Name of the Lab: Electronics Lab
Class: 5th sem (ET&T)
Title of the Practical: Performance of thyristor, TRIAC & DIAC

Q1: Give the introduction of thyristor?
A1: In power electronics the thyristor is the most common and popular family of switching devices. According to constructions, the numbers of semiconductor layer of thyristor family member are nearly similar but their position arrangements are different and also the terminals are connected in different positions. The most widely used of this family are silicon controlled rectifiers (SCRs), triacs, and diacs.

Q2: What is SCR?
A2: Silicon controlled rectifier is the oldest member of thyrister family. It has four layers (pnpn), three terminals (anode, cathode, and gate) and three junctions. Two transistor one is PNP and other is NPN connect to base-collector and collector-base with each other or one diode p-n and a transistor npn connected to same polarity layer. It is current controlled device, because the gate current controls SCR.

Q3: How can do SCR Testing?
A3: The silicon controlled rectifier can be tested easily by Ohmmeter. The procedure is to connect the negative and positive lead to the cathode and anode respectively and again connect with the reverse direction, on both case for a good SCR the ohmmeter shows near infinity (exceed one mega).

Q4: What is DIAC?
A4: Diode which works on a.c. is called DIAC. The DIAC is a five layers and contains two terminal, anode A1 (or main terminal MT1) and anode A2 (or main terminal MT2) like a TRIAC just without a gate. It is a bidirectional, switching device. Its applications are fan speed regulator, temperature controller etc.When MT1 is +ive w.r.t MT2 it works on 1st quadrant, if MT1 is –ve w.r.t MT2 it works on 3rd quadrant**.**

Q5: What is TRIAC?
A5: Thyrister which works on a.c. is called TRIAC.It have five layers, three terminals (MT1, MT2, and Gate), and bidirectional device. The five layers TRIAC can be divided into two haves one is SCR1 and other is SCR2 connected in parallel of opposite polarity. Its applications are as a static switch, in a AC voltage stabilizers etc. When MT2 is +ive w.r.t MT1 it works on 1st quadrant, if MT2 is –ve w.r.t MT1 it works on 3rd quadrant.

Q6: Compare the SCR, and TRIAC?
A6:

SCR	TRIAC
1. SCR is unidirectional devise.	1. It is bidirectional device.
2. The gate current can be only +ve.	2. The gate current can be +ve or –ive.
3. It can work in only one quadrant.	3. It can works in two quadrants.
4. UJT is used for triggering SCR.	4. DIAC is used for triggering TRIAC.
5. Its applications are as a controlled rectifier , inverter, chopper, speed control of motor, battery charger etc.	5. Its applications are as a static switch, in a AC voltage stabilizers , fan control, light dimmer etc.

Q7: Compare the DIAC, and TRIAC.
A7:

DIAC	TRIAC
1. It is two terminal devices.	1. It is three devices.
2. Break over voltage cannot be controlled.	2. Break over voltage can be controlled by gate current.
3. It is a low power device.	3. It is high power device.
4. It is used as a triggering device for the TRIAC.	4. It is used in fan control, light dimmer etc.

Q8: How can do DIAC Testing?
A8: in DIAC testing by Ohmmeter the procedure is firstly connect the negative and positive lead to the anode M1 and anode M2 and in the second arrangement again connect with the reverse direction, on both case for a good DIAC the ohmmeter shows near infinity (exceed one mega). A low resistance in either direction indicates that the device is not opened i.e. DIAC is defective. This does not indicate a shorted device. Further testing of DIAC requires a special circuit setup to check the terminal voltage.

Q9: Use of DIAC?

A9: In general the DIAC is used to triggering the TRIAC because the triggering characteristic of TRIAC is nonsymmetrical. The other applications are:

1) Counters, register and timing circuits of computers,
2) Pulse generator,
3) Voltage sensors,
4) Oscillators
5) Proximity sensor circuit etc.

Q10: Basic Operation of a Diac?

A10: The construction of a diac is similar to an open base “NPN” transistor. The bidirectional transistor-like structure exhibits a high-impedance blocking state up to a voltage break over point (VBO) above which the device enters a negative-resistance region. These basic diac characteristics produce a bidirectional pulsing oscillator in a resistor-capacitor AC circuit. Since the diac is a bidirectional device, it makes a good economical trigger for firing triacs in phase control circuits like light dimmers, motor speed controls, etc.

Title of the Practical: Frequency calculation of pulse in UJT relaxation oscillator

Q1: What is UJT?

A1: Unijuction transistor has only one p-n junction. It consists of a lightly doped n-type silicon bar. The p- type impurity is diffused into the base producing the pn junction these are referred to as the emitter, base 1 and base 2 respectively. It is also called double based device.

Q2: What is inter base resistance?

A2: The resistance of the silicon bar is called inter base resistance R_{BB} represented by the two resistors in series of Rb1 and Rb2.

The inter base resistance is given by

$$R_{bb} = R_{b1} + R_{b2}$$

Q3: What is the specification of UJT?

A3: The very basic specifications of a UJT are:

(a) V_{bb} (max) - The maximum interbase voltage that can be applied to the UJT

(b) R_{bb} -the interbase resistance of the UJT

(c) η - The intrinsic standoff ratio which defines Vp.

(d) I_p - The peak point emitter current

Q4: What is intrinsic standoff ratio?

A4: If a voltage V_{bb} is applied between the bases with emitter open, the voltage will divide up across R_{b1} and R_{b2}.Voltage across Rb1, $V1 = \frac{Rb1}{(Rb1 + Rb2)} Vbb \qquad \frac{V1}{Vbb} = \frac{Rb1}{(Rb1 + Rb2)}$

The ratio $\frac{V1}{Vbb}$ is called the *intrinsic stand-off ratio* represented by η . Thus $\eta = \frac{Rb1}{(Rb1 + Rb2)}$

Q5: Application of UJT?

A5: The device has-a unique characteristic that when it is triggered, its emitter current increases re generatively (due to negative resistance characteristic) until it are restricted by emitter power supply. The low cost per unit, combined with its unique characteristic, have warranted its use in a wide variety of applications. A few include oscillators, pulse generators, saw-tooth generators, triggering circuits, phase control, timing circuits, and voltage-or current-regulated supplies.

Q6: What is relaxation oscillator?

A6: A relaxation oscillator produces a non-sinusoidal output, such as a square wave or sawtooth. The oscillator contains a nonlinear component such as a transistor that periodically discharges the energy stored in a capacitor or inductor, causing abrupt changes in the output waveform.

Q7: What is UJT relaxation oscillator?

A7: UJT Relaxation Oscillator circuit, mainly used for triggering purposes This circuit is ideally suited for triggering an SCR – since UJT is capable of generating sharp, high powered pulses of short duration whose peak and average power don't exceed the power capabilities of the SCR gate for which they are intended.

$$f_o = \frac{1}{RC \ln(\frac{1}{1-\eta})} - (1)$$

Oscillator frequency

η =0.5 (we take)

Substituting the value of η in (1)

$$f_o = \frac{1}{RC \ln(\frac{1}{1-0.5})} = \frac{1}{RC \ln 2} = \frac{1.44}{RC}$$

$$f_o \cong \frac{1.5}{RC} - (2)$$

Q8: How does a UJT relaxation oscillator works?

A8: When power is applied to the given circuit, capacitor C starts charging exponentially through R to the applied voltage V_{CC}. The voltage across C is the voltage applied to the emitter of UJT. When C is charged to V_p , then UJT turns ON. This greatly reduces the effective resistance between emitter and base1 of UJT. A sharp pulse of current flows from base1 to emitter, discharging C through R_{b1}. When the capacitor voltage drops below V_p , UJT is brought back to the previous state and the capacitor again begins to charge towards V_{bb}. This produces a saw tooth wave. R_{b1} and $R_{b2}$are used to protect UJT from overheating. This intern provides sharp pulses across them: Rb1 produces a positive spike and R_{b2}produces a negative spike.

Q9: Practical examples of the use of the relaxation oscillator?

A9: This type of circuit was used as the time base in early oscilloscopes and television receivers. Variants of this circuit find use in stroboscopes used in machine shops and nightclubs. Electronic camera flashes are a monostable version of this circuit, generating one cycle of the saw tooth, the rising edge as the flash capacitor is charged and the rapid falling edge as the capacitor is discharged and the flash is produced upon receiving the firing signal from the shutter button. Use as a time base in oscilloscopes was discontinued when the much more linear Miller Integrator time base circuit using "hard" valves, (vacuum tubes) as a constant current source, was developed.

Q10: What do oscillators do?

A10: Oscillators produce a waveform (mostly sine or square waves) of desired amplitude and frequency. They can take input from the output itself. For a complete oscillator circuit we require a feedback device, amplifier and feedback factor.

Title of the Practical: Application of TRIAC in AC load control

Q1: What do you mean by TRIAC?

A1: TRIAC is one of the bidirectional devices of thyristor family. TRIAC have five layer and three terminals, the name TRIAC comes from its three electrodes (terminals). It has no cathode terminal, one of the three is gate and the others are A_1 (MT1 i.e. main terminal) and A_2 (MT2) as it conducts by terminal. Triac can be triggered with either positive or negative gate pulses when the anode terminal potentials are positive or negative respectively.

Q2: Basic Operation of a Triac?

A2: Its primary function is to control power bilaterally in an AC circuit. Operation of a triac can be related to two SCRs connected in paralleling opposite directions. Although the gates are separately for each SCR in a triac has a single gate and can be triggered by either polarity. Since a triac operates in both directions, it behaves essentially the same in either direction as an SCR would behave in the forward direction (blocking or operating).

Q3: How can do TRIAC Testing?

A3: The TRIAC can be tested easily by Ohmmeter. The procedure is in the first arrangement connect the negative and positive lead to the anode A1 and anode A2 and in the second arrangement again connect with the reverse direction, on both case for a good TRIAC the ohmmeter shows near infinity (exceed one mega). Now if we momentarily touch the gate to the anode A1 (for first arrangement) then the ohmmeter shows reduced resistance i.e. less than one mega and if we remove the touch then the ohmmeter remains same (i.e. shows reduced resistance). Again if we momentarily touch the gate to the anode A2 (for second arrangement) then the ohmmeter shows reduced resistance i.e. less than one mega and if we remove the touch then also the ohmmeter remains same (i.e. shows reduced resistance).

Q4: What is the use of TRIAC?

A4: TRIAC can be used as follows:

1) As a high power lamp switch.
2) Electronic change over of transformer taps.
3) Light dimmer
4) Speed controls for electric fans and other electric motors
5) Modern computerized control circuits
6) For minimizing radio interference.

Q5: Application of Triac in High Power Lamp Switching?

A5: Use of the triac as an ac on/off switch When the switch S is in on, the triac is cut-off and so the lamp-is' dark. When the switch is put in off, a small gate current flowing through the gate turns the triac on and so the lamp is switched on to give rated output.

Q6: Application of Triac in AC Power Control?

A6: A triac control circuit. Here it is controlling ac power to load by switching on and off during the positive and negative half cycles of the input sinusoidal signal. During the positive half cycle of the input voltage, diode D_1 is forward biased, D_2 is reverse-biased, and the gate terminal is positive with respect to A_1 During the negative half cycle, the diode D_2 is forward biased and diode D_1 is reverse-biased, so that the gate becomes positive with respect to terminal A_2 - The point of commencement of conduction is controlled by adjusting the resistance R_2.

Q7: Triacs cannot be used in A.C. voltage regulator for which type of load?

A7: Triacs cannot be used in A.C. voltage regulator for inductive load.

Q8: TRIAC characteristics?

A8: In the V-I characteristics of TRIAC, the first quadrant and the third quadrant are identical to those of the first quadrant of SCR but in normal operation the gate voltage is positive in first quadrant and the gate voltage is negative in third quadrant. In the family of V-I characteristics curve for a TRIAC, the magnitude of break over voltage and holding current become smaller as the values of gate current ($I_{G2} > I_{G1} > I_{G0}$) increases like SCR. To turn the TRIAC off the anode current must be reduced below the holding current.

Q9: How to commutate to the traic?

A9: However, the triac is less versatile than the SCR when turn-off is considered. Because the triac can conduct in either direction, forced commutation by reverse-biasing cannot be employed. So turn-off is either by current starvation, which is usually impracticable, or else by ac line commutation.

Q10: What are the limitations of traic?

A10: There are two limitations enforced on the use of triac at present state of commercially available devices. The first is the frequency handling capability produced by the limiting dv/dt at which the triac remains blocking when no gate signal is applied. This dv/dt value is about 20 Vmicros^{-1} compared with a general figure of 200 Vmicro s^{-1} for the SCR, so that the limitation of frequency is at the power level of 50 Hz. The same dv/dt limitation means the load to be controlled is preferably a resistive one. When high frequencies and high dv/dt are involved then the back-to-back SCRs cannot be replaced by the triac.

Title of the Practical: Performance of IGBT & GTO

Q1: What is IGBT?

A1: The insulated gate bipolar transistor or IGBT is a three-terminal power semiconductor device, noted for high efficiency and fast switching. The structure is very similar to that of a vertically diffused MOSFET featuring a double diffusion of a p-type region and an n-type region. An inversion layer can be formed under the gate by applying the correct voltage to the gate contact as with a MOSFET. The main difference is the use of a p^+ substrate layer for the drain. The effect is to change this into a bipolar device as this p-type region injects holes into the n-type drift region.

Q2: What is the full form of IGBT?

A2: Insulated-gate bipolar transistor.

Q3: What is blocking operation of IGBT?

A3: Blocking Operation: The on/off state of the device is controlled, as in a MOSFET, by the gate voltage V_G . If the voltage applied to the gate contact, with respect to the emitter, is less than the threshold voltage V_{th} then no MOSFET inversion layer is created and the device is turned off. When this is the case, any applied forward voltage will fall across the reversed biased junction J2. The only current to flow will be a small leakage current.

Q4: What is On-state Operation of IGBT?

A4: The turning on of the device is achieved by increasing the gate voltage V_G so that it is greater than the threshold voltage V_{th}. This results in an inversion layer forming under the gate which provides a channel linking the source to the drift region of the device.

Q5: Application of IGBT?

A5: It switches electric power in many modern appliances: electric cars, trains, variable speed refrigerators, air-conditioners and even stereo systems with switching amplifiers. Since it is designed to rapidly turn on and off, amplifiers that use it often synthesize complex waveforms with pulse width modulation and low-pass filters. The IGBT is used in medium- to high-power applications such as switched-mode power supply, traction motor control and induction heating.

Q6: What is the full form of GTO?

A6: Gate turn-off thyristor.

Q7: Can you explain GTO?

A7: A gate turn-off thyristor (GTO) is a special type of thyristor, a high-power semiconductor device. GTOs, as opposed to normal thyristors, are fully controllable switches which can be turned on and off by their GATE lead.

Q8: Difference between SCR and GTO?

A8: Thyristors (SCR) can only be turned ON and cannot be turned OFF. Thyristors are switched ON by a gate signal, but even after the gate signal is removed, the thyristor remains in the ON-state until any turn-off condition occurs. The GTO can be turned-on by a gate signal, and can also be turned-off by a gate signal of negative polarity.

Q9: Explain the Turn-on process of GTO?

A9: Turn on is accomplished by a "positive current" pulse between the gate and cathode terminals. As the gate-cathode behaves like PN junction, there will be some relatively small voltage between the terminals. The turn on phenomenon in GTO is however, not as reliable as an SCR (thyristor) and small positive gate current must be maintained even after turn on to improve reliability.

Q10: Explain the Turn-off process of GTO?

A10: Turn off is accomplished by a "negative voltage" pulse between the gate and cathode terminals. Some of the forward current is used to induce a cathode-gate voltage which in turn induces the forward current to fall and the GTO will switch off (transitioning to the 'blocking' state).GTO thyristors suffer from long switch off times, whereby after the forward current falls, there is a long tail time where residual current continues to flow until all remaining charge from the device is taken away

Title of the Practical: Study of relaxation oscillator circuit using PUT

Q1: What is relaxation oscillator?
A1: A relaxation oscillator produces a non-sinusoidal output, such as a square wave or sawtooth. The oscillator contains a nonlinear component such as a transistor that periodically discharges the energy stored in a capacitor or inductor, causing abrupt changes in the output waveform.
Q2: What is the full form of PUT?
A2: The programmable unijunction transistor.
Q3: What is PUT?
A3: It is also a four-layer P-N-P-N solid-state device with a gate connected directly to the sandwiched N-type layer. The term "programmable" is applied because the inter base resistance R_{BB}, the intrinsic stand-off ratio Ƞ and peak-point voltage V_P, as defined in UJT can be programmed to any desired values through external resistors R_B and R_{B2} and the supply voltage V_{BB}. From figure we see that by voltage divider rule when $I_G = 0$,

$$V_G = (R_{B1} / R_{B1} + R_{B2}) V_{BB} = Ƞ V_{BB}$$

Q4: What is the polarity of gate for the PUT circuit?
A4: In the PUT, Gate is always positively biased w.r.t cathode and negatively w.r.t anode.
Q5: Can you explain operation of PUT?
A5: The P-N-P-N device has its gate connected to the junction of external resistors R_{B1} and R_{B2}. When anode voltage exceeds the gate voltage by about 0.7 V, first junction that is the junction right after the anode gets forward biased and PUT turns on. When anode voltage becomes less than the gate voltage, PUT is turned off.
Q6: Comparison between PUT and UJT?
A6: In PUT R_{B1} and R_{B2} are the external resistors to the device permitting the adjustment of Ƞ and hence V_G while in the UJT both R_{B1} and R_{B2} represent the bulk resistance and ohmic base contacts of the device (both inaccessible). Although the characteristics of the PUT and UJT are similar, the peak and valley currents of the PUT are typically lower than those of a UJT of a similar rating. In addition, the minimum operating voltage of PUT is also lower than that of UJT.
Q7: What are the applications of PUT?
A7: It is usually used in time delay, logic, SCR trigger circuits, in relaxation oscillator etc.
Q8: PUT is in the relaxation oscillator?
A8: One popular application of PUT is in the relaxation oscillator. The instant the supply V_{BB} is switched on, the capacitor starts charging toward V_{BB} volts, since there is no anode current at this point. The instant the voltage across the capacitor equals V_P, the device fires and anode current $I_A = I_P$ is established through the PUT. As soon as the device fires, the capacitor starts discharging rapidly through the low on-resistance of the PUT and R_K. Consequently, a voltage spike is produced across R_K during the discharge. As soon as the capacitor C gets discharged, the PUT turns off and the charging cycle starts all over again as narrated above.
Q9: What is the difference between PUT and thyristor?
A9: programmable unijunction transistor, it is a device like the thyristor only a difference is that , the gate is connected to the N type material near the anode.
Q10: Practical examples of the use of the relaxation oscillator?
A10: This type of circuit was used as the time base in early oscilloscopes and television receivers. Variants of this circuit find use in stroboscopes used in machine shops and nightclubs. Electronic camera flashes are a monostable version of this circuit.

Title of the Practical: Design of snubber circuit

Q1: Mention methods of triggering or firing of SCR?
A1: Triggering methods are used for SCR: 1) Voltage Triggering. 2) Gate Triggering.3) dv/dt Triggering .4) Light Triggering. 5) Temperature Triggering. For triggering of SCR using some circuits it is called firing circuits.
Q2: Explain gate triggering & why we preferred it?
A2: By applying a positive gate voltage between gate and cathode the gate current provide the holes to inner p layer by which junction J2 is breaks down before the forward voltage reaching to V_{BO} and SCR is turn ON it is called the gate triggering. The other triggering methods can be damage the SCR by this reason we preferred the gate triggering because it is a safest method for triggering.
Q3: Why we are using protection circuit?
A3: There are different ratings specified by the SCR's manufacturers and for reliable operation, the values are never exceeds by there specified rating. If any reason the value is increased by limiting values we are using a protection circuit to protect the SCR.
Q4: How to protect an SCR using protection circuits?
A4: SCRs are sensitive to high voltage, over-current, and any form of transients. For satisfactory and reliable operation they are required to be protected against such abnormal operating conditions. Because of complex and expensive protection, usually some margin is provided in the equipment by selecting devices with ratings higher (3 or 4 times higher) than those required for normal operation. But it is always not economical to use devices of higher ratings, hence their protection is imperative.
Q5: What is Over-voltage?
A5: The SCR will breakdown and start conducting before the peak forward voltage is attained so that the high voltage is transferred to another part of the circuit (usually the load). External voltage surges cannot be controlled by the SCR circuit designer. Voltage surges often lead to either malfunctioning of the circuit by unintentional turn-on of SCR or permanent damage to the device due to reverse breakdown.
Q6: Why we use snubber circuit?
A6: Snubbers are circuits which are placed across semiconductor devices for protection and to improve performance. Snubbers can do many things:-Reduce or eliminate voltage or current spikes ,Limit dI/dt or dV/dt,Shape the load line to keep it within the safe operating area (SOA),Transfer power dissipation from the switch to a resistor or a useful load, Reduce total losses due to switching, Reduce EMI by damping voltage and current ringing.
Q7: Types of snubber circuit?
A7: There are many different kinds of snubbers but the two most common ones are the resistor-capacitor (RC) damping network and the resistor-capacitor-diode (RCD) turn-off snubber.
Q8:**Over-current Protection?**
A8: The turn-on of SCR causes a large current to flow and poses a problem of over-current.
1) Over-current protection can be provided by connecting a circuit breaker and a fuse in series with the SCR, as usually done for the protection of any circuit. Fuses when used, their arc voltages are kept below 1.5 times the peak circuit voltage.
2) Current magnitude detection can be employed and is used in many applications. When an over-current is detected the gate circuits are controlled either to turn-off the appropriate SCRs, or in phase commutation, to reduce the conduction period and so the average value of the current.
3) If the output to the load from the SCR circuit is alternating current, LC resonance provides over-current protection as well as filtering.
Q9: Circuit details of subber circuit?
A9: Snubber circuit contains capacitor and resistance is connected in series and this snubber circuit connects to the SCR in parallel. This capacitor is charged by the extra voltage, which is exceeding by the limiting value.
Q10: Working of snubber circuit?
A10: SCR can be protected against over voltage by employing shunt connected snubber circuit. Such protective circuits register a fall in resistance with the increase in voltage and so develop a virtual short-circuit across the SCR when a high voltage is applied.

Title of the Practical: Study of SCR commutating circuits

Q1: What are the different modes of operation of SCR?
A1: Three modes 1) reverse blocking mode.2) forward blocking mode.3) forward conduction mode.
Q2: Can you explain each mode of operation?
A2: **Reverse blocking mode**: when anode is –ive w.r.t cathode small leakage current flow to SCR and it is in OFF state.
Forward blocking mode: when anode is +ive w.r.t. cathode and forward voltage is less than V_{BO} (break over voltage) small forward leakage current is flow to the SCR.and it is in OFF state s in OFF state.
Forward Conduction mode: when forward voltage reach to V_{BO} SCR is start to conduct (ON). The thyristor has been triggered into conduction and will remain conducting until the forward current drops below a threshold value known as the "holding current".
Q3: What is V_{BO}, holding current and latching current?
A3: **V_{BO}**: It is the maximum forward voltage that can be applied between anode and cathode, when gate is open. And beyond this voltage the SCR will turn ON.
Holding current (I_H): It is the minimum anode current, if anode current is reduced below the I_H, SCR will be turned OFF.
Latching current (I_L): It is the minimum anode current that SCR must attain during turn ON process to maintain conduction when gate signal is removed. $I_L > I_H$.
Q4: What is commutation?
A4: The process of turning off of a conducting thyrister is known as commutation. Once the thyrister is fired (turned on), the gate loses control over it, for turning off the thyrister we use some methods is called commutation methods. There are two ways to commutating a thyrister .1) By reducing anode current below the holding current is called current commutation.
2) By applying the large reverse voltage across the thyrister called the voltage commutation.
Q5: What is natural commutation and forced commutation?
A5: **Natural commutation**: When thyrister is turn off, due to the forward current going below the holding current it is said to be natural commutation. It works only in AC supply, in this type of commutation external commutation circuit is not required.
Forced commutation: When thyrister operate on a pure DC input voltage, their forward current cannot be reduced below holding current therefore thyrister must commutated forcibly by using additional commutation circuit ,it is called forced commutation .By this external circuit thyrister will turn off either bellowing anode current to holding current or applying reverse voltage to the thyrister.
Q6: Classification of forced commutation methods?
A6: The six distinct classes by which the SCR can be turned off are:
Class A: Self commutated by a resonating load
Class B: Self commutated by an L-C circuit
Class C: C or L-C switched by another load carrying SCR
Class D: C or L-C switched by an auxiliary SCR
Class E: An external pulse source for commutation
Class F: AC line commutation.
Q7: How can do natural commutation?
A7: When the anode current is reduced below the level of the holding current, the SCR turns off. However, it must be noted that rated anode current is usually larger than 1,000 times the holding value. Since the anode voltage remains positive with respect to the cathode in a dc circuit, the anode current can only be reduced by opening the line switch S, increasing the load impedance R_L or shunting part of the load current through a circuit parallel to the SCR, i.e. short-circuiting the device.
Q8: What is reverse-bias Turn-off?
A8: A reverse anode to cathode voltage (the cathode is positive with respect to the anode) will tend to interrupt the anode current. The voltage reverses every half cycle in an ac circuit; so that an SCR in the line would be reverse biased every negative cycle and would turn off. This is called phase commutation or ac line commutation. To create a reverse biased voltage across the SCR, which is in the line of a dc circuit, capacitors can be used. The method of discharging a capacitor in parallel with an SCR to turn-off the SCR is called forced commutation.
Q9: What is Gate Turn Off?
A9: In some specially designed SCRs the characteristics are such that a negative gate current increases the holding current so that it exceeds the load current and the device turns-off.
Q10: What s free-wheeling diode?
A10: The diode which is placed across the load to carry the load current, when the power semiconductor switch turns off. This is also referred to as a commutation diode since it assists in commutation, or turn-off, of the power switch.

Title of the Practical: Chopper circuit using SCR

Q1: What is chopper or DC to DC converter?
A1: One way to get a variable DC voltage is to use AC to DC converter (phase controlled rectifier) .An alternate way to get a variable DC voltage is to use a DC to DC converter, is also called chopper. Chopper circuits convert a fixed DC voltage at their input into variable DC voltage.
Q2: Difference between phase uncontrolled & phase controlled rectifier or AC to DC converter?
A2: In a rectifier circuit when we use diode, it gives the fixed DC output voltage, it is called uncontrolled rectifier. In place of diode if we use the thyrister, it gives the variable DC output voltage, it is called controlled rectifier. In controlled rectifier the o/p voltage is a function of firing angle (α) it means the voltage is vary according the value of 'α'.
Q3: What is firing angle (α) or delay angle?
A3: It is the value of "ωt" (ωt = α) at which instant a thyrister is turn on. Its value is varying from 0° to 180°. The delay between the start in conduction of a power semi-conductor and the instance when the supply voltage across it begins to go positive.
Q4: What is the 1- ϕ half wave and full wave controlled rectifier?
A4: In half wave controlled rectifiers can control the DC o/p power in only one half cycle of the input AC supply where as in full wave controlled rectifiers can control the DC o/p power in both the half cycles of the input AC supply. If input supply voltage is single phase so it is called 1- ϕ half wave and full wave controlled rectifiers. If input supply voltage is three phase so it is called 3- ϕ half wave and full wave controlled rectifiers.
Q5: Use of SCR?
A5: SCR can be used as follows:
1) SCR as static conductor. 2) SCR for power control. 3) SCRs for speed control dc motor. 4) SCR for over light detector. 5) Series static switch. 6) Variable resistance phase control. 7) Battery charging regulator. 8) Emergency light system. 9) Relay controls. 10) Motor control. 11) Inverters. 12) Heat control. 13) Chopper.
Q6: Which types of switching devices can use in chopper circuit?
A6: The chopper circuit can use any switching device like SCR, power BJT, Power MOSFET or IGBT. The chopper circuit using SCRs requires commutation circuits to turn off the SCR.Due to the switching action the voltage across the load is a rectangular waveform. By changing the on or off time it is possible to change the average dc voltage across the load.
Q7: The shape of output wave is depending upon?
A7: The shape of output wave depends on the type of load. For resistive load, the load current will have a rectangular shape and it will be in phase with the load voltage. The load current with the inductive load will be exponential in nature.
Q8: Classification of choppers?
A8: Basically, choppers are two types:
1) Step-down choppers: The load voltage can be controlled between 0 to V i.e. the output can at most be equal to the input.
2) Step-up choppers: The load voltage can be higher than the input dc voltage, V.
Q9: A step-up chopper has 'Vs' as the source voltage and 'α' as the duty cycle. The output voltage for this chopper is given by?
A9: The output voltage for this chopper is given by: - Vs/ (1- α)
Q10: Which one of the most suitable device for a D.C. to D.C. converter?
A10: One of the most suitable device for a D.C. to D.C. converter is GTO (Gate turn-off thyristor).

Title of the Practical: Study of Parallel inverter using two thyristors

Q1: What is inverter or DC to AC converter?
A1: Which device can convert DC power into AC power at desired voltage and frequency is called inverter.
Q2: Classification of inverter?
A2: Classification based on the power semiconductor device used:
1) Thyrister based inverter. 2) Transistor based inverter.3) MOSFET based inverter.4) IGBT based inverter.
Classification based on the configuration of the inverter:
1) Series inverter.2) Parallel inverter. 3) Bridge inverter.
Q3: What are the components of Parallel inverter?
A3: Center tapped transformer (due to this parallel inverter is also called a Center tapped inverter), two SCRs S1 and S2 are switched alternately, connect the I/P dc source, C is the commutation capacitor connected parallel with load (so it is called parallel inverter), L inductor.
Q4: What are the advantages of Parallel inverter?
A4:1) The load voltage waveform is not dependent on the load.
2) Only two SCRs are required as compared to at least four in bridge inverter.
3) It uses simple class C commutation.
4) It is simple and economical circuit.
5) Distortion in the output is low.
Q5: What are the disadvantages of Parallel inverter?
A5:1) The centre tapped output transformer is essential for the operation of the circuit. The transformer efficiency will not be 100% hence the efficiency of this type of inverter will be reduced.
2) There is always a possibility of magnetic saturation of the core.
3) This circuit is suitable to handle only fixed load.
Q6: What is the type of output waveform of Parallel inverter?
A6: The type of output waveform of parallel inverter is square in shape and it is independent of load.
Q7: Inverters designed from BJT are preferable used in saturation region than active region, why?
A7: Inverters designed from BJT are preferable used in saturation region than active region because of high efficiency and high power output.
Q8: Application of inverter?
A8: Inverter is very popular in all industrial applications and is therefore very widely used for variable speed drives; it is used in UPS, induction heating, etc.
Q8: Explain Uninterruptible power supply?
A8: An uninterruptible power supply (UPS) takes its power from two or more sources simultaneously. It is usually powered directly from the AC mains, while simultaneously charging a storage battery. Should there be a dropout or failure of the mains, the battery instantly takes over so that the load never experiences an interruption. Such a scheme can supply power as long as the battery charge suffices, e.g., in a computer installation, giving the operator sufficient time to effect an orderly system shutdown without loss of data.
Q10: What is Mc Murray inverter?
A10: The auxiliary impulse commutated inverter (also popularly known as Mc Murray inverter) this one of the circuit techniques that is used to generate the pulse width Modulated (PWM) voltage. The main objective to use this circuit as a full bridge is to generate a quasi square or stepped load voltage wave, rather than square wave

Title of the Practical: Study of Cycloconverter circuit using thyristors

Q1: What do you mean by cycloconverter or AC to AC converter?
A1: A cycloconverter an AC waveform, such as the mains supply, to another AC waveform of other frequency. The word "cyclo" means frequency, so it is basically a frequency changer circuit.
Q2: What are the types of cycloconverter?
A2: A device which converts input power at one frequency to output power at a different frequency with one stage conversion is called cycloconverter. Basically, cycloconverters are two types:
1) Step-down cycloconverter.
2) Step-up cycloconverter.
Q3: What is Step-down and Step-up cycloconverter?
A3: In step-down cycloconverters, the output frequency f_o is lower than the supply frequency f_S , i.e. $f_o < f_S$
In Step-up cycloconverter, the output frequency f_o is higher than the supply frequency f_S, i.e. $f_o > f_S$
Q4: Explain the cycloconverter?
A4: They are most commonly used in three phase applications. In most power systems, the amplitude and the frequency of input voltage to a cycloconverter tend to be fixed values, whereas both the amplitude and the frequency of output voltage of a cycloconverter tend to be variable. The output frequency of a three-phase cycloconverter must be less than about one-third to one-half the input frequency.
Q5: Application of cycloconverter?
A5: A typical application of a cycloconverter is for use in controlling the speed of an AC traction motor and in starting of a synchronous motor. Most of these cycloconverters have a high power output – on the order of a few megawatts – and silicon-controlled rectifiers (SCRs) are used in these circuits. By contrast, low cost, low-power cycloconverters for low-power AC motors are also in use, and many such circuits tend to use TRIACs in place of SCRs. It may be noted that the use of a cycloconverter is not as common as that of an inverter and a cycloinverter is rarely used. However, it is common in very high power applications.
Q6: What is Tap converter?
A6: A dramatically improved output waveform can be achieved by employing the circuit known as the tap converter, The tap converter utilizes a Scott transformer connection and somewhat more sophisticated control logic (adding several more SCRs) to switch among a variety of transformer taps and thereby fabricate a far smoother signal.
Q7: What are the Advantages of cycloconverter?
A7:1) As it is ac to ac converter no dc link is required to be as in case of the inverter.
2) The power flow is bidirectional, from source to load or vice-versa.
3) It is possible to obtain a high quality sine wave at very low frequency.
4) Since the SCRs are self commutated, separate commutation circuits are not required.
Q8: What are the Disadvantages of cycloconverter?
A8: 1) It is possible to change the output frequency in steps; smooth stepless control of output frequency is not possible.
2) Waveform distortion may creep in at low operating frequencies.
3) Control circuit is very complex and difficult to design.
Q9: In a step-down cycloconverter commutation required is?
A9: In a step-down cycloconverter commutation required is natural commutation.
Q10: How to improve the quality of the output of cycloconverter?
A10: The quality of the output waveform improves if more switching devices are used.

Title of the Practical: Study of time delay relay circuit using UJT and thyristor

Q1: What is time delay circuit?
A1: The Time Delay circuit is directly connected to the AC lines to derive power to the components. Resistor R1 drops AC voltage and D1 rectifies the same to give low volt DC. The high value capacitor C1 act as a smoothing capacitor as well as the time delay device. That is the SCR conducts only after C1 is fully charged. It takes around 2 minutes. When C1 charges fully gate of SCR gets firing pulse and it conducts. This charges C2 which also give another one minute to fire the Triac trough R3. When the triac conducts, AC load gets electrical continuity and turns on. Capacitor C3 keeps the voltage level at the gate of triac and eliminates the back lash effect.
Q2: Explain Objective of this experiment?
A2: To construct time delay circuit using SCR triggered by UJT. To build relaxation oscillator using UJT and the timing can be varied by different capacitors and potentiometer. The pulses generated by UJT should be given to gate for triggering. The SCR can be turned ON with reference to the input pulses.
Q3: What is Time-delay relays?
A3: Some relays are constructed with a kind of "shock absorber" mechanism attached to the armature which prevents immediate, full motion when the coil is either energized or de-energized. This addition gives the relay the property of time-delay actuation..
Q4: Basic types of time-delay relay contacts?
A4: **Normally-open, timed-closed (NOTC) contact**: these relays open immediately upon coil de-energization and close only if the coil is continuously energized for the time duration period. Also called normally-open, on-delay relays.
Normally-open, timed-open (NOTO) contact: these relays close immediately upon coil energization and open after the coil has been de-energized for the time duration period. Also called normally-open, off delay relays.
Normally-closed, timed-open (NCTO) contact: these relays close immediately upon coil de-energization and open only if the coil is continuously energized for the time duration period. Also called normally-closed, on-delay relays.
Normally-closed, timed-closed (NCTC) contact: these relays open immediately upon coil energization and close after the coil has been de-energized for the time duration period. Also called normally-closed, off delay relays.
Q5: Application of time-delay relay?
A5: Time-delay relays are very important for use in industrial control logic circuits. Some examples of their use include:
1) Flashing light control (time on, time off)
2) Engine auto start control
3) Furnace safety purge control
4) Conveyor belt sequence delay
Q6: What are mechanical time-delay relays?
A6: mechanical time-delay relays used pneumatic dashpots or fluid-filled piston/cylinder arrangements to provide the "shock absorbing" needed to delay the motion of the armature.
Q7: What are electronic-timer relays?
A7: Newer designs of time-delay relays use electronic circuits with resistor-capacitor (RC) networks to generate a time delay, and then energize a normal (instantaneous) electromechanical relay coil with the electronic circuit's output. The electronic-timer relays are more versatile than the older, mechanical models.
Q8: Explain the time delay relay construction?
A8: Time-delay relays can be constructed to delay armature motion on coil energization, de-energization, or both. Time-delay relay contacts must be specified not only as either normally-open or normally-closed, but whether the delay operates in the direction of closing or in the direction of opening.
Q9: Can you explain one of the applications of time-delay relays?
A9: Flashing light control (time on, time off): two time-delay relays are used in conjunction with one another to provide a constant-frequency on/off pulsing of contacts for sending intermittent power to a lamp.
Q10: What is motor soft-start delay control?
A10: Motor soft-start delay control: Instead of starting large electric motors by switching full power from a dead stop condition, reduced voltage can be switched for a "softer" start and less inrush current. After a prescribed time delay (provided by a time-delay relay), full power is applied.