging of capacitor when capacitor voltage reaches to peak point voltage (Vp)of UJT ,UJT turns ON and then capacitor get path for discharging .Discharging of capacitor C_1 generates triggering pulses for SCR and hence SCR turns ON and it connects load to +V i.e. energizes load after certain time delay this time delay depends on value of R_1 and C_1.

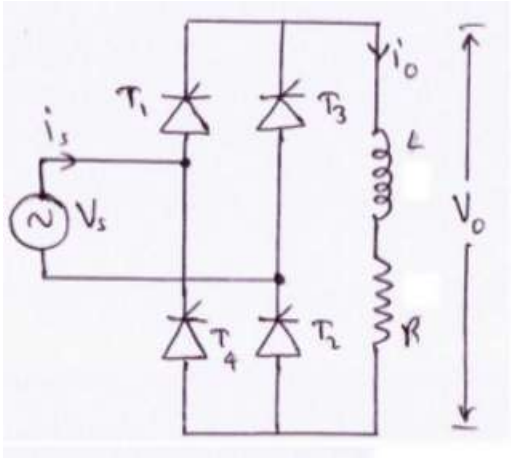
Applications of Electronics Timer circuit:

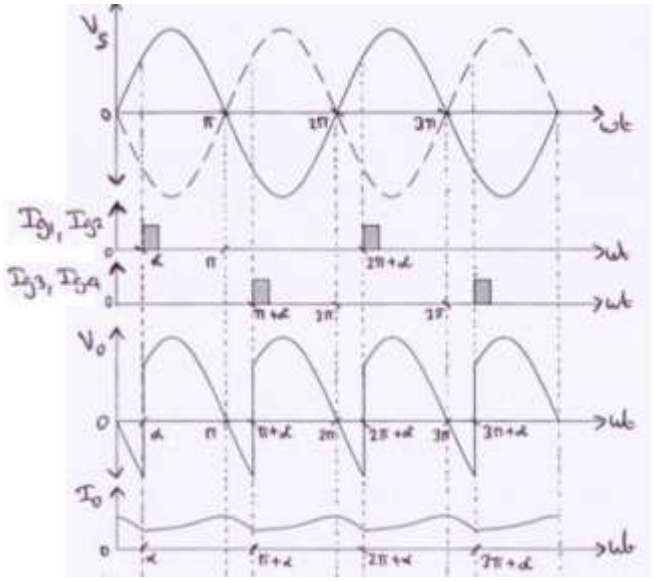
1) Use as time delay circuit for providing ON delay time /OFF delay time.
2) In the industries to control the process/operation with specified time interval .

b) Describe working of fully controlled bridge rectifier with RL load.

Ans: [Circuit diagram 2M, Working 2M ,waveforms optional]

Circuit diagram and waveforms:





Working: FWCR with RL- load it becomes a two-quadrant converter. Here, output voltage is either positive or negative but output current is always positive.

The fully controlled bridge converter consists of four thyristors T1 , T2 , T3 and T4 connected in the form of full wave bridge configuration as shown in the figure. Each thyristor is controlled and turned on by its gating signal and naturally turns off when a reverse voltage appears across it.

During the positive half cycle when the upper line of the transformer secondary winding is at a positive potential with respect to the lower end the thyristors T1 and T2 are forward biased during the time interval ωt = 0 to π . The thyristors T1 and T2 are triggered simultaneously at ωt = α , the load is connected to the input supply through the conducting thyristors T1 and T2 . The output voltage across the load follows the input supply voltage .

Due to the inductive load T1 and T2 will continue to conduct beyond ωt = π , even though the input voltage becomes negative. T1 and T2 conduct together during the time period α to π+ α , for a time duration of π radians (conduction angle of each thyristor = 180°)

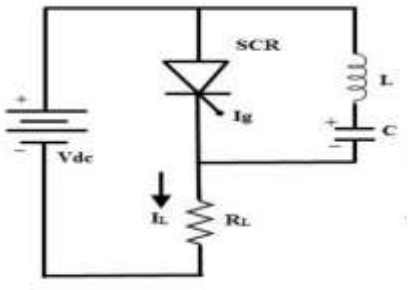
During the negative half cycle of input supply voltage for ωt = π to 2π the thyristors T3 and T4 are forward biased. T3 and T4 are triggered at ωt = π + α . As soon as the thyristors T3 and T4 are triggered a reverse voltage appears across the thyristors T1 and T2 and they naturally turn-off and the load current is transferred from T1 and T2 to the thyristors T3 and T4 . The output voltage across the load follows the supply voltage . In the next positive half cycle when T1 and T2 are triggered, T3 and T4 are reverse biased and they turn-off.

c) What is class B commutation? Explain its operation with neat diagram.

Ans: [Class B explanation 1M, Circuit diagram 2M,operation 1M]

Class B commutation means self-commutation by LC circuit **:** Class B is a self commutation circuit in which commutation of SCR is achieved automatically by L and C components, once the SCR is turned ON. In this, the LC resonant circuit is connected across the SCR but not in series with load as in case of class A commutation and hence the L and C components do not carry the load current.

Circuit Diagram :



Operation : When the DC supply is applied to the circuit, the capacitor charges with an upper plate positive and lower plate negative up to the supply voltage E. When the SCR is triggered, the current flows in two directions, one is through Vdc+ – SCR – R_L–Vdc- and another one is the commutating current through L and C components.

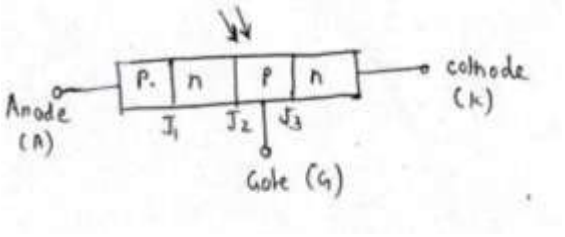
Once the SCR is turned ON, the capacitor is starts discharging through C+ – L – T – C-. When the capacitor is fully discharged, it starts charging with a reverse polarity. Hence a reverse voltage applied across the SCR which causes the commutating current Ic to oppose load current I_L.

When the commutating current Ic is higher than the load current, the SCR will automatically turn OFF and the capacitor charges with original polarity.

d) Draw layered diagram of LASCR. What is the effect of increasing intensity of light? State any two applications.

Ans: [Diagram-2M,Effect -1M, Application-1M(Any Two)]

Layered Diagram of LASCR :



Effect of increasing intensity of light : As light intensity increases forward voltage required to turn on LASCR decreases hence break over voltage goes on decreasing with light intensity.

Applications of LASCR

1) Photoelectric control
2) Motor speed control
3) Used in high voltage dc transmission (HVDC)
4) Static reactive power or volt ampere reactive (VAR) compensation.

e) Compare power transistor and power MOSFET w.r.t

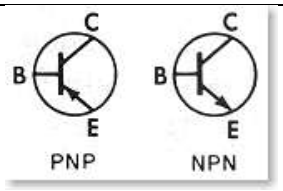
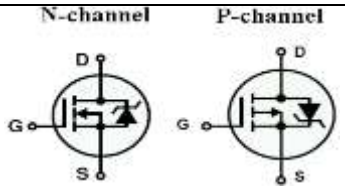
(i)Symbol

(ii) switching speed

(iii) Sio_2 layer

(iv) On state loss

Ans: [Each point 1M]

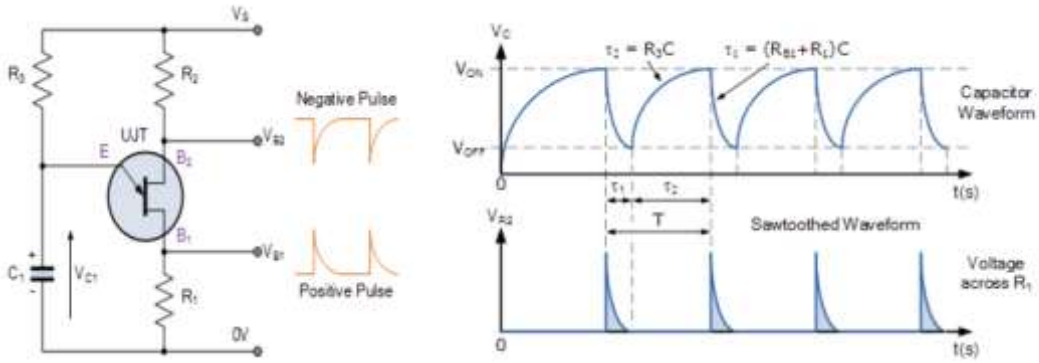
Parameter	Power transistor	Power MOSFET
Symbol		
Switching speed	slow	fast
Sio_2 Layer	Not Present	Present
On state losses	Less	more

The frequency of oscillation is therefore given by $f = 1/T$.

Where $T = 2.3\ R_3C_1 \log(1/1-\eta)$

f) Draw circuit diagram of UJT Relaxation oscillator . Draw output waveform and give expression for frequency of oscillation

Ans: [Circuit diagram 2M, Output wave 1M, Expression 1M]



Circuit diagram of UJT Relaxation oscillator: **Output waveforms at Capacitor and R_1 :**