POWER ELECTRONICS AND SIMULATION LAB

B.Tech III Year – II SEM

NAME: _____

ROLL NO: _____

BRANCH: _____

DEPARTMENT OF

ELECTRICAL AND ELECTRONICS ENGINEERING

Aurora's Technological and Research Institute

Parvathapur, Uppal, Hyderabad-500 039**.**

LABORATORY PRACTICE

I HEAR, I FORGET

I SEE, I REMEMBER

I DO, I UNDERSTAND

**PRACTCAL APPROACH IS PROBABLY THE BEST
APPROACH TO GAIN A CLEAR INSIGHT**

CODE OF CONDUCT FOR THE LABORATORIES

- ❖ All students must observe the Dress Code while in the laboratory.

- ❖ Sandals or open-toed shoes are NOT allowed.

- ❖ Foods, drinks and smoking are NOT allowed.

- ❖ All bags must be left at the indicated place.

- ❖ The lab timetable must be strictly followed.

- ❖ Be PUNCTUAL for your laboratory session.

- ❖ Experiment must be completed within the given time.

- ❖ Noise must be kept to a minimum.

- ❖ Workspace must be kept clean and tidy at all time.

- ❖ Handle all apparatus with care.

- ❖ All students are liable for any damage to equipment due to their own negligence.

- ❖ All equipment, apparatus, tools and components must be RETURNED to their original place after use.

- ❖ Students are strictly PROHIBITED from taking out any items from the laboratory.

- ❖ Students are NOT allowed to work alone in the laboratory without the Lab Supervisor

- ❖ Report immediately to the Lab Supervisor if any injury occurred.

- ❖ Report immediately to the Lab Supervisor any damages to equipment.

Before leaving the lab

- ❖ Place the stools under the lab bench.

- ❖ Turn off the power to all instruments.

- ❖ Turn off the main power switch to the lab bench.

- ❖ Please check the laboratory notice board regularly for updates

GENERAL LABORATORY INSTRUCTIONS

➢ You should be punctual for your laboratory session and should not leave the lab without the permission of the teacher.

➢ Each student is expected to have his/her own lab book where they will take notes on the experiments as they are completed.

➢ The lab books will be checked at the end of each lab session. Lab notes are a primary source from which you will write your lab reports.

➢ You and your batch mates will work closely on the experiments together. One partner doing all the work will not be tolerated. All the Batch mates should be able to explain the purpose of the experiment and the underlying concepts.

➢ Please report immediately to the member of staff or lab assistant present in the laboratory; if any equipment is faulty.

Organization of the Laboratory

➢ It is important that the experiments are done according to the timetable and completed within the scheduled time.

➢ You should complete the prelab work in advance and utilize the laboratory time for verification only.

➢ The aim of these exercises is to develop your ability to understand, analyze and test them in the laboratory.

➢ A member of staff and a Lab assistant will be available during scheduled laboratory sessions to provide assistance.

➢ Always attempt experiments; first without seeking help.

➢ When you get into difficulty; ask for assistance.

Assessment

➢ The laboratory work of a student will be evaluated continuously during the semester for 25 marks. Of the 25 marks, 15 marks will be awarded for day-to-day work.

➢ For each experiment marks are awarded under three heads:
_ Prelab preparation – 5 marks
_ Practical work – 5marks, and
_ Record of the Experiment – 5marks

➢ Internal lab test(s) conducted during the semester carries 10 marks.

➢ End semester lab examination, conducted as per the JNTU regulations, carries 50 marks.

➢ At the end of each laboratory session you must obtain the signature of the teacher along with the marks for the session out of 10 on the lab notebook.

Lab Reports

➢ Note that, although students are encouraged to collaborate during lab, each must individually prepare a report and submit.

- ➢ They must be organized, neat and legible.
- ➢ Your report should be complete, thorough, understandable and literate.
- ➢ You should include a well-drawn and labeled engineering schematic for each circuit
- ➢ Investigated.
- ➢ Your reports should follow the prescribed format, to give your report structure and to make sure that you address all of the important points.
- ➢ Graphics requiring- drawn straight lines should be done with a straight edge. Well drawn freehand sketches are permissible for schematics.
- ➢ Space must be provided in the flow of your discussion for any tables or figures. Do not collect figures and drawings in a single appendix at the end of the report.
- ➢ Reports should be submitted within one week after completing a scheduled lab session.

Presentation

- ➢ Experimental facts should always be given in the past tense.
- ➢ Discussions or remarks about the presentation of data should mainly be in the present tense.
- ➢ Discussion of results can be in both the present and past tenses, shifting back and forth from experimental facts to the presentation.
- ➢ Any specific conclusions or deductions should be expressed in the past tense.

Report Format

Lab write ups should consist of the following sections:

- ➢ **Aim**: A concise statement describing the experiment and the results. This is usually not more than 3 sentences. Since the abstract is a summary of what you have done, it's a good idea to write this last.
- ➢ **Apparatus**: Describe what equipment and components you used to conduct the experiment.
- ➢ **Theory**: Several paragraphs that explain the motivation of the experiment. Usually in this statement you state what you intent to accomplish as well as the expected results of the experiment.
- ➢ **Procedure**: Describe how you conducted the experiment
- ➢ **Results and Analysis**: This is the main body of the report. Graphs, tables, schematics, diagrams should all be included and explained. Results of any calculations should be explained and shown. State the results of the experiment. Include any problems encountered.
- ➢ **Conclusion**: Explain how the experiment went, and whether you were able to achieve the expected results stated in the introduction.

Name of the student: _____

Roll Number: _____

INDEX

Circuit Diagram :

MODEL GRAPH:

1. a) STUDY OF CHARACTERISTICS OF SCR

Aim: To obtain and study the V-I characteristics of SCR and to obtain the values of Latching and Holding currents.

Apparatus:

S.No	Equipment	Range	Type	Qty
1	PE Trainer Kit		-	01
2	Ammeter	(0 – 2)A	DC	01
3	Ammeter	(0 – 200)A	DC	01
4	Voltmeter	(0 – 600) V	DC	01
5	Lamp Load			01
6	Power Oscilloscope			01

Theory:

When Anode is positive with respect to the cathode, SCR is said to be forward biased. Whenever the applied voltage becomes more than the Forward Breakover Voltage(V_{BO}), SCR starts conducting. By giving a suitable triggering pulse to the gate, the SCR can be made to conduct at a lower anode to cathode voltage. When the SCR is reverse biased it acts as an open circuit upto Reverse Breakdown voltage after which the SCR breaks down.

Latching current is the minimum value of anode current which it must attain during turn-on process to maintain conduction when gate signal is removed. Holding current is defined as the minimum value of anode current below which SCR turns off.

OBSERVATIONS & TABULAR COLUMN:

| S No	Ig = μ A		Ig = μ A		Ig = μ A	
	Va (V)	Ia (A)	Va (V)	Ia (A)	Va (V)	Ia (A)

PROCEDURE:

1) Connect the circuit as per the circuit diagram. Make sure that the voltage knobs of the power supply are in the minimum position.

2) Switch ON the power supply.

3) Keep the gate voltage in the zero voltage position.

4) Gradually increase the anode voltage from 0V to 200V.

5) Observe and note down the anode current and voltage across the SCR for each value of anode voltage.

6) Increase the gate voltage to a higher value, say 2.1V & repeat steps (4) & (5).

7) Repeat steps (4) & (5) for a higher value of gate voltage.

8) For a particular value of gate current reduce the anode voltage. Note down the value of current at which the SCR turns OFF as Holding current.

9) Keep the gate voltage at a particular value .Turn ON the SCR .Reduce the gate current in steps and note down the value of current at which SCR remains ON even when the gate current is reduced to zero as Latching current.

10) Bring the voltage knobs to the initial position and switch off the supply.

11) Draw the graph between anode to cathode voltage and current.

Result:

Reasoning Questions:

1) Explain V-I characteristics of SCR?
2) What are Latching current and Holding current?
3) Define V_{BO} & V_{BR}? Which has a grater value and why?
4) Why is Latching current greater than Holding current?
5) What is the effect of increasing gate current in the turning on of SCR?

CIRCUIT DIAGRAM:-

MODEL GRAPH:

Output characteristics
of a power MOSFET.
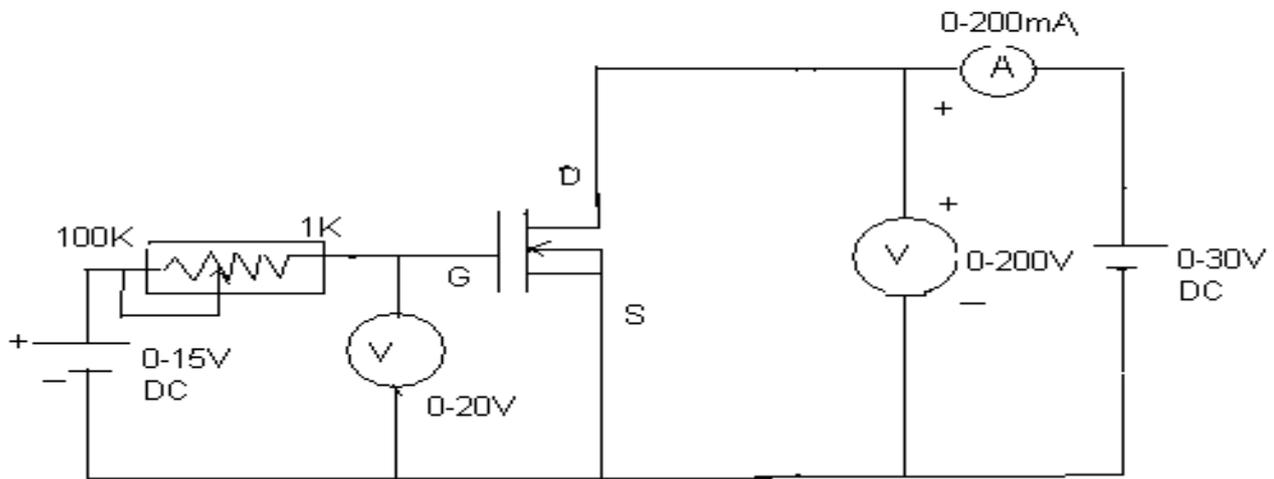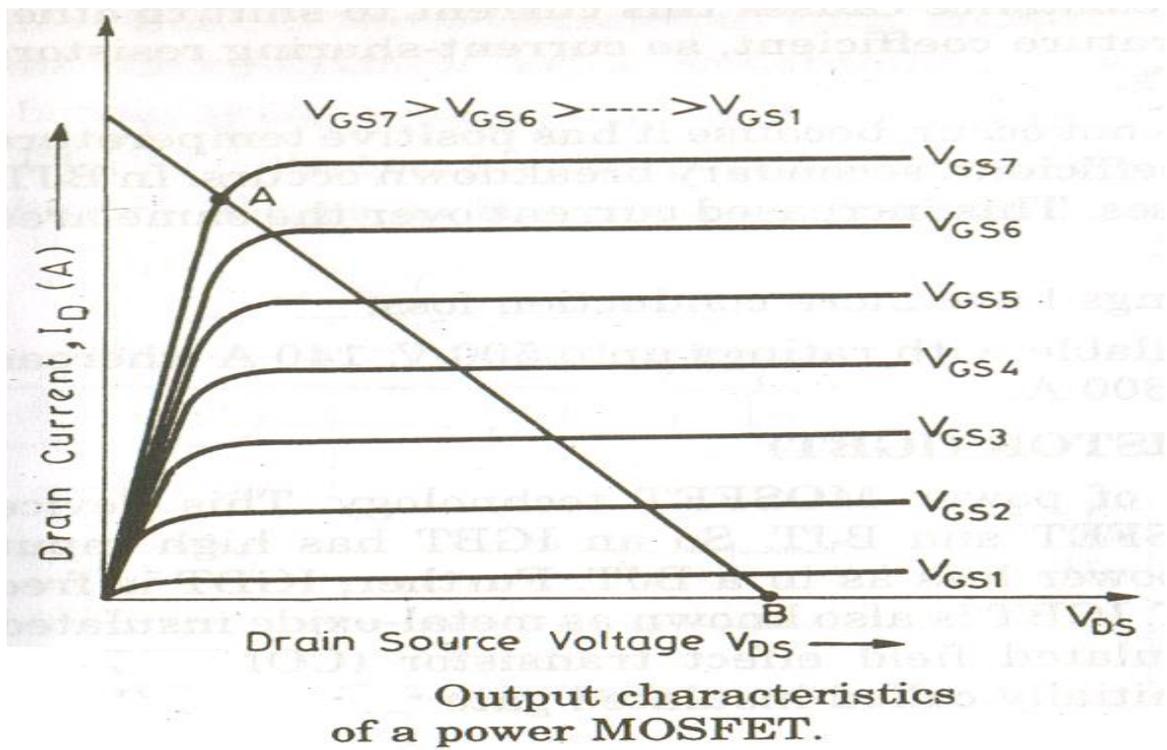
B) STUDY OF CHARACTERISTICS OF MOSFET

AIM: To obtain and study the V-I characteristics of MOSFET

Apparatus:

S.No	Equipment	Range	Type	Qty
1	PE Trainer Kit		-	01
2	Ammeter	(0 – 2)A	DC	01
3	Ammeter	(0 – 200)A	DC	01
4	Voltmeter	(0 – 600) V	DC	01
5	Lamp Load			01
6	Power Oscilloscope			01

THEORY:

A Metal Oxide Semiconductor Field Effect Transistor is a recent device developed by combining the areas of Field-effect concept and MOS Technology. A MOSFET is a voltage controlled device. When gate circuit is open, no current flows from drain to source and load. When gate is made positive with respect to source, an electric field is established and current can flow from drain to source. If V_{GS} is made more positive more current flows from drain to source which shows that drain current I_D is enhanced by the gradual increase of gate voltage.

PROCEDURE:(Output characteristics)

1) Connect the circuit as per the circuit diagram. Make sure that the voltage knobs of the power supply are in the minimum position.
2) Switch ON the power supply.
3) Keep the gate to source voltage (V_{GS}) at zero value.
4) Change the value of Drain to source voltage (V_{DS}) from zero to maximum value, ands for each value of V_{DS} ,note down the value of I_D.
5) Adjust V_{GS} to a higher value(say 3V) and repeat step(4).
6) Repeat step (5) for different values of V_{GS}.
7) Bring the voltage knobs to the initial position and switch off the supply.
8) Draw the output characteristics of MOSFET.

OBSERVATIONS & TABULAR COLUMN:

output characteristics:

S No	V$_{GS}$ = (V)		V$_{GS}$ = (V)		V$_{GS}$ = (V)	
	I$_D$ (A)	V$_{DS}$ (V)	I$_D$ (A)	V$_{DS}$ (V)	I$_D$ (A)	V$_{DS}$ (V)

Transfer characteristics

| S No	V$_{DS}$ = (V)		V$_{DS}$ = (V)		V$_{DS}$ = (V)	
	I$_D$ (A)	V$_{GS}$ (V)	I$_D$ (A)	V$_{GS}$ (V)	I$_D$ (A)	V$_{GS}$ (V)

Transfer characteristics:

PROCEDURE   (Transfer characteristics)

1) Connect the circuit as per the circuit diagram. Make sure that the voltage knobs of the power supply are in the minimum position.

2) Switch ON the power supply.

3) Keep the gate to source voltage (V_{DS}) at zero value.

4) Change the value of gate to source voltage (V_{GS}) from zero to maximum value, ands for each value of V_{GS} ,note down the value of I_D.

5) Adjust V_{DS} to a higher value(say 3V) and repeat step(4).

6) Repeat step (5) for different values of V_{DS}.

7) Bring the voltage knobs to the initial position and switch off the supply.

8) Draw the transfer characteristics of MOSFET.

Result:

Reasoning Questions:

1) What is MOSFET?
2) What are the advantages of MOSFET over SCR?
3) Explain the characteristics of MOSFET?
4) Why is MOSFET able to give a very high gain ?
5) What is the symbol of a MOSFET? Why , usually a diode is shown connected across the terminals of MOSFET?

Circuit Diagram:
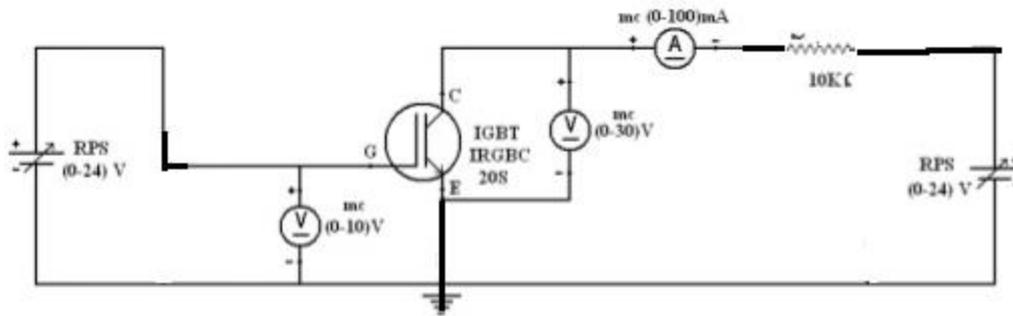
Output characteristics

MODEL GRAPH:
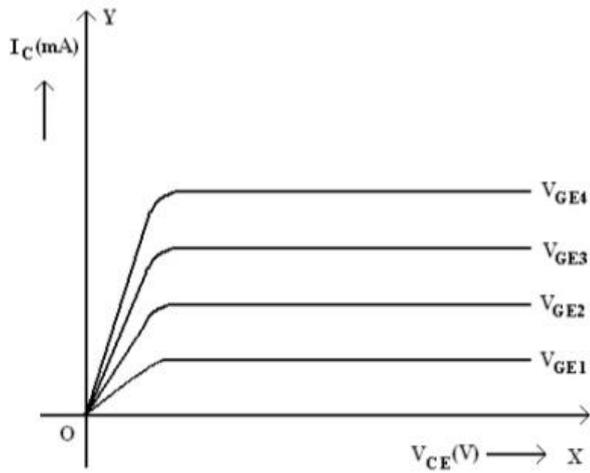
Transfer characteristics:
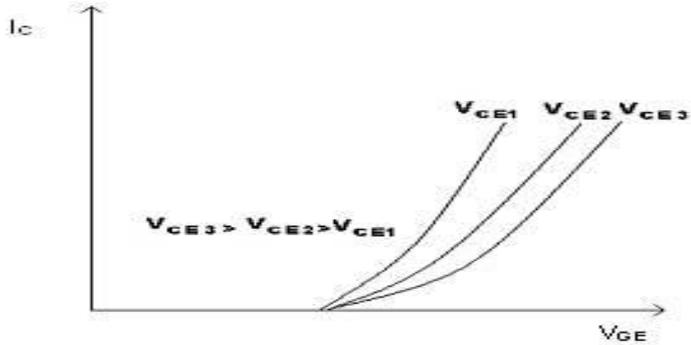
C) STUDY OF CHARACTERISTICS OF IGBT

AIM:

To study the output or collector characteristics and transfer characteristics of IGBT.

EQUIPMENT REQUIRED:

1. IGBT characteristics circuit Trainer
2. Ammeters   :   0-500mA
3. Voltmeters   :   0-50V,0-20V.
4. Patch Chords

PROCEDURE:

Transfer Characteristics:

1. Make connections as per circuit Diagram.
2. Initially keep all the controls in minimum position value.
3. By varying V2 keep Vce constant (say 3V,5V), now by varying V1 take the values of Ic and Vge.
4. Plot the graph between Ic and Vge for every value of Vce.

OBSERVATIONS & TABULAR COLUMN:

Transfer Characteristics:

S No	V_{ce} = (V)		V_{ce} = (V)		V_{ce} = (V)	
	I_c (A)	V_{Ge} (V)	I_c (A)	V_{Ge} (V)	I_c (A)	V_{Ge} (V)

OBSERVATIONS & TABULAR COLUMN

Collector Characteristics:

S No	V_{Ge} = (V)		V_{Ge} = (V)		V_{Ge} = (V)	
	I_C (A)	V_{Ce} (V)	I_C (A)	V_{Ce} (V)	I_C (A)	V_{Ce} (V)

<u>Procedure for collector characteristics:</u>

1. Initially keep all the controls in minimum position value.
2. Initially adjust Vce to some constant value say 5V by varying V1.
3. Vary V1 and note down the values of Ic and Vce
4. Plot the characteristics between Ic and Vce.

<u>Result:</u>

CIRCUIT DIAGRAM:

(1) R- Triggering
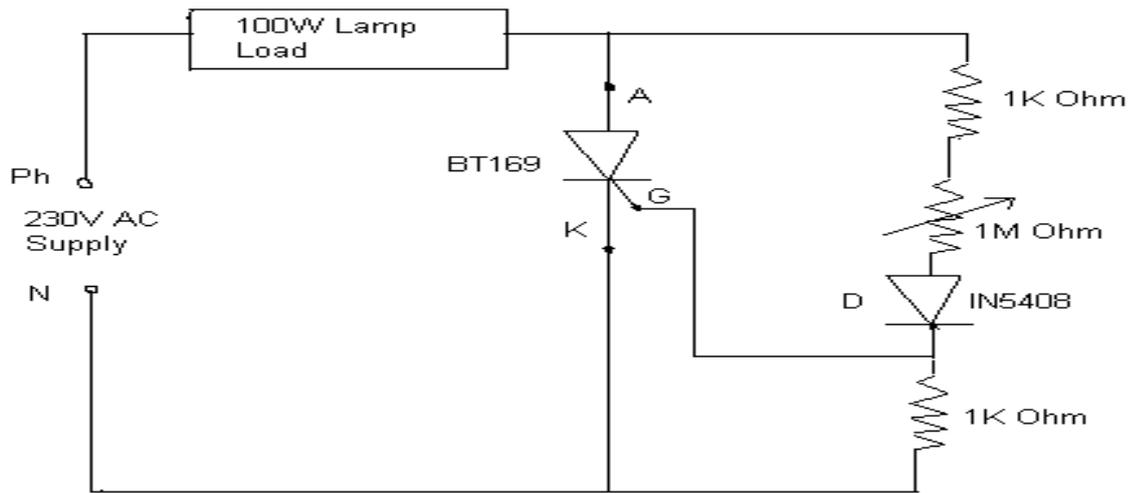
(ii) RC- Triggering
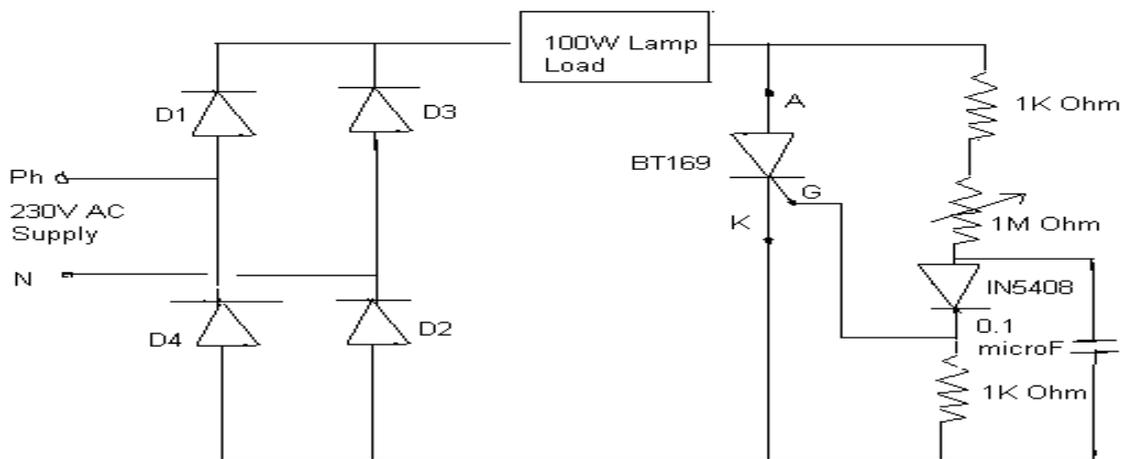
(iii) UJT Triggering
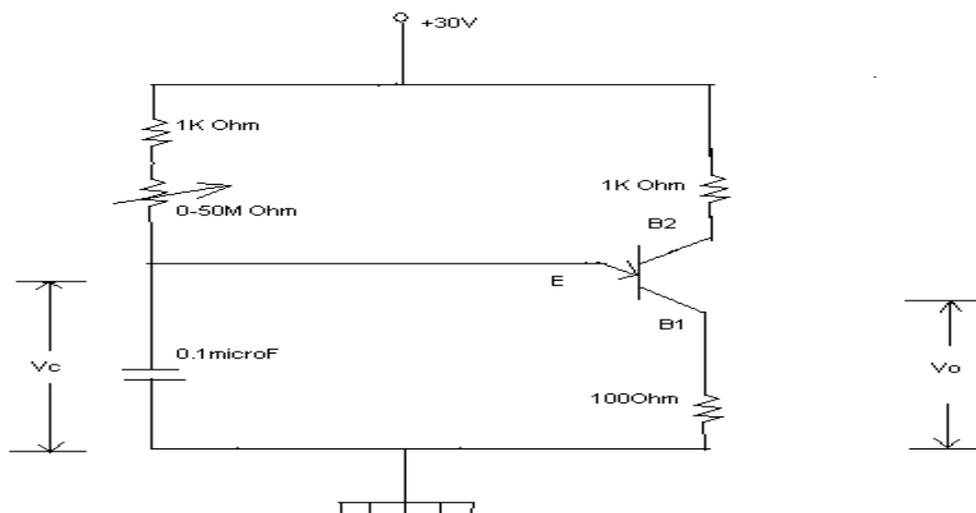
2. GATE FIRING CIRCUITS

AIM: To learn about different firing circuits (R,RC & UJT) used for triggering SCRs..

Apparatus:

S.No	Equipment	Range	Type	Qty
1	PE Trainer Kit		-	01
2	Multimeter		Digital	01
3	Lamp Load			01
4	Power Oscilloscope			01

THEORY:

There are different methods for triggering an SCR. The most commonly used method is gate triggering. By applying a positive signal at the gate terminal of the SCR, it can be triggered much before the specified break over voltage. The gate triggering is of different types:

R-Triggering: Here the gate current is supplied by an ac source through a fixed resistance, variable resistance and a diode. During the positive half cycle of the input ac voltage, SCR becomes forward biased. Gate current increases as the input increases towards peak value. When I_g reaches a value equal to the minimum current required for turning ON the SCR, it turns on. By varying the variable resistance connected in the gate circuit, the firing angle can be varied. Limitation of this method is that firing angle can be varied only up to 90^0.

RC Triggering: Using this circuit, a larger variation in firing angle can be obtained by changing the phase and amplitude of the gate current. By varying the variable resistor, the firing angle can be controlled from 0 to 180^0. In the negative half cycle, the capacitor charges through diode D2 with lower plate positive to the peak supply voltage. The capacitor voltage remains constant at $-E_{max}$ until the supply voltage attains zero value. Now, as the SCR anode voltage passes through zero and becomes positive, capacitor begins to discharge and charge in the opposite direction. When the capacitor charges to positive voltage equal to gate trigger voltage V_{gt}, SCR is triggered, and after this capacitor holds to V_{gt} . During the negative half cycle, diode D1 prevents the turning on of the SCR.

OBSERVATIONS & TABULAR COLUMN:

For R-Triggering

| S no.	Firing angle, a (degrees)	Average Voltage (Voltmeter reading)

For RC -Triggering

S no.	Firing angle, a (degrees)	Average Voltage (Voltmeter reading)

For UJT-Triggering

| S no.	Firing angle, a (degrees)	Discharge Time constant, msec

MODEL GRAPH
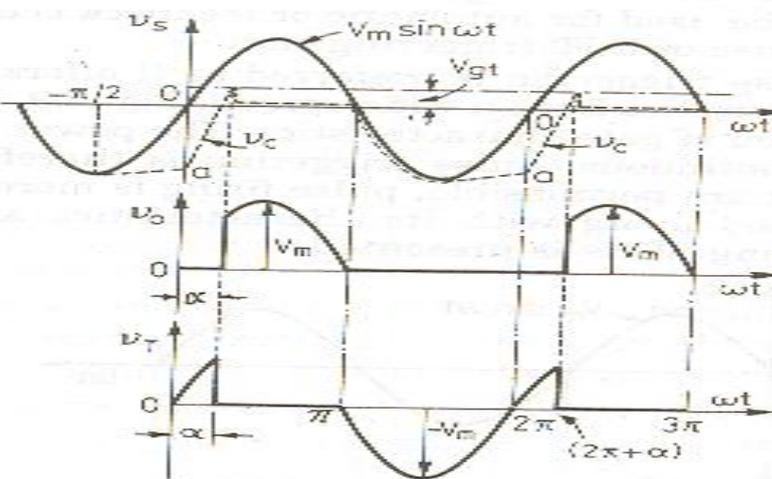
UJT Triggering: UJT is often used as a triggering device for SCRs and TRIACs. Here, UJT is used as a relaxation oscillator. The capacitor gets charged, when the supply is ON. When the capacitor voltage becomes equal to the peak voltage, UJT turns on. The capacitor discharges through the low resistance path containing R_{B1} and R_1. The pulses produced by the quick discharge of the capacitor is applied across the gate-cathode region of the SCR, to make it turn-on. By varying the resistance Rc, the charging of the capacitor can be varied, which in turn will vary the time at which UJT turns on and which will vary the firing angle.

PROCEDURE:
1) Make connections as per the circuit diagram (1).
2) Switch on the supply.
3) Observe the output waveform in the CRO.
4) Vary the firing angle. Observe the change in the waveform.
5) Note down the firing angle and corresponding voltage from the multimeter.
6) Switch off the supply.
7) Make connections as per the circuit diagram (2).
8) Repeat the steps (2) to (5).
9) Make connections as per the circuit diagram (3).
10) Repeat the steps (2) to (5).
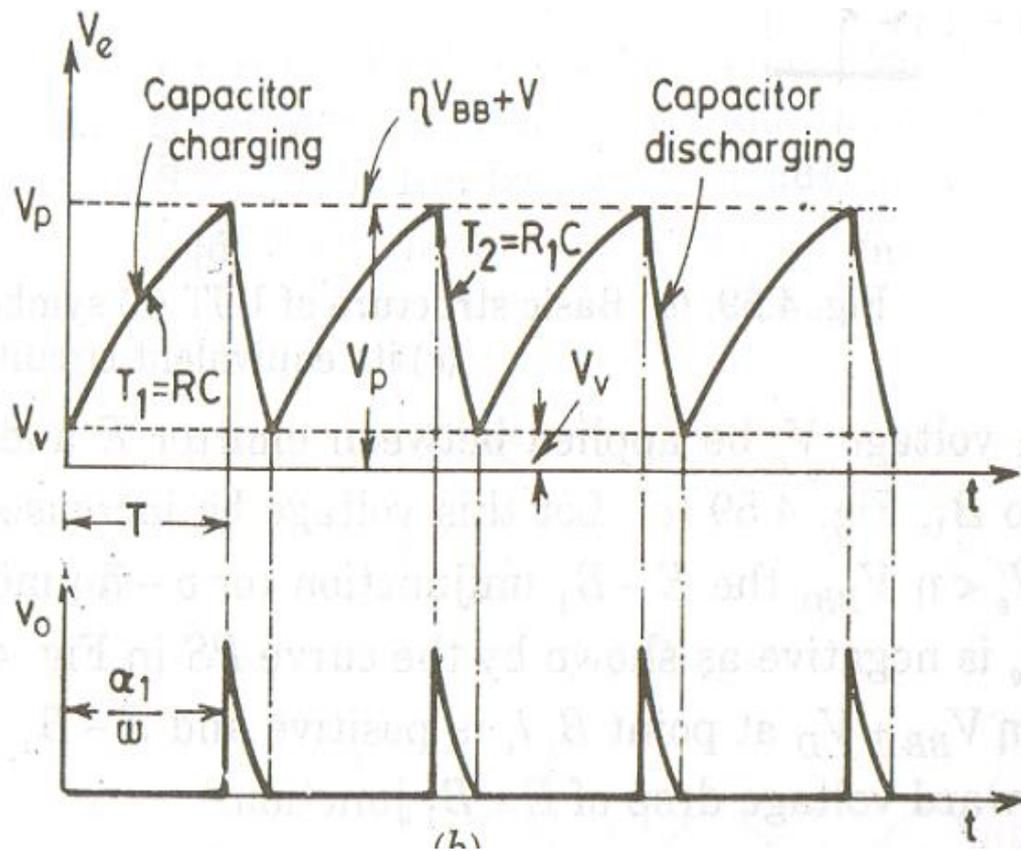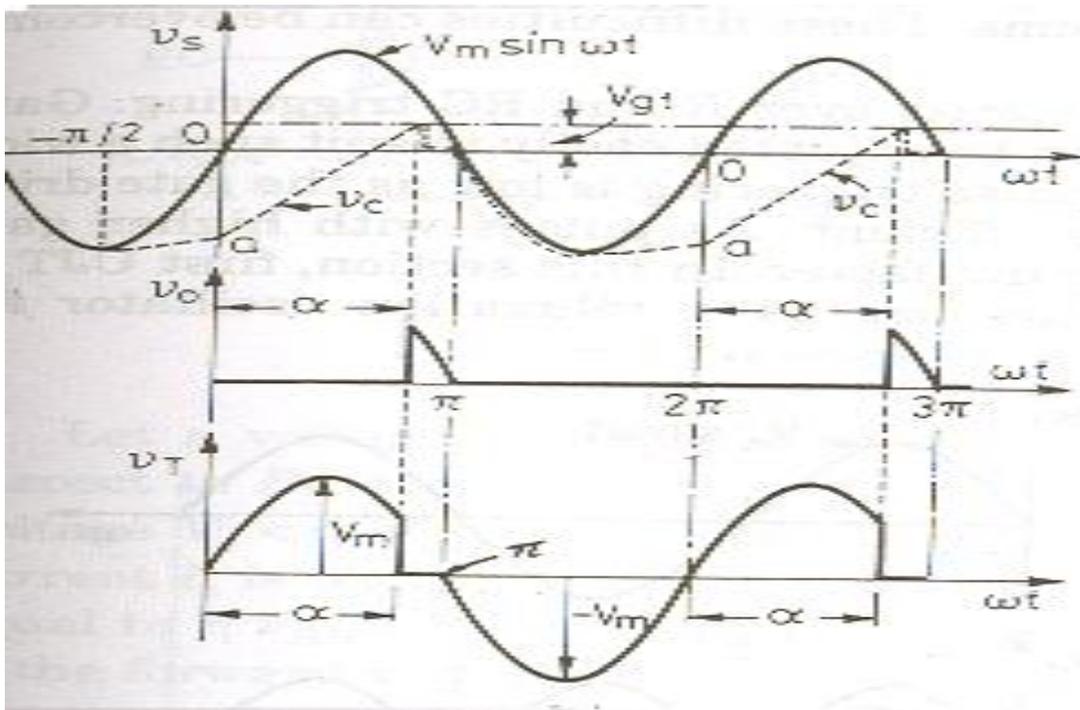
Result:

Reasoning Questions:

1) Explain R,RC and UJT triggering? Which is the most effective?

2) What is the maximum possible firing angle in R-Triggering?

3) How the triggering pulses are generated in UJT triggering?

4) How to change the triggering instants in UJT triggering?

5) Explain the waveforms?

CIRCUIT DIAGRAM:
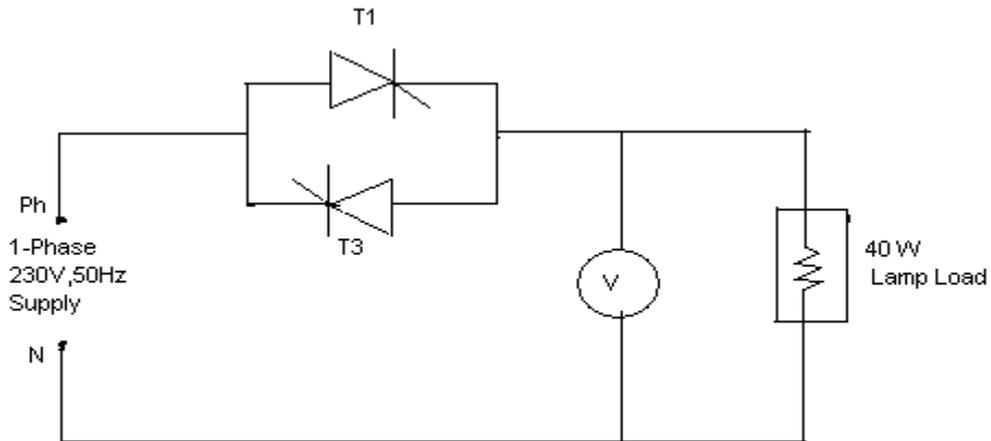
OBSERVATIONS AND TABULAR COLUMN:

Firing Angle , a	Measured value of Output voltage (volt)	Calculated value of Output voltage (volt)

Sample Calculation:

3. AC VOLTAGE CONTROLLER

AIM: To study the operation and observe the waveforms of an A.C. Voltage controller with R & RL load.

Apparatus:

| S.No	Equipment	Range	Type	Qty
1	PE Trainer Kit		-	01
2	Multimeter		Digital	01
3	Lamp Load			01
4	Power Oscilloscope			01

THEORY:

Ac Voltage controllers are thyristor based devices which convert fixed alternating voltage directly to variable alternating voltage without a change in frequency. A.C voltage controller uses two thyristors connected in antiparallel. Thyristor T1 is forward biased during the positive half cycle of the input voltage. When T1 is triggered at a firing angle a, it starts conducting. During the conduction period of the SCR (from a to π for R load and from a to (π + a) for RL load) output voltage follows the input voltage.

During the negative half of input voltage T1 is reverse biased and is OFF and T2 is forward biased and it starts conducting from (π+a). Output voltage follows the input voltage . By changing the firing angle, output voltage can be controlled.

PROCEDURE:

1) Make connections as per the circuit diagram. Use 100W / 230V lamp as the load.

2) Keep the firing pulse selector switch in the 4th position (UJT relaxation oscillator based firing) to get the required gate pulses.

3) Switch on the supply.

4) Observe the output waveform in the powerscope. Vary the conduction angle and observe the change in the waveform. Note down the output voltage value from the multimeter.
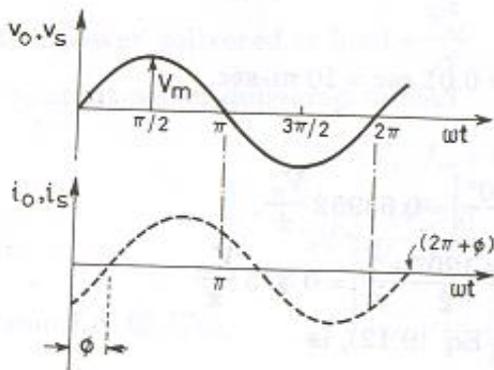
(c) $\alpha \le \phi$
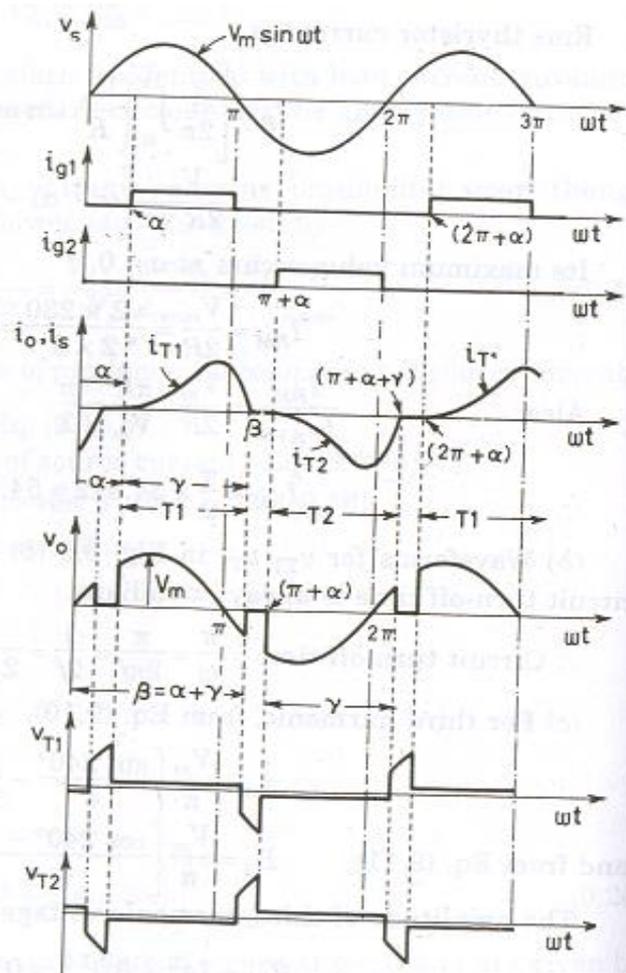
1ph AC voltage controller with RLload

Result:

Reasoning Questions:

1) Explain the working of AC Voltage controller?

2) Define Displacement angle, Displacement factor and distortion factor?

3) Displacement angle * Displacement factor = _____

4) Explain the waveforms with R & RL load?

5) With RL load, the firing angle should be always greater than power factor. Why? (What is the effect of power factor in the working of an AC voltage controller with RL load?)

CIRCUIT DIAGRAM:

MODEL GRAPH:

Waveforms for fully-controlled bridge with resistive-load
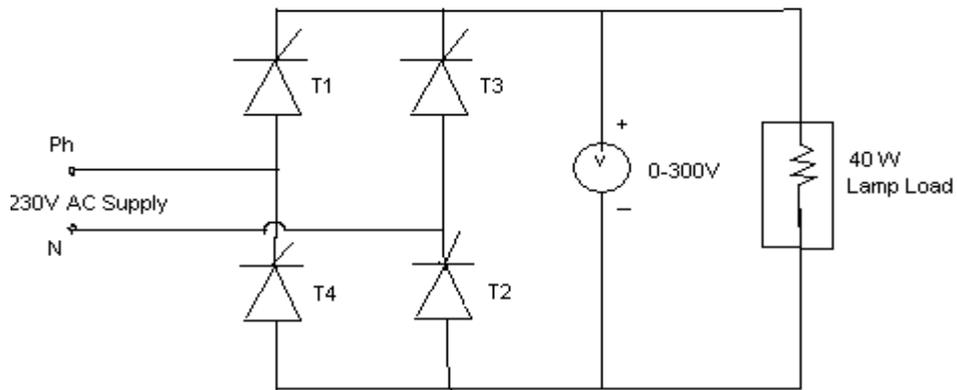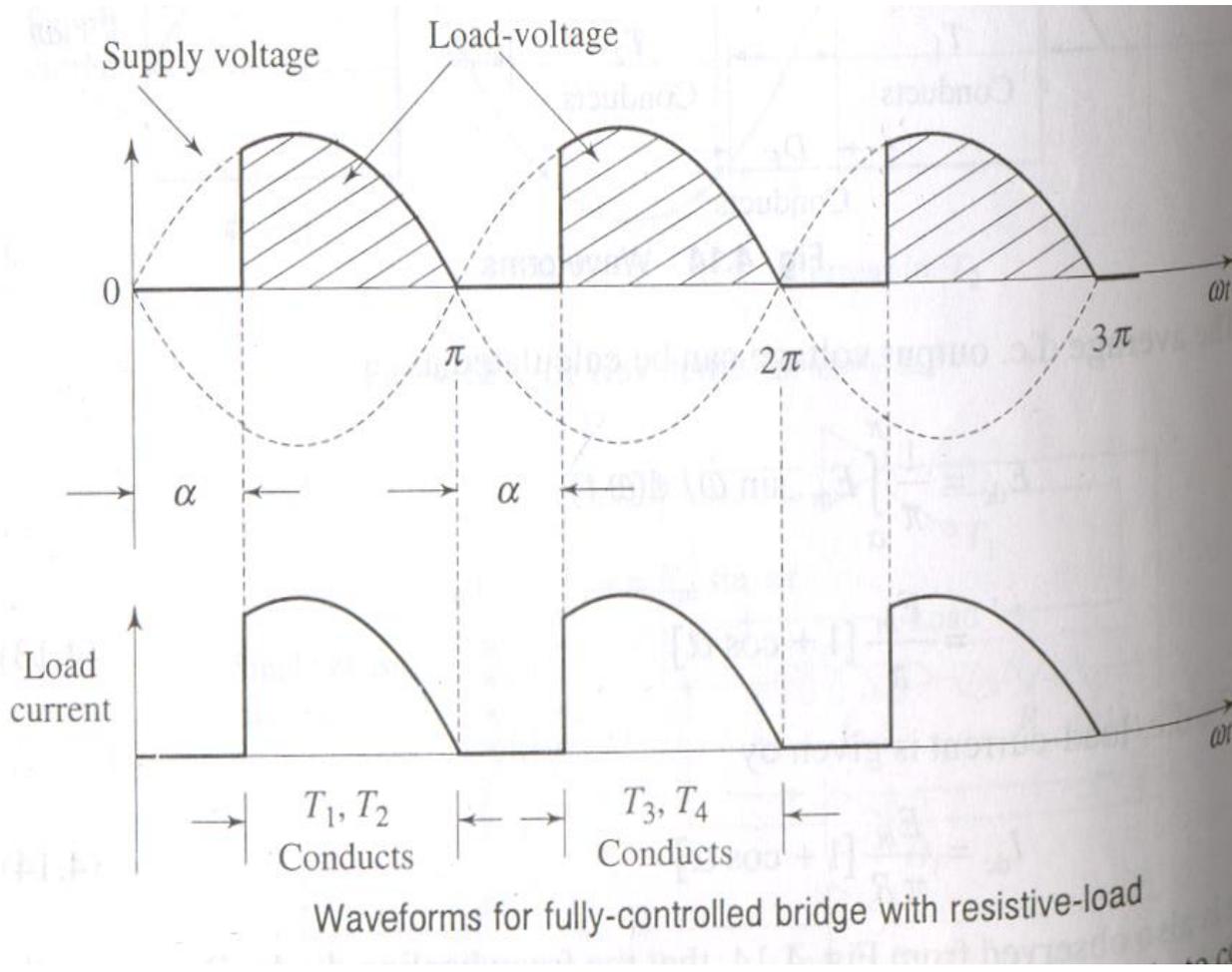
4. FULLY CONTROLLED CONVERTER

AIM: To study the operation of a fully controlled converter with R & RL loads.

Apparatus:

S.No	Equipment	Range	Type	Qty
1	PE Trainer Kit		-	01
2	Multimeter		Digital	01
3	Lamp Load			01
4	Power Oscilloscope			01

THEORY:

A fully controlled converter controls output voltage in both the half cycles of the input voltage. T1 & T2 are forward biased in the positive half cycle of the input voltage. When triggered at a firing angle a, T1 & T2 start conducting from a. Thus from a to π, output voltage follows positive half of the input voltage. From π to π+a, thyristors T1 & T2 are reverse biased and T3 & T4 are forward biased . At π+a, T3 & T4 are triggered. Current flows through the load in the same direction giving a positive value of output voltage. Thus unidirectional current flows through the load in both the half cycles of input AC. By controlling the value of a, we can control the output voltage.

PROCEDURE:

1) Make connections as per the circuit diagram. Use 100W / 230V lamp as the load.
2) Keep the firing pulse selector switch in the 4th position(UJT relaxation oscillator based firing) to get the required gate pulses.lp
3) Switch on the supply.
4) Observe the output waveform in the power scope. Vary the conduction angle and observe the change in the waveform. Note down the output voltage value from the multimeter and compare with the value obtained from the formula.

## OBSERVATIONS & TABULAR COLUMN:

Peak Voltage, Vm =

S no.	Firing angle, a (degrees)	Average voltage (as per formula)	Average Voltage (Voltmeter reading)

SAMPLE CALCULATION:

Result:

Reasoning Questions:

1) What are the different configurations for a Fully Controlled converter?
2) Explain the working of a Fully Controlled converter?
3) Explain the waveforms with R & RL loads?
4) What is the equation for average voltage in a Fully Controlled converter?
5) What are the applications of a Fully Controlled converter?

CIRCUIT DIAGRAM:

MODEL GRAPH:

Waveforms for -controlled bridge with resistive-load
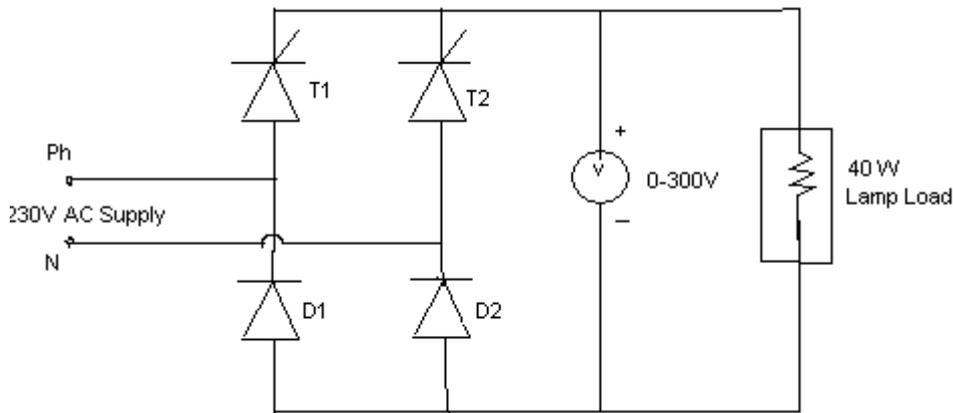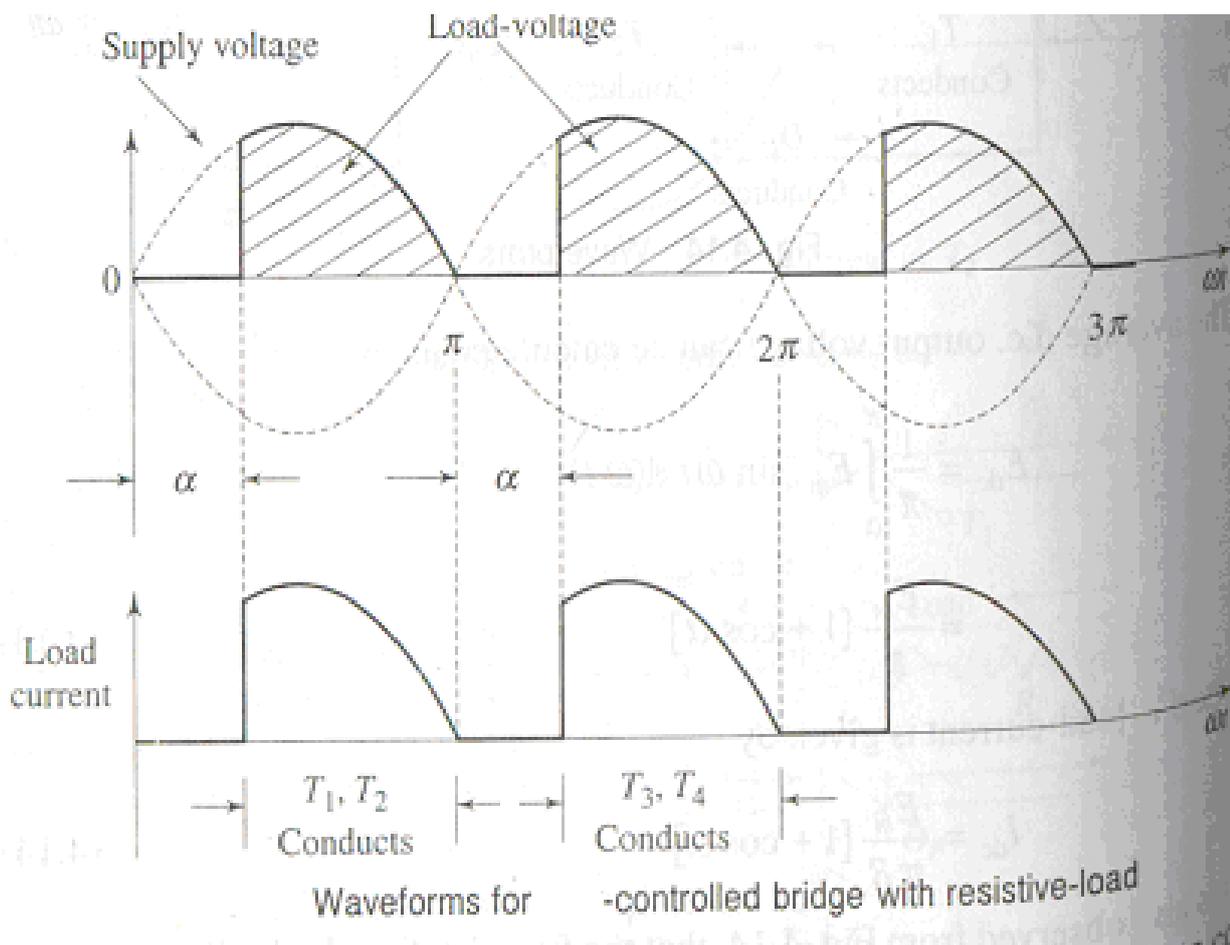
5. HALF CONTROLLED CONVERTER

AIM: To study the operation of a half controlled converter with R & RL loads.

Apparatus:

S.No	Equipment	Range	Type	Qty
1	PE Trainer Kit		-	01
2	Multimeter		Digital	01
3	Lamp Load			01
4	Power Oscilloscope			01

THEORY:

       A half controlled converter controls output voltage in both the half cycles of the input voltage. T1 & D2 are forward biased in the positive half cycle of the input voltage. When triggered at a firing angle a, T1 starts conducting from a . Thus from a to π, output voltage follows positive half of the input voltage. From π to π+a, thyristor T1 & diode D2 get reverse biased and D1 & T2 are forward biased . At π+a, T2 is triggered. Current flows through the load in the same direction giving a positive value of output voltage. Thus unidirectional current flows through the load in both the half cycles of input AC. By controlling the value of a, we can control the output voltage.

PROCEDURE:

1) Make connections as per the circuit diagram. Use 40W / 230V lamp as the load.
2) Switch on the supply.
3) Observe the output waveform in the powerscope.
4) Vary the conduction angle and observe the change in the waveform. Note down the output voltage value from the multimeter and compare with the value obtained from the formula

OBSERVATIONS & TABULAR COLUMN:

Peak Voltage, Vm =

S no.	Firing angle, a (degrees)	Average voltage (as per formula)	Average Voltage (Voltmeter reading)

SAMPLE CALCULATION:

Result:

Reasoning Questions:

1) Explain the working of a Half controlled converter?

2) What are the disadvantages ?

3) Explain the waveforms with R & RL loads?

4) What is the equation for average voltage in a Half controlled converter?

5) What are the two different modes of operation in a Half controlled converter?

CIRCUIT DIAGRAM:

MODEL GRAPH:

Voltage and current waveforms for a single-phase to single-phase cycloconverter with discontinuous load current
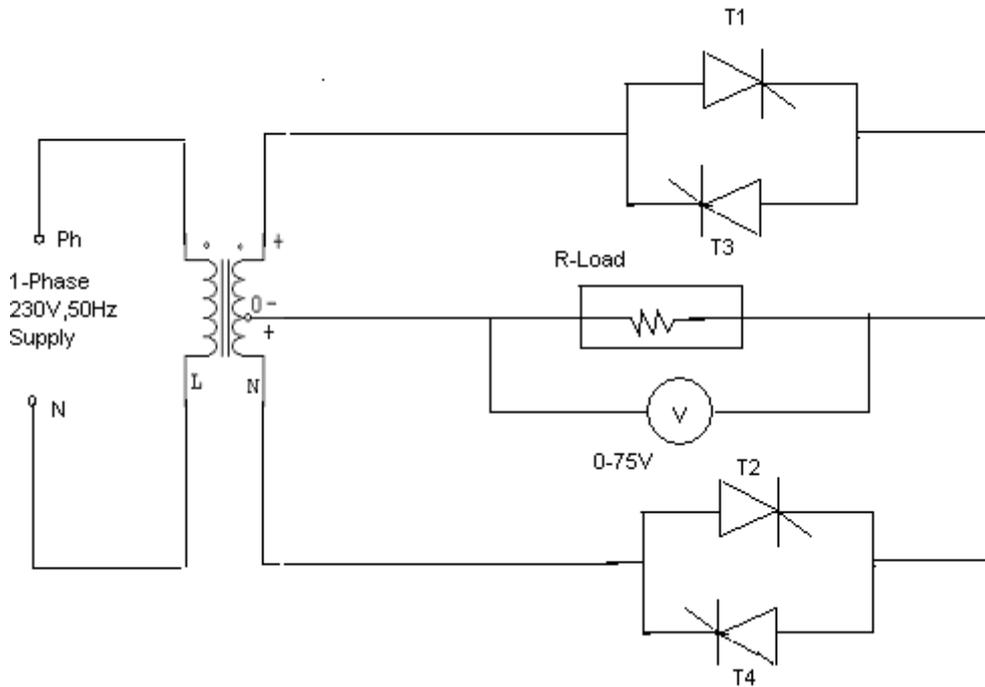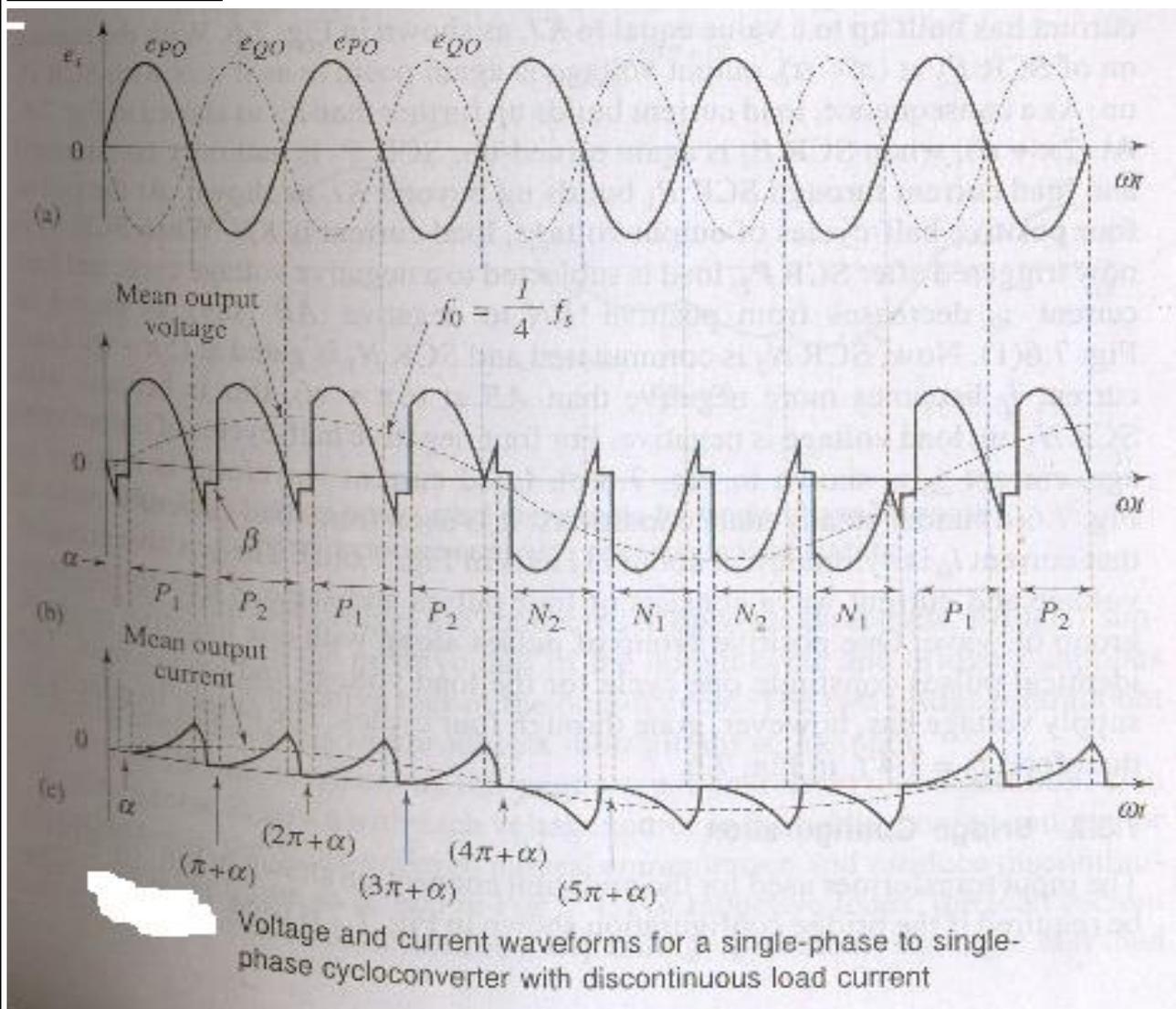
6. SINGLE PHASE CYCLO CONVERTER

AIM: To study the operation of a cyclo converter with R load.

Apparatus:

S.No	Equipment	Range	Type	Qty
1	PE Trainer Kit		-	01
2	Multimeter		Digital	01
3	Lamp Load			01
4	Power Oscilloscope			01

THEORY:

　　　　Cyclo converters are used for frequency conversion. Groups of antiparallelly connected SCRs are used here. By selecting which SCR is to be triggered at a particular time, we can change the output voltage frequency according to the requirement.

PROCEDURE:

1) Make connections as per the circuit diagram.

2) Keep the firing pulse selector switch in the 2nd position (for 25Hz output) to get the required gate pulses.

3) Switch on the supply.

4) Observe the output waveform in the CRO.

5) Repeat the procedure with mode selector switch in position 3 (for 12.5Hz operation).

OBSERVATIONS

Frequency of the input voltage   =

Frequency of the output voltage   =

SAMPLE CALCULATION:

Result:

Reasoning Questions:

1) What are the applications of cycloconverters?
2) How the frequency change is made possible in cycloconverters?
3) What are the different types of cycloconverters? Explain each?
4) Explain the sequence of triggering for (1/3)rd frequency?
5) Draw & Explain waveforms for RL load?

CIRCUIT DIAGRAM:
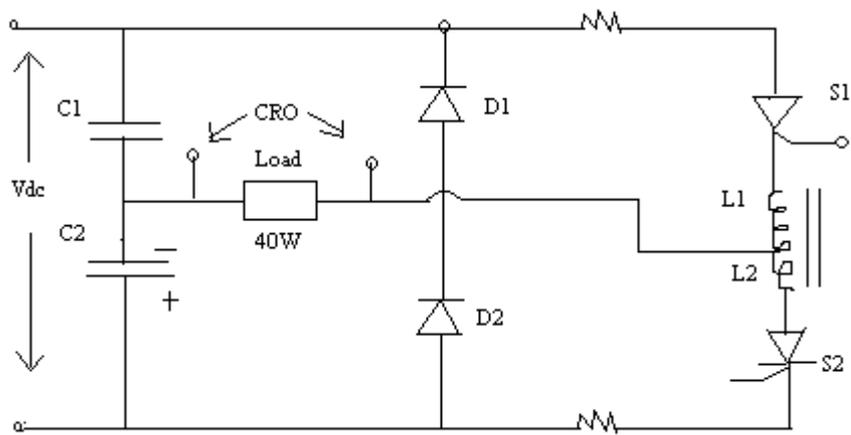
OBSERVATION TABLE :

S.No	Inverter frequency (Hz)	O/p AC

7. SERIES INVERTER

**AIM:** To study the operation of a 1Φ series inverter.

Apparatus:

S.No	Equipment	Range	Type	Qty
1	PE Trainer Kit		-	01
2	Multimeter		Digital	01
3	External power supply	(0-30)V, 2A	DC	01
4	Power Oscilloscope			01

THEORY:

In a series inverter the commutation elements are in series with the load. Assumer that voltage across capacitor C_2 is E_c in the polarity shown, Capacitor C1 is charged to (E_{dc} +E_c) When SCR1 is fired, there will be two parallel paths for load current I_L (=i_1+i_2) current i_1 will flow form positive dc terminal through SCR1; L1 load and capacitor C2 to the negative supply terminal. Current i2 will flow from C1 through SCR11 and L1 to the load. The driving voltage, the circuit elements and the initial conditions re identical for both the parts. Therefore, the two currents are equal Hence, one half of the load current will come from the DC supply and the other half from the discharge of the capacitor. AT the end of the half zero, SCR1 will be turned off, end the voltage across the capacitors reversed. Identical operations take place when SCR2 is triggered.

PROCEDURE:

1. Switch ON the supply & observe for the power indication.
2. Check the firing pulses for both thyristors individually on CRO.
3. Measure the DC supply.
4. Switch off the supply and connect the circuit as per the circuit diagram.
5. Observe the output voltage waveform across the output.
6. Vary the frequency and observe and note down the change in the waveform with frequency.

MODEL GRAPH:

Firing
Pulse to   S1

          S2

Inventer
output
waveform
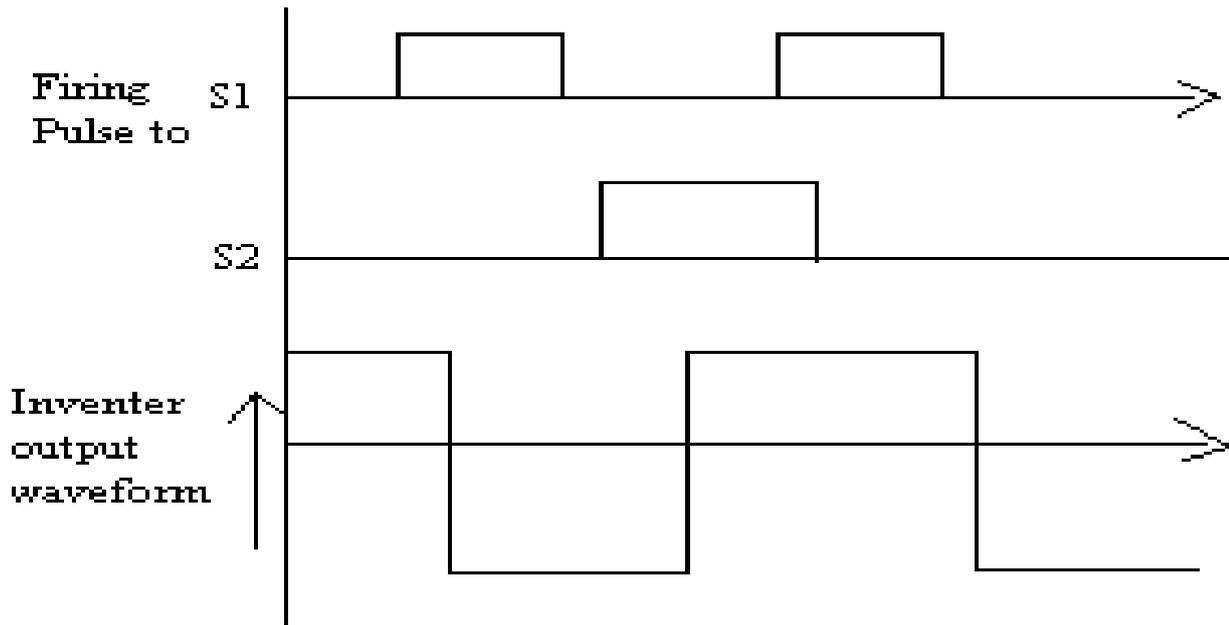
PRECAUTION:

1. Since the DC supply is of 300V should be very cautions while handling the equipment. Handling and manual contact of the two pins simultaneously with the switch ON, will be hazardous.

2. When there is any indication of short circuit, press the resetable fuse for 2 to 3 sec. If power comes there is no short circuit, but only because of transient currents, the fuse is set. But if the resetable fuse indicator glows again, there is a problem of short circuit and connections should be checked before trying the reset switch once again.

3. When the lamp flickering is not there, switch off the equipment and repeat the procedure from the start. This may be due to commutation failure.

Result:

Reasoning Questions:

1) Explain the working of a series inverter?
2) Explain the waveforms?
3) What are the applications?
4) What are the differences between a basic series inverter and a modified one?

CIRCUIT DIAGRAM:
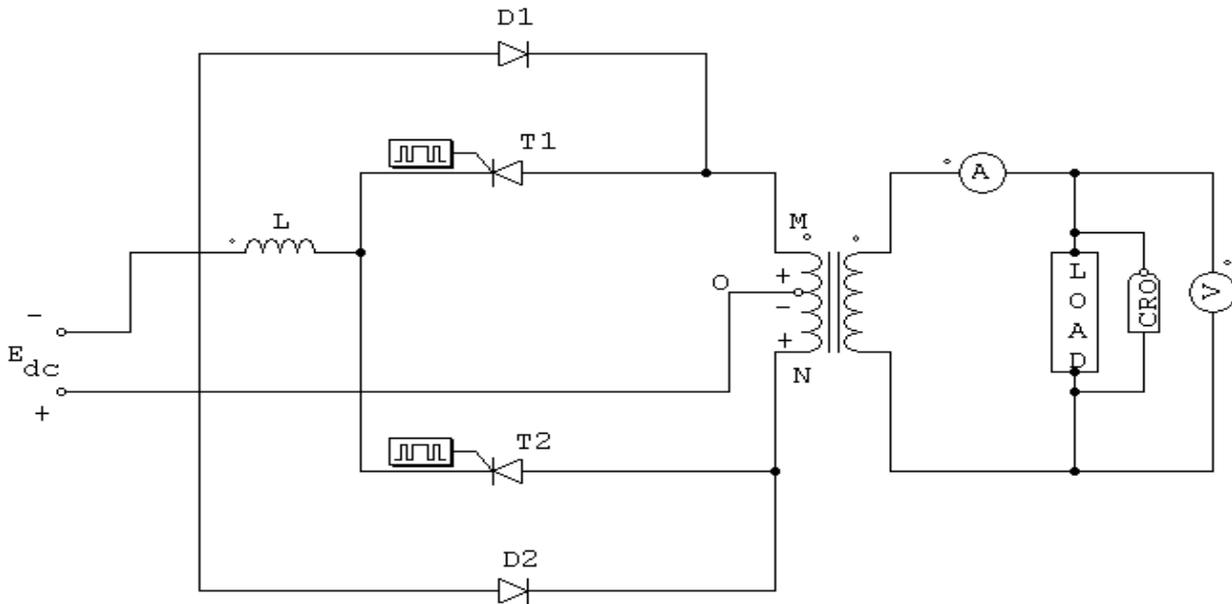
PARALLEL INVERTER

OBSERVATION TABLE :

S.No	Inverter frequency (Hz)	O/p AC

8. PARALLEL INVERTER

AIM: To study the operation of SCR parallel inverter

Apparatus:

S.No	Equipment	Range	Type	Qty
1	PE Trainer Kit		-	01
2	Multimeter		Digital	01
3	External power supply	(0-30)V, 2A	DC	01
4	Power Oscilloscope			01

THEROY:

SCRs 1 &2 are the main load carrying SCR. The commutating components are L&C. Diodes 1& 2 permit load reactive power to be fed back to the DC supply. These are called the feedback diodes. When sCR1 is conducting supply voltage E_{dc} will appear across the left half of the transformer primary winding OA. Terminal O is positive with reference to A thus, capacitor C will get charged to twice the input voltage. The load voltage will be positive and of magnitude Edc. At the end of the half period, SCR2 is fired. Capacitor C will immediately apply a reverse voltage of 2Edc across SCR 1 and turns it off. When SCR 1 is turned off the capacitor will discharge through SCR2, inductor L, Diode D1 and a portion of the transformer winding LA. Thus the energy stored in the capacitance will be fed back to the load through the transformer coupling of windings LA and PQ. During this period, the potential of point L will be fixed by the DC input supply and voltage will still be positive. The load current which earlier was flowing through SCR1 will flow through OL and diode D1 to the negative input terminal. The current through the inductor L will now flow through D2, M, B & S2 . The trapped energy in L will be fed back to the load. Since the point M is now connected to the negative supply terminal, the load voltage polarity will be reversed. Also the capacitor will be charged in the opposite direction.

MODEL GRAPH:

Voltage and current waveforms
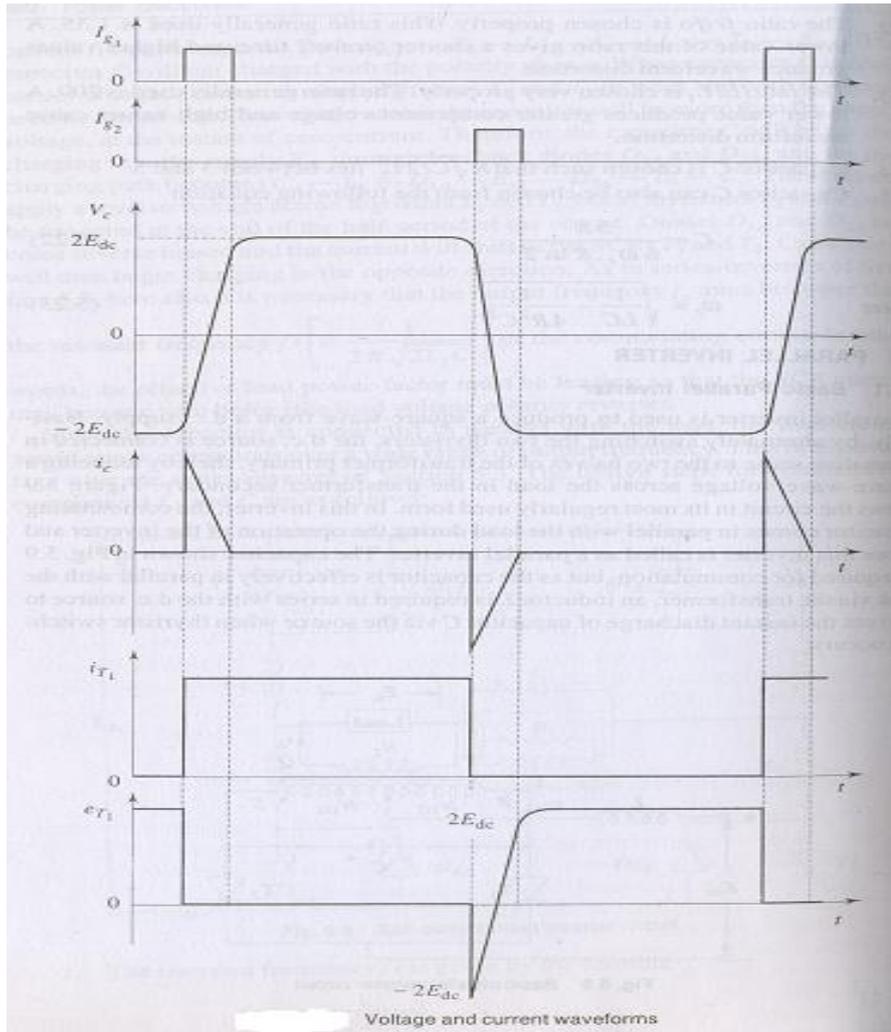
PROCEDURE:

1. Connect the circuit as per the circuit diagram connect an external voltage sup[ply across the V_{dc} terminals

2. Apply the triggering pulses to SCR1 & SCR2

3. Keep the triggering frequency minimum

4. Switch ON the CRO, experiment kit and the external power supply.

5. Observe the output waveforms in the CRO. Change the frequency and observe the change in waveform with frequency. Note down the voltage values for different frequencies.

6. Keep the frequency knob in the minimum position and switch off the supply.

Result:

Reasoning Questions:

1) Explain the working of a parallel inverter?

2) Explain the waveforms?

3) What are the applications?

CIRCUIT DIAGRAM:
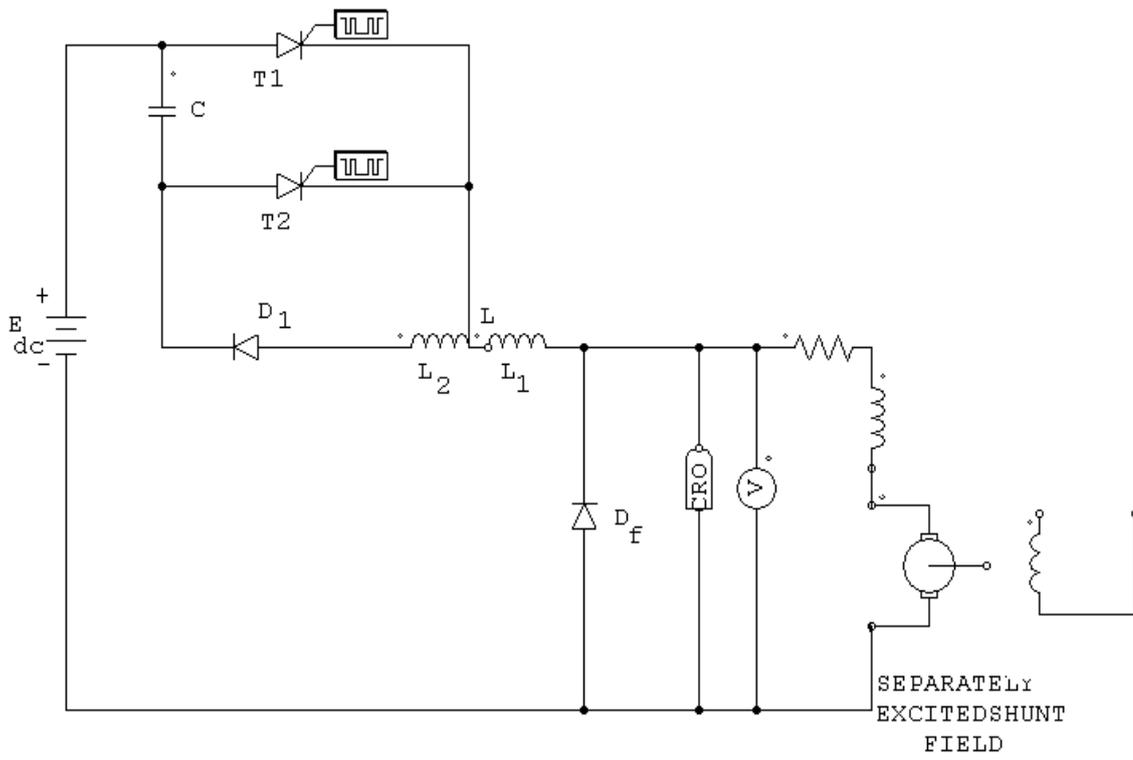
DC JONES CHOPPER

S.No	Amplitude (V)	Time period(Sec)

9. JONES CHOPPER

AIM: To study the operation of Jones chopper.

Apparatus:

S.No	Equipment	Range	Type	Qty
1	PE Trainer Kit		-	01
2	Multimeter		Digital	01
3	Power Oscilloscope			01

THEORY:

This chopper is an example of class D commutation. In this circuit, T1 is the main thyristor. T_2, C, D_2 & auto transformer forms the commutating circuit for the main thyristor T1 . Therefore the special feature of this circuit is the tapped auto transformer T through which the load current flows. Here L_1 & L_2 are closely coupled so that the capacitor always gets sufficient energy to turn-off the main SCR T_1.

Let us assume that initially capacitor E is charged to a voltage E_{dc} with the polarity shown . T1 ;is triggered at time t = t1, current flows through path CA -T_1-L_2-D_2-CB& plate A is negative. However diode D1 prevents further oscillation of the resonating L_2C circuit. Hence capacitor C retains its charge until SCR T2 is triggered.

PROCEDURE:

1. Connect the circuit as shown in figure.
2. Connect the CRO across the output
3. Switch ON the power supply
4. Observe the output waveform in CRO
5. Note down its amplitude & time-period.
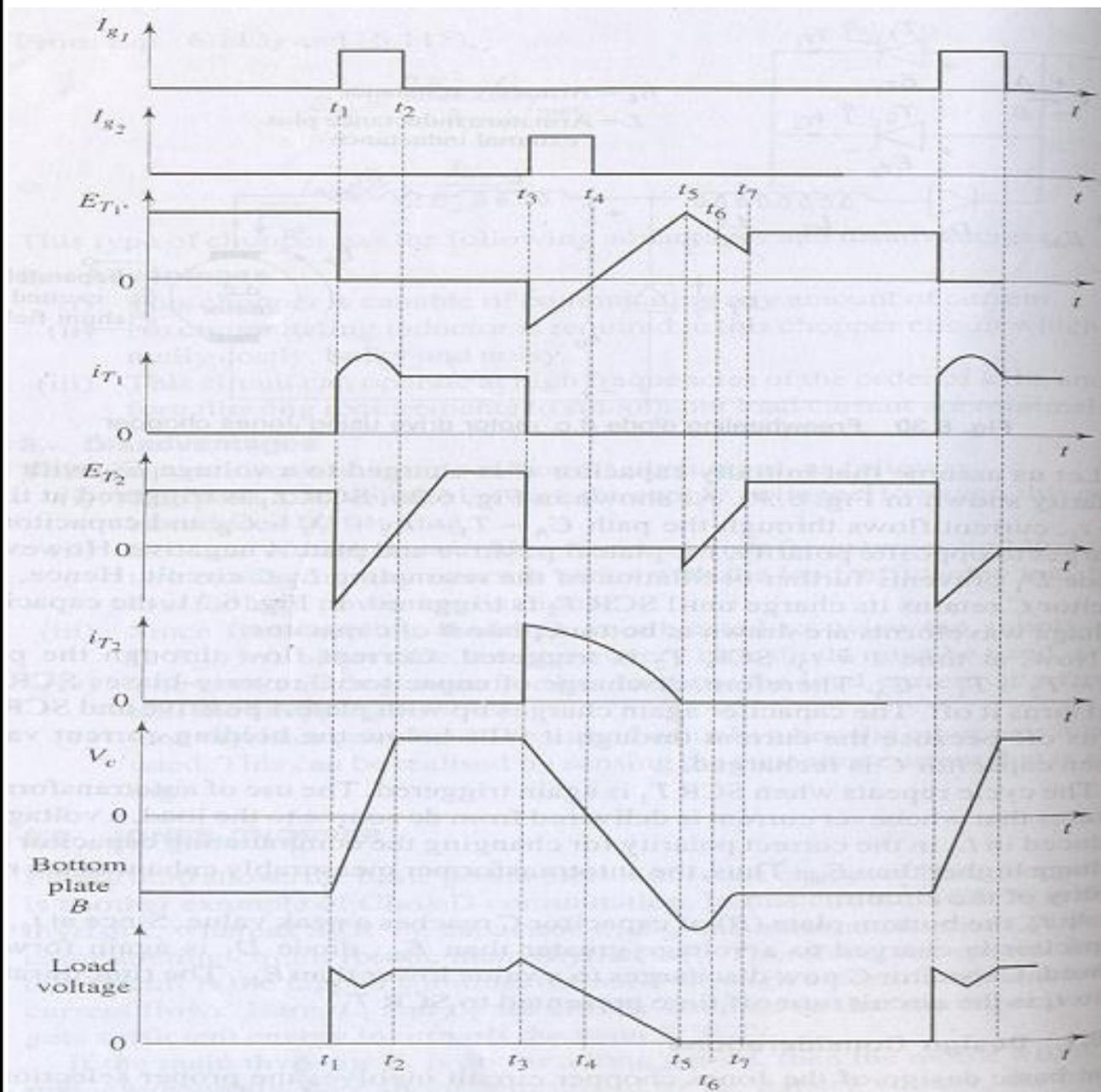
Jones chopper voltages and current waveforms

Result:

Reasoning Questions:

1) What is a chopper?
2) What are the different types of Choppers?
3) Explain the working?
4) Explain the waveforms?

Class A commutation Circuit Diagram.
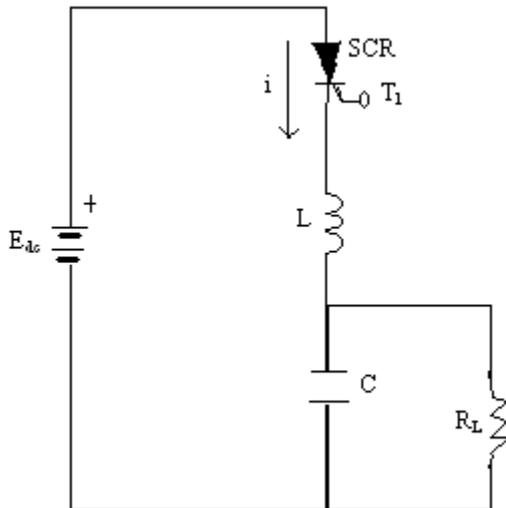
(a) Load in parallel with capacitor

CLASS A COMMUTATION CIRCUIT

CLASS A COMMUTATION WAVEFORMS :
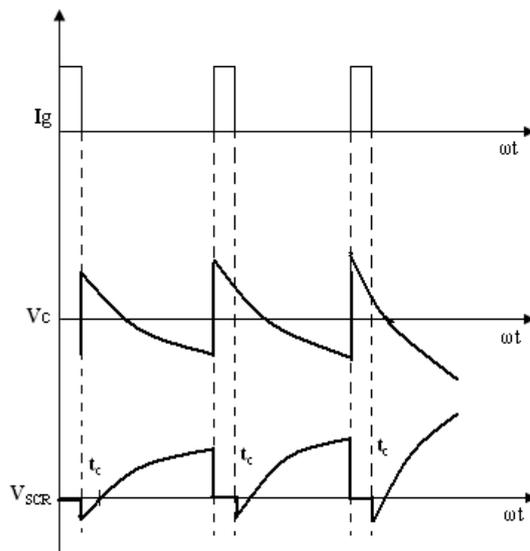
Voltage and currents in Class A (load is parallel with capacitor)

t_c = SCR turn off time in µ sec's

10. Forced Commutation circuits

1. CLASS A COMMUTATION

(SELF COMMUTATION BY RESONATING THE LOAD)

AIM :

To study the class A forced com mutation circuit.

Apparatus :

1. Forced Commutation Unit.

2. C.R.O. and Probes

3. Patch Cords

4. Differential Module

5. Variable Resistive Load - 360Ω / 2A

THEORY :

This is also known as resonant commutation, load commutation. L and C are used as a commutating components in the circuit. We have two arrangements in class A commutation one is a high value of load RC is connected across capacitor and another is one is small value of load RC is series with the LC circuit.

Actually in this process of commutation the forward current passing through the device is reduced to less than the level of holding current of the device. Hence this method also known as the current commutation method. When the forward current is become less than zero then the device is automating turned off. This has happened by load RL and commutation components forms an under damped resonant circuit. When SCR is in ON Capacitor charged to E_{dc}, When it charges full supply voltage E_{dc} the current passing through the device delay to a value less than the holding current of the device, then turns off the device takes place. This is called self commutation because SCR turns off automatically after it has been turned ON. Turn OFF time is determined by R-L-C components. These are most suitable for with frequency i.e., above 1000Hz it is used in series inverter.

If the 'SCR' is active region the commutation intervals (freq. pot) only and is dormat of the rest of the time period (Duty Cycle) is called Auxiliary Commutation.

Procedure :

1.   Make all connections in the power circuit as per the circuit diagram.

2.   Connect Trigger output T_1 to the gate and cathode of T_1 SCR in the power circuit.

3.   Switch ON the DC supply, trigger outputs and observe the voltage waveforms across SCR, Load and Capacitor.

4.   Vary the frequency and observe the waveforms but no use of duty cycle in this circuit.

5.   Commutation will fails by varying R_L Load as well as frequency Intervals.

6.   If commutation fails switch OFF the DC supply trigger outputs and retry again after changing the frequency.

7.   Repeat the same for different values of RL & C.

8.   Large resistive load is connected in parallel with capacitor and low value of resistive load connected in series with C.

Class B Commutation Circuit Diagram :
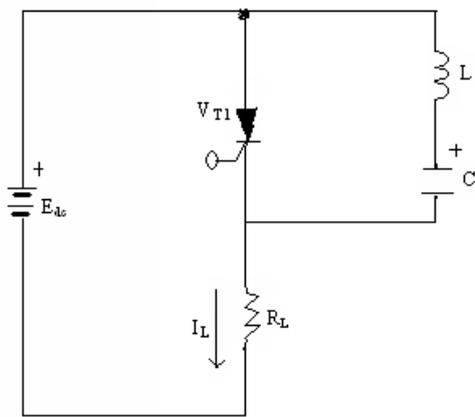
CLASS B COMMUTATION CIRCUIT

b. **Class B Commutation**
(Self Commutation by an LC Circuit)

AIM :

To study the class B Commutation circuits

Apparatus :

1.   FORCED COMMUTATION unit

2.   C.R.O. and Probes.

3.   Patch Cords

4.   Differential Module

5.   Variable Resistive Load 360Ω / 2A.

Theory:

In this method the LC resonating circuit is across the SCR. In this commutations reverse voltage is applied to the thyristor to turn off it. In this arrangement soon the supply voltage applied the capacitor C starts getting charged up to the E_{dc} at no triggering signal. When thyristor is get triggered current flows through the load RL and a pulse current through the resonating LC circuit. When thyristor gets triggered the capacitor get discharges and get charged in reverse direction. Due to the reverse voltage a commutating current is starts flows through the SCR to opposes the load current I_L. When $I_c > I_L$ SCR becomes turned off. When it turns off capacitor again gets charged through RL process continued.

From above we clear that thyristor after getting on for some time automatically gets off and after remaining in off state for some time is again gets turned ON. This process ON / OFF is continuous frequency of ON / OFF states desired by commutating components. This is self commutating circuit because turns off takes place automatically after turned ON. This type circuits used in DC chopper circuits.

CLASS B COMMUTATION WAVEFORM:
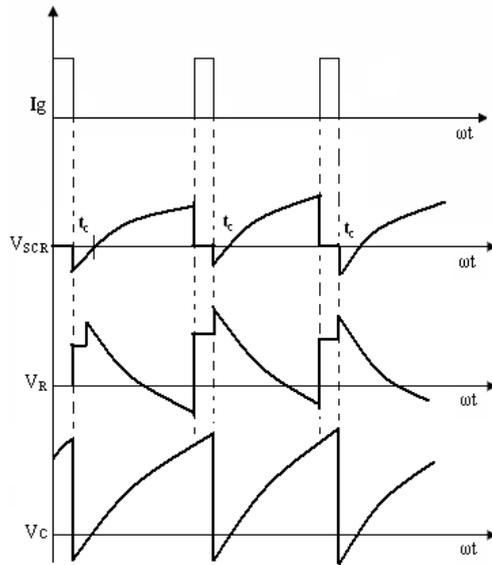
Voltages and currents in class B

tc = SCR turn off time in μ sec's.

Procedure:

1.   Make all connections as per the circuit diagram.

2.   Connect the trigger output T_1 to the gate and cathode of the SCR T_1

3.   Switch ON the power supply and put ON the trigger output supply.

4.   Observe the voltage waveforms across load and SCR and Capacitor by varying the frequency control potentiometer. Duty cycle is of no use in the circuit.

5.   Commutation will fails by varying frequency intervals as well as load resistance.

6.   If commutation fails switch OFF the DC supply trigger outputs and retry again after changing the frequency.

7.   Repeat the same for different values of R load C.

Class C Commutation Circuit Diagram:
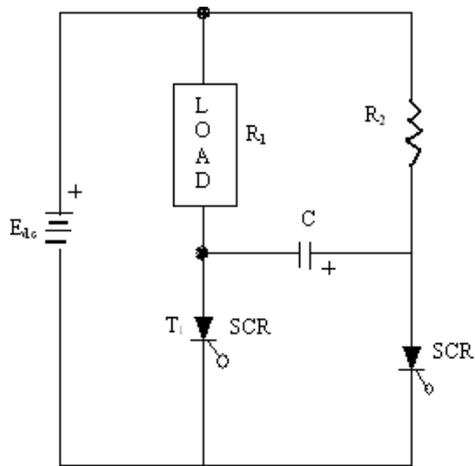
CLASS C COMMUTATION CIRCUIT

C. Class C commutation
(Complementary Commutation)

AIM :

To study the CLASS C FORCED COMMUTATION circuit.

Apparatus :

1. Forced Commutation Unit.

2. C.R.O. and Probes

3. Patch cords

4. Differential Module

5. Two Resistive Loads 360Ω / 2A – 2No's.

Theory:

In this type of commutation circuit the transfer of current between two loads, that is a thyristor carrying load current is commutated by transferring its load current to another incoming thyristor called complementary thyristor is connected in parallel with main thyristor.

Actually in this circuit initially both T_1 & T_2 at off, when trigger pulse is applied to the gate 0 & T_1 it is triggered I_c & I_L starts flowing, and C gets charged by the supply voltage E_{dc}. When triggering pulse is applied to the gate of T_2, it will turned ON soon reverse voltage applies across the main thyristor and immediately it turns off.

Now capacitor charges in reverse polarity when T_1 triggered ON the discharging current of capacitor turns off the T_2. This is very much used frequencies below. This is used in MC Murray bed ford inverter.

Procedure:

1. Make all connections as per the circuit diagram.

2. Connect the trigger outputs from firing circuit to the Gate and Cathode of thyristor T_1 & T_2 in the power circuit.

3. Switch ON supply and put on the trigger output pulse switch and observe the waveforms across R1, R2 and C by varying frequency and duty cycle potentiometer.

Class C Commutation Waveforms:
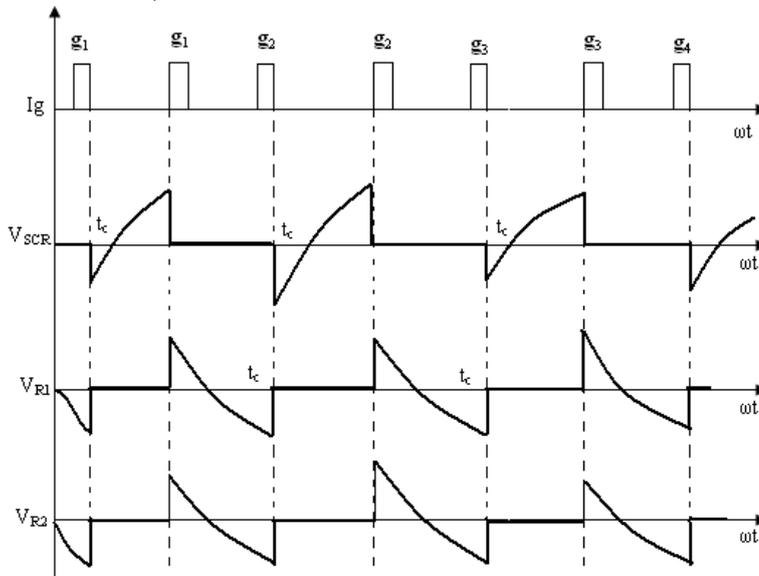
Voltages and currents in class C

4. t_c = SCR turn off time in μ sec's

If commutation will fails by varying load as well as freq. pot and duty cycle.

5. If commutation fails switch OFF the DC supply trigger outputs and retry again after changing the frequency.

6. Repeat the same for different value of Capacitor and inductors as given in power circuit.

Class D commutation Circuit Diagram:
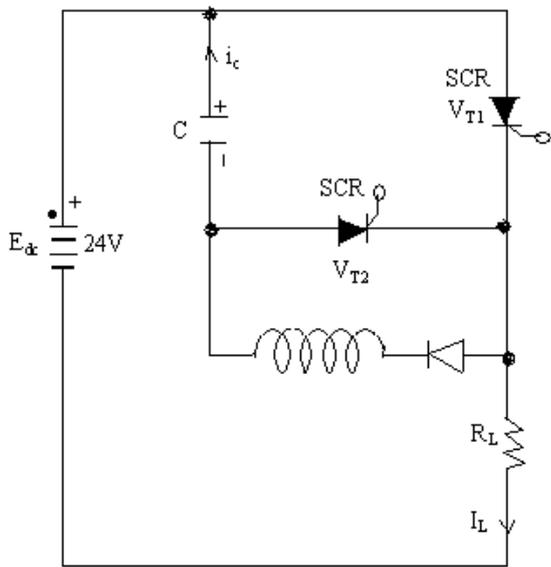
CLASS D COMMUTATION CIRCUIT

D. CLASS D COMMUTATION
(Auxiliary Commutation)

AIM :

To study the Class D Forced Commutation Circuit.

Apparatus :

1. **Hi-Q Electronic Systems**, FORCED COMMUTATION Unit.

2. C.R.O. and Probes

3. Patch cords

4. Differential Module

5. Variable Resistive Load 360Ω/2A

6. Regulated DC Power Supply of 30V / 2A

Theory :

In this Commutation circuit method and auxiliary thyristor T_2 is required to commutate the main thyristor T_1. Here L, D, and T_2 are commutating components. Initially T_2 is triggered first to charge up the capacitor, when C has to charged fully, T_2 gets turns off owing lack of current this is due to increase of voltage across capacitor. Then T_1 is triggered ON two currents appears, which are load current through R_L and commutation current through C, T_2, L and D. Now capacitor starts discharging, reverse discharge is not possible due to blocking diode D. When T_2 is triggered C gets reverse discharging. When this discharging current that is commutating current I_c becomes more than the load current I_L, T_1 get turned off. After T_1 gets off C again get charged after fully charge T_2 gets off repeats above sat again.

Choppers and invertors under this auxiliary commutation circuit by circuit high efficiency is possible mainly used in Jones Chopper circuit.

Procedure:

1. Make all connections as per the circuit diagram.

2. Connect trigger output from firing circuit and power circuit thyristor T_1 & T_2 Gate and Cathode connect tiring pulses T_1 to T_2 and T_2 to T_1

Class D commutation waveforms:
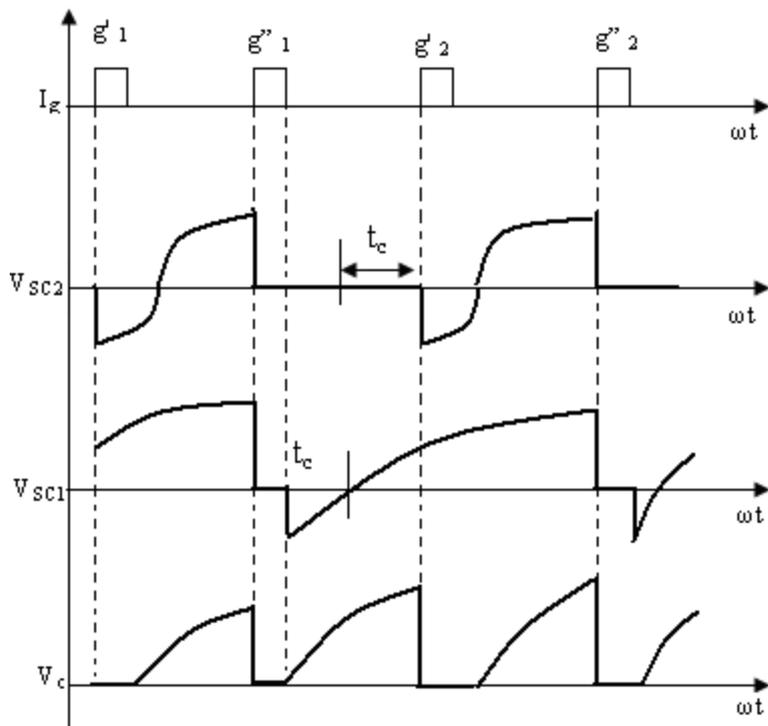
3. Initially keep the trigger ON/OFF at OFF position to initially charge the capacitor, this can be observed by connecting C.R.O. terminals across the capacitor, when capacitor is not charged to give DC supply externally.

4. Now switch ON the supply and observe voltage waveforms across load T1, T2 and capacitor.

5. Change the commutating components and observe waveforms at different frequency and duty cycle.

6. If commutation fails switch OFF the DC supply trigger outputs and retry again after changing the frequency.

Class E Commutation Circuit Diagram:
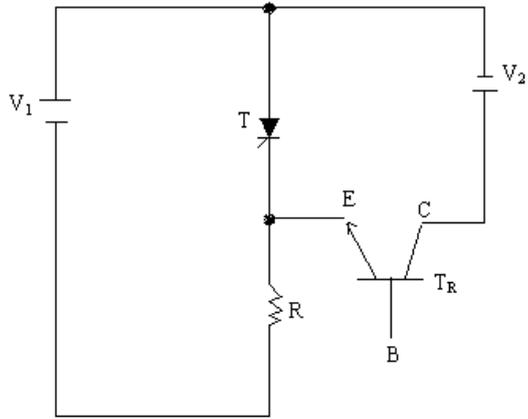
CLASS E COMMUTATION CIRCUIT

E. Class E commutation

(External Pulse commutation)

AIM :

To study the class E forced Commutation circuit.

Apparatus :

1. FORCED COMMUTATION Unit.

2. C.R.O. and Probes

3. Patch cords

4. Differential Module

5. Variable Resistive Load 360Ω/2A

6. Regulated DC Power Supply of 30V / 2A

THEORY :

In class E commutation the reverse voltage is applied to the current carrying thyristor from an external pulse source across or in series with the conducting thyristor near the commutating pulse is applied through a transistor emitter. The turn off time of the thyristor is smaller than the width of the pulse.

When T_1 is triggered, current flows through the R load and the transistor. A voltage V_2 is connected to the collector of transistor the emitter is connected to cathode of T_1. The voltage V_2 appears across T_1 as a reverse voltage then T_1 gets turns off. This type of commutating method is capable of very high efficiency.

PROCEDURE:

1. Make all connections as per circuit diagram.

2. Connect V_2 supply of 5V from an external DC supply

3. Connect trigger outputs T_1 & T_2 from firing circuit to the power circuit T_2 to gate and cathode of SCR and T_1 to transistor base and emitter.

4. Switch ON DC power supply, trigger output switch and external DC supply.

Observe the voltage waveforms across load and SCR by varying frequency and duty cycle controls.

CLASS E COMMUTATION WAVEFORMS:
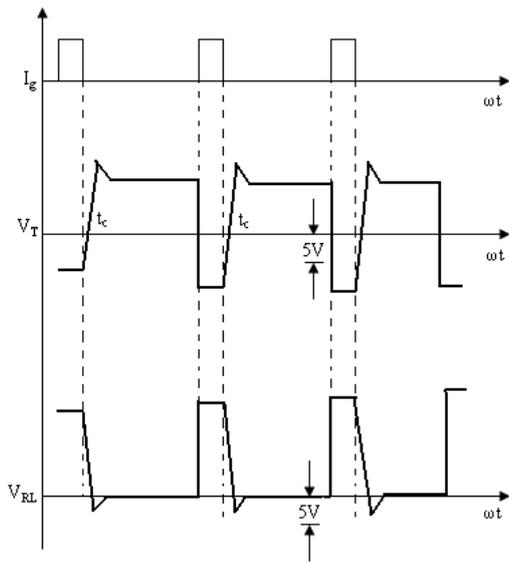
5. If commutation fails switch OFF the DC supply trigger outputs and retry again after changing the frequency.

6. Repeat the same by varying frequency and duty cycle.

Fault:

1. If power ON (IRS) indicator not glowing.

   a. Check the input AC power supply

   b. Check mains chord

   c. Check the 500mA, AC fuse in 3 pin power inlet socker on back panel of unit.

   d. Check the power ON/OFF (IRS) switch.

2. for no output in power circuit.

   a. Check internal unregulated DC supply.

   b. Check the 2A fuse on front panel

   c. Check the device 2A fuses on back panel

   d. Check for any loose connections

After external checking if the problem persists contact to our company.

Result

CIRCIUT DIAGRAM:
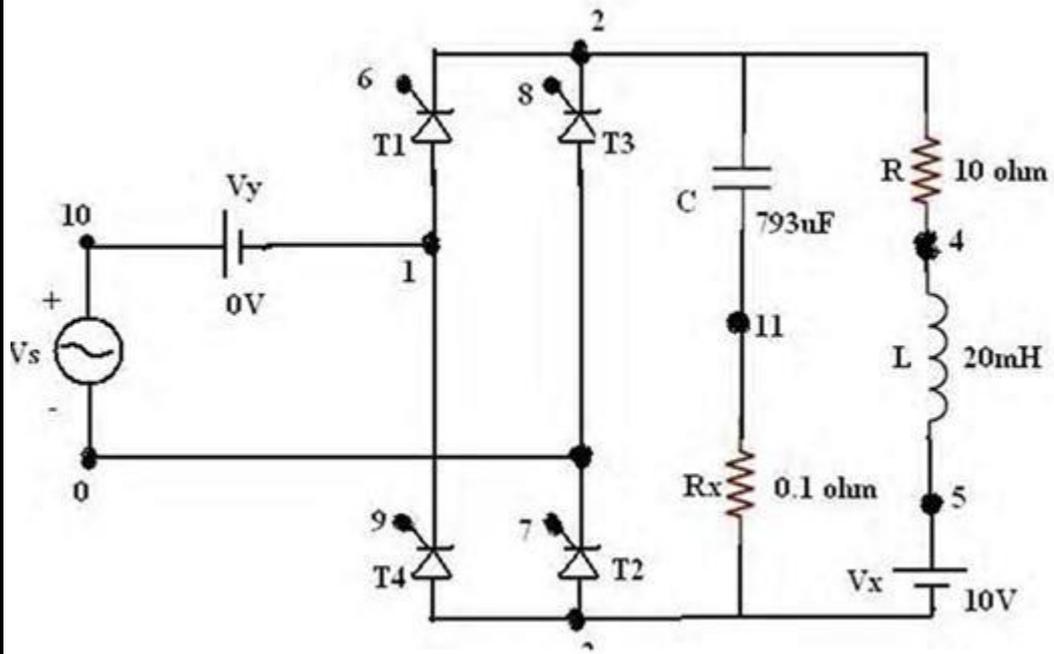
11. PSPICE Simulation of Single Phase full Converter Circuit with RLE load.

AIM : The objective is to study the output waveforms of single phase full converter using thyristors at various load locations.

APPARATUS : PSPICE software

PROBLEM : A single phase full converter is connected to a RLE load with R=10Ω,L=20mH and voltage =10V. It is supplied with a voltage of 325.27V, 50Hz supply. Simulate the converter using PSPICE for delay angle 60 degrees and plot 1)output voltage 2) load current.

THEORY :

A Single phase consisting of four SCR's as shown in the circuit diagram . The load is assumed to be of RLE type where E is the load emf and it may also be due to a battery in the load circuit or due to emf generated from a dc motor.Thyristors T1 and T2 are simultaneously triggered and ∏ radians later pair T3 and T4 is to be triggered.Load current or output current is considered to be continuous throughout the operation.

PROCEDURE :

1. Represent the nodes for the given circuit.
2. Write PSPICE program by initializing all the circuit parameters as per given flow chart.
3. From the desktop of the computer click on START menu followed by "programs" and by clicking appropriate program group as DESIGN LAB EVAL8 followed by "DESIGN MANAGER ".
4. Open the run text editor from microsim window and start writing PSPICE program.
5. Save the program with .cir extension.
6. Open the run spice A/D window from microsim window.
7. Open the file menu from run spice A/D window and then the saved circuit file.
8. If there are any errors,simulates will be displayed as "simulation error occurred".

MODEL OF SCR :

A   Model of SCR:
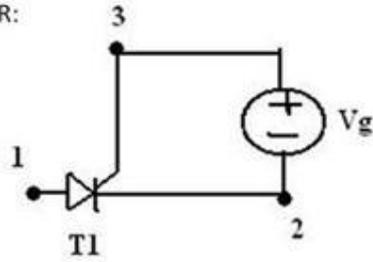
$$F_1 = P_1 I_g + P_2 I_a$$

$$= 50 I_g + 11 I_a$$
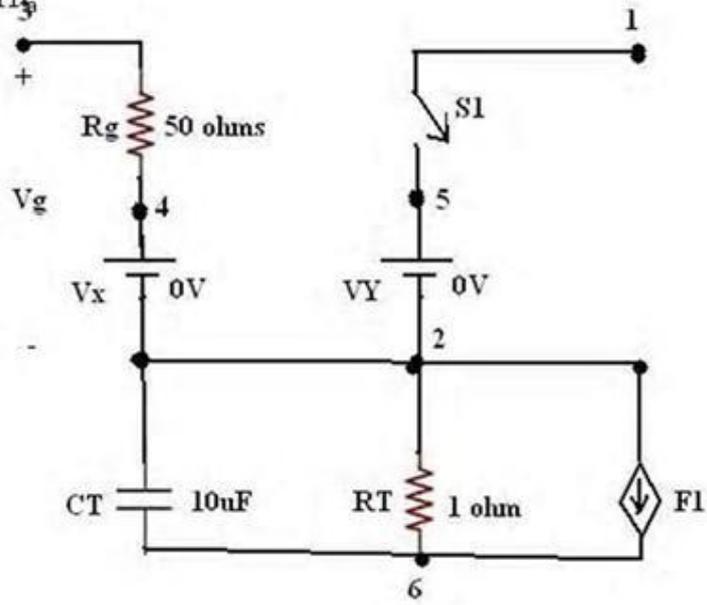
9. To see the errors click on o/p file icon and open examine o/p.

10. To make changes in the program ,open the circuit file, modify ,save and run the program.

11. If there are no errorssimulation will be completed & a statement "simulation completed" will be displayed.

12. To see the o/p , click on o/p file icon and open examine o/p and note down the values.

13. If probe command is used in the program,click on o/p file icon and open run probe.Select variables to plot on graphical window and observe the output plots.

PROGRAM CODE :

*Single Phase Full Converter Using RLE Load

*Voltage Sources

Vs10 0 Sin (0 325.27 50)

*Gating Pulse Voltage Source For Scr.
Vg1 6 2 Pulse (0v 40v 3333.33us 1ns 1ns 400us 20000us)
Vg2 7 0 Pulse (0v 40v 3333.33us 1ns 1ns 400us 20000us)
Vg3 8 2 Pulse (0v 40v 13333.33us 1ns 1ns 400us 20000us)
Vg4 9 1 Pulse (0v 40v 13333.33us 1ns 1ns 400us 20000us)
*Circuit Elements
R 2 4 10
L 4 5 20mh
Vx5 3 Dc 10v
Vy10 1 Dc 0
*Scr In The Circuit
Xt1 1 2 6 2 Scr
Xt2 3 0 7 0 Scr
Xt3 0 2 8 2 Scr
Xt4 3 1 9 1Scr
*Sub Ckt For Scr
.SubcktScr1 2 3 2
S1 1 5 6 2 Smod
Rg3 4 50
Vx4 2 Dc 0v

Vy5 7 Dc 0v

Dt7 2Dmod

Ct 6 2 10uf

> ## OUT PUT WAVEFORMS:

> ## INPUT VOLTAGE
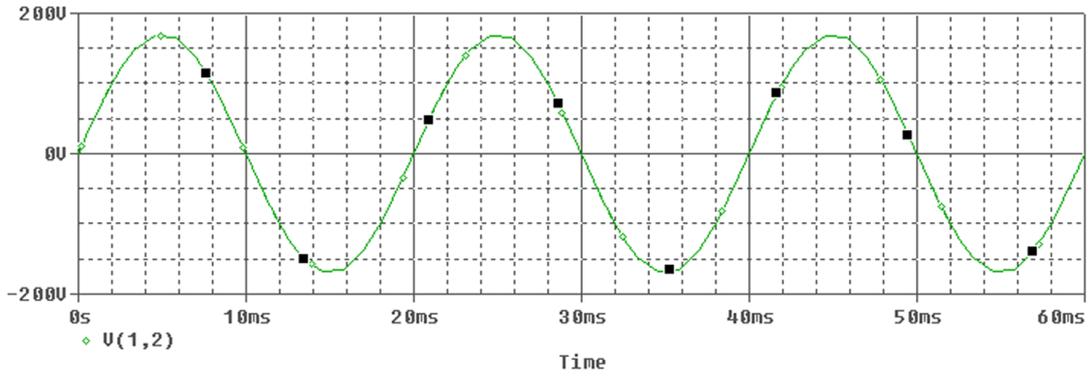
> ## OUTPUT VOLTAGE
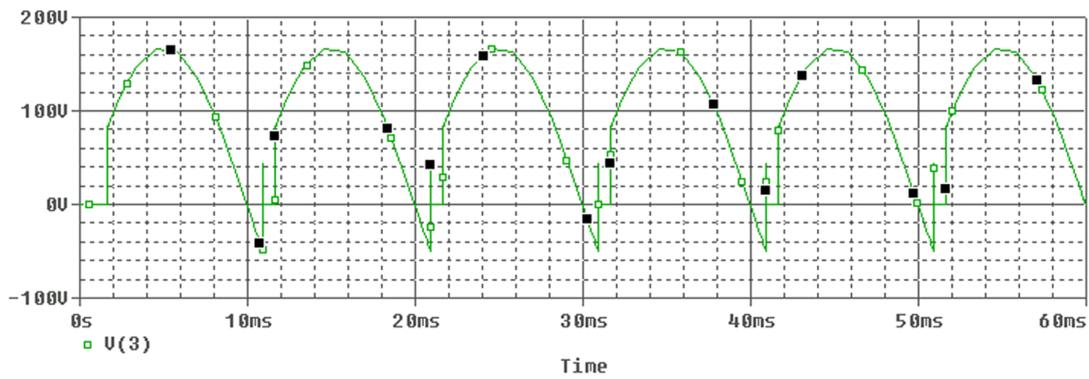
> ## OUTPUT CURRENT
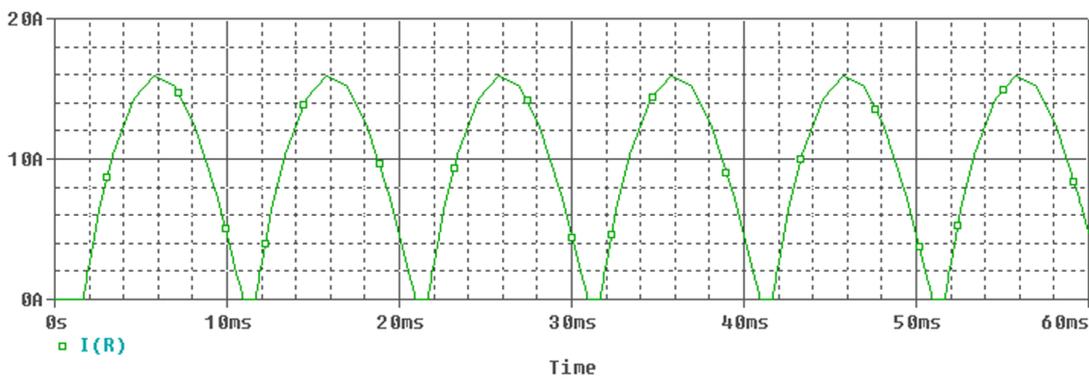
```
Rt 6 2 1ohm
F1 2 6 Poly(2)VxVy 0 50 11
ModelSmodVswitch (Ron=0.0105Roff=10e+5 Von=0.5vVoff=0v)
Model Dmod D(Is=2.22e-15 Bv=1200Tt=0 Cjo=0)
Ends Scr
*Analysis
.Tran 0 40ms
.Options Abstol=1.0n Reltol=1.0m Vntol=0.01 Itl5=20000
.Four 50 I(Vy)
Probe
.End
```

RESULT:

CIRCIUT DIAGRAM:
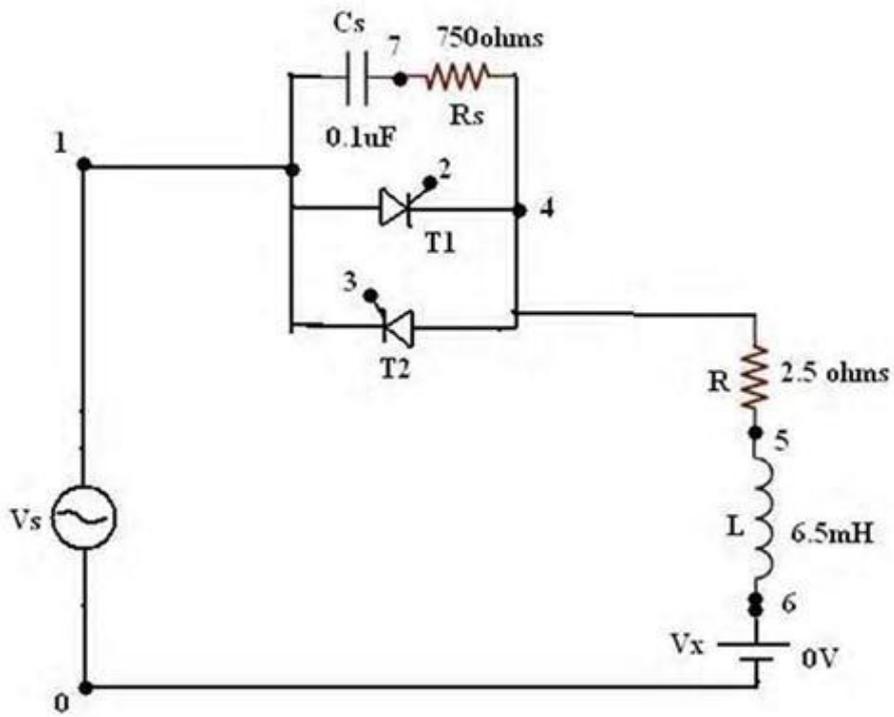
12. 1-PH AC VOLTAGE CONTROLLER
USING RLE - LOAD

AIM : To study output waveforms of single phase voltage controller for RLE loads using PSPICE simulation.

APPARATUS : PSPICE software.

PROBLEM : A single phase AC voltage controller is connected to a RLE load with R=3.5Ω, L=6.5mH and voltage 0V it is supplied with a voltage of 325.27V, 50Hz supply simulate the controller by using PSPICE for delay angle 30 degrees. Plot : 1.Output Voltage across Load.
  2. Input voltage. 3. Input current. 4. Load current.

THEORY : AC voltage controller's are thyristor based devices ,which converts the fixed Ac voltage into variable AC voltage with same frequency .The circuit diagram of Single phase AC voltage controller is shown in figure .It consists of two SCR"s connected in anti parallel. The input and output voltage waveforms are also shown. The SCR"s are gate controlled and gate pulses are obtained from firing unit.

A) For R-Load: For the first half cycle of input voltage waveform SCR T1 conducts and
gives controlled output to load. During the other half cycle of input voltage waveform SCR T2
conducts .

During the Positive half cycle T1 is triggered at a firing angle of wt= a .T1 starts conducting and source voltage is applied to the load from a to π. At wt= π both Vo and Io falls to zero. Just after wt= π, T1 is reverse biased and therefore it is turned off by self commutation.

During the negative half cycle of T2 is triggered at wt= π+a, then T2 conducts from wt = π+a
Vo rms=Vph{[(Π−a)+(1/2) sin 2a] /Π}1/2
Where Vorms is the theoretical RMS value of the output voltage, Vph is the phase voltage of the input voltage and a is the firing angle.

B) For RL –Load: During the first half cycle wt = 0 to π SCR T1 is forward biased and is triggered at wt=a and output current starts building up through load .At wt=π, load and source voltage are zero.
But the output current is not zero because of inductive load. At wt= (β>π), the load current reduces to zero, angle β is called extinction angle. After wt = π, SCR T1 is reverse biased, but does not turn off because the output current is not zero.

At wt=β, only when output current is zero T1 turns off. During the negative half cycle SCR T2
is forward biased and is triggered at wt =π+a. The output current flows through the load in reverse direction. The operation of SCR T2 is similar as that of SCR T1 during the period wt=π+a to wt = (2β-a) but in the negative direction. At wt= (2β-a) the SCR t2 is commutated and the next positive half cycle will be regulated by SCR T1.
In this way the AC Voltage controller will be useful for regulating the AC voltage.
Vorms=Vph {[(β −a)+(1/2) (sin 2a− (1/2) sin 2β)] / 2π} 1/2

➢ OUT PUT WAVEFORMS:
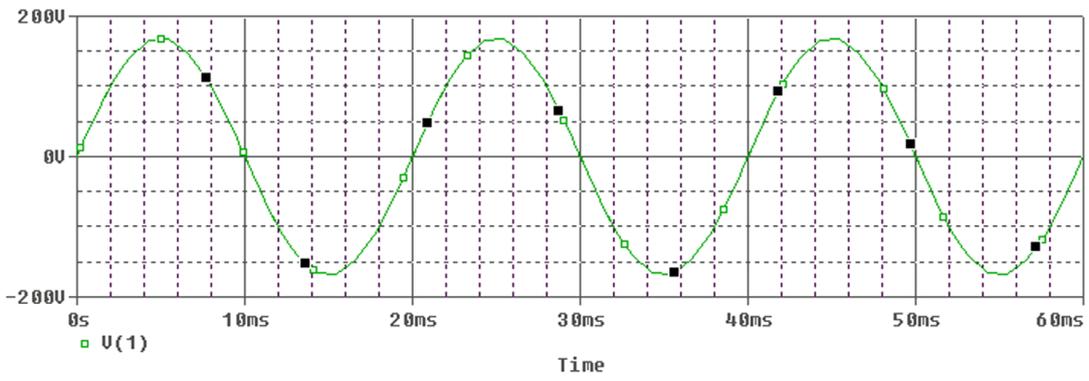
OUTPUT VOLTAGE
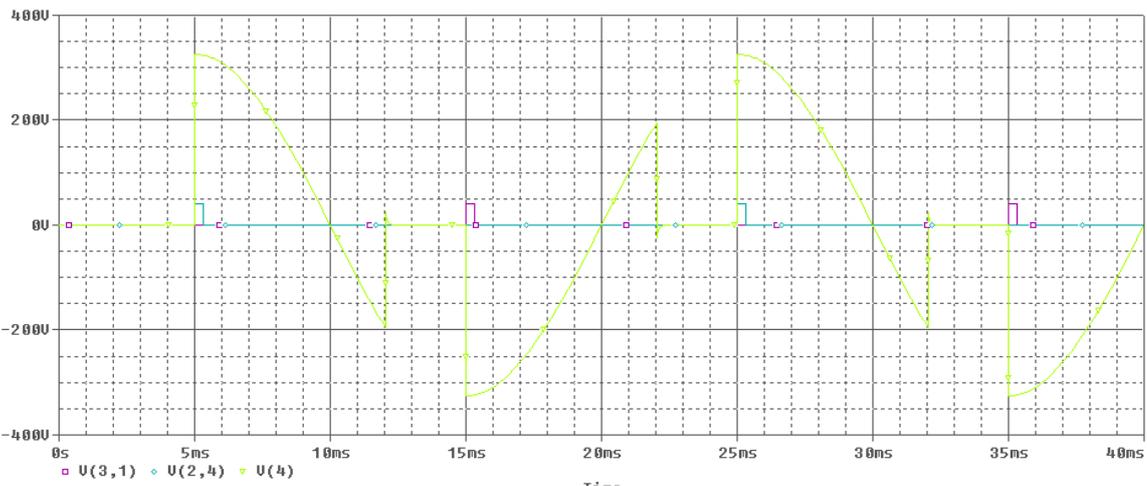
INPUT CURRENT
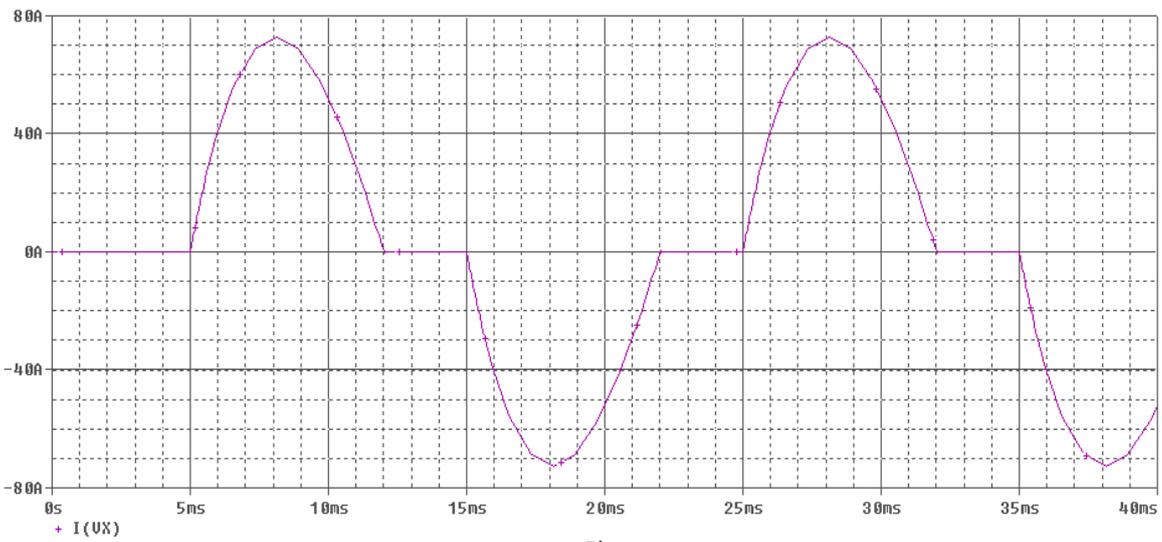
Theoretically the value of Extinction angle calculated by $\beta = (\pi + \varphi)$; Where $\varphi = \tan^{-1}(wL/R)$

PROCEDURE:

1. Represent the nodes for the given circuit.
2. Write PSPICE program by initializing all the circuit parameters as per given flow chart.
3. From the desktop of the computer click on START menu followed by "programs" and by clicking appropriate program group as DESIGN LAB EVAL8 followed by "DESIGN MANAGER
4. Open the run text editor from microsim window and start writing PSPICE program.
5. Save the program with .cir extension.
6. Open the run spice A/D window from microsim window.
7. Open the file menu from run spice A/D window and then the saved circuit file.
8. If there are any errors, simulates will be displayed as "simulation error occurred".
9. To see the errors click on o/p file icon and open examine o/p.
10. To make changes in the program ,open the circuit file, modify ,save and run the program.
11. If there are no errors simulation will be completed & a statement "simulation completed" will be displayed.
12. To see the o/p , click on o/p file icon and open examine o/p and note down the values.
13. If probe command is used in the program,click on o/p file icon and open run probe.Select variables to plot on graphical window and observe the output plots.

PROGRAM CODE :

```
Vs1 0 Sin(0 325.27 50)
Vg1 2 4 Pulse(0v 10v 5000us 1ns 1ns100us 20000us)
Vg2 3 1 Pulse(0v 10v 15000us 1ns 1ns100us 20000us)
R 4 5 2.5
L 5 6 6.5mh
Vx6 0 Dc 0v
Cs 1 7 0.1uf
Rs7 4 75
* Subcircuit Calls For Thyristor Model
Xt1 1 4 2 4 Scr
Xt2 4 1 3 1 Scr
.SubcktScr1 2 3 2
S1 1 5 6 2 Smod
Rg3 4 50
Vx4 2 Dc 0v
Vy5 2 Dc 0v
Rt2 6 1
Ct 6  2 10uf
F1 2 6 Poly(2) VxVy0 50 11
.Model SmodVswitch (Ron=0.0105 Roff=10e+5 Von=0.1v Voff=0v)
.Ends Scr
.Tran 0 40ms
.Probe
.Options Abstol= 1.00n Reltol = 1.0m Vntol=1.0m Itl5=10000
.Four 60 I(Vx)
.End
```

RESULT:

Circuit Diagram:
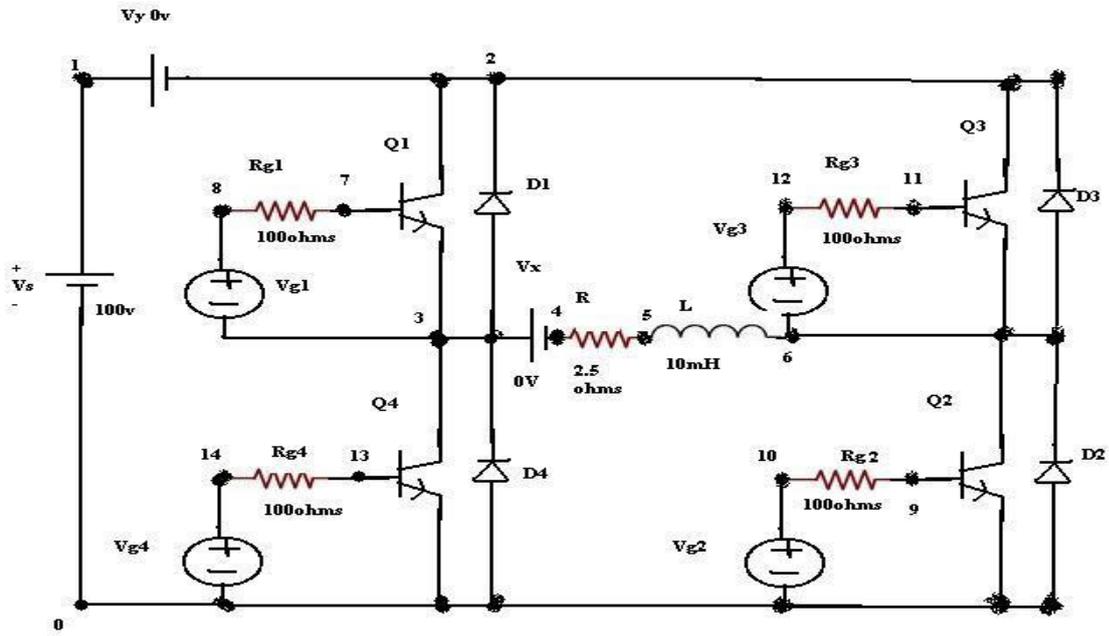
13.PSPICE SIMULATION OF SINGLE PHASE CONVERTER WITH PWM INVERTER

AIM : The objective is to study and analyze the working of a single phase inverter with a PWM
control and plot the output voltage at different load conditions.

APPARATUS : PSPICE Software

PROBLEM: The single phase inverter uses the PWM control with fire pulses per half cycle the DC supply voltage is vs=100v. the modulation index m is 0.6 the output frequency is fo=60Hz. The load is resistive with R=2.5Ω. use pspice
a) To plot the output voltage vo
b) To calculate its fourier co efficient the spice model parameters of the transistor are
Is=6.7342µF, BF=416.4, CJC=3.638p, and CJE=4.493p and that of diodes are Is=2.2E-15,
BV=1800v, TT=0.

THEORY :
PWM inverter are gradually taking over types of inverter induced applications PWM techniques are characterized by constant amplitude pulses. The width of these pulses is however,
modulated to obtained inverter output voltage control and to reduce harmonic content.
This method of pulse modulator is an extension of single phase pulse modulator. In multi pulse
modulation (MPM) several equidistant pulses per help cycle are used for simplicity the effect utility two symmetrical special pulse per half cycle.

PROCEDURE :

1. Represent the nodes for the given circuit.

2. Write PSPICE program by initializing all the circuit parameters as per given flow chart.

3. From the desktop of the computer click on START menu followed by "programs" and by clicking appropriate program group as DESIGN LAB EVAL8 followed by "DESIGN MANAGER

4. Open the run text editor from microsim window and start writing PSPICE program.

5. Save the program with .cir extension.

6. Open the run spice A/D window from microsim window.
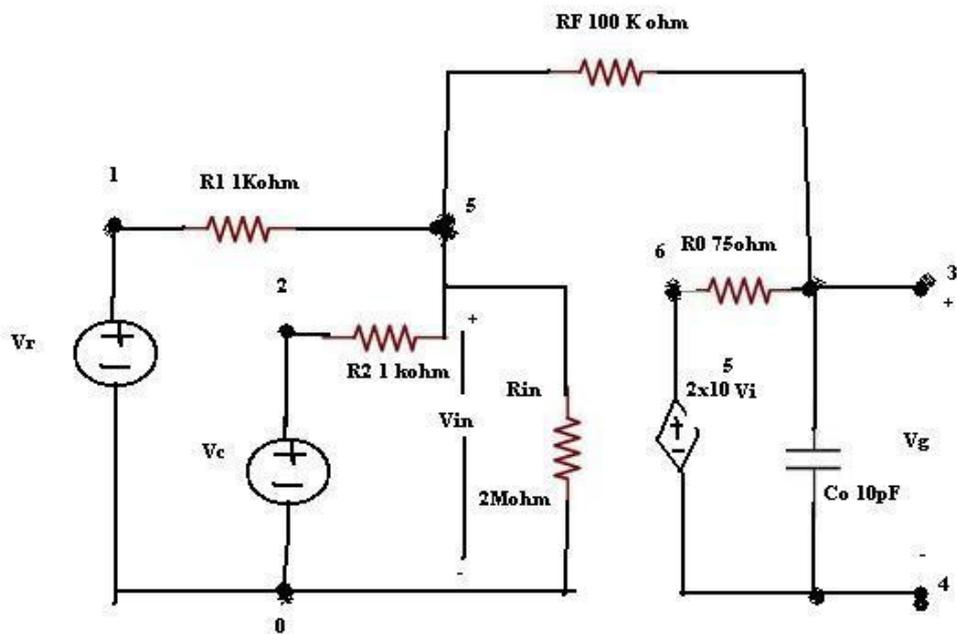
PWM Generator

7. Open the file menu from run spice A/D window and then the saved circuit file.

8. If there are any errors, simulates will be displayed as "simulation error occurred".

9. To see the errors click on o/p file icon and open examine o/p.

10. To make changes in the program ,open the circuit file, modify ,save and run the program.

11. If there are no errors simulation will be completed & a statement "simulation completed" will be displayed.

12. To see the o/p , click on o/p file icon and open examine o/p and note down the values.

13. If probe command is used in the program,click on o/p file icon and open run probe.Select variables to plot on graphical window and observe the output plots.

PROGRAM CODE :

```
*Single phase inverter with PWM control
Vs 1 0 dc 100v
vr 17 0 pulse(50v 0v 0 833.33us 833.33us 1ns 1666.667us)
Rr 17 0 2meg
Vc1 15 0 pulse(0v -30v 0 1ns 1ns 8333.33us 16666.67us)
Rc1 15 0 2meg
Vc3 16 0 pulse(0v -30v 8333.33us 1ns 1ns 8333.33us 16666.67us)
Rc3 16 0 2meg
R 4 5 8
L 5 6 1uH
Vx 3 4 dc 0v
Vy 1 2 dc 0v
D1 3 2 dmod
D2 0 6 dmod
D3 6 2 dmod
D4 0 3 dmod
.model dmod d(is=2.2e-15 BV=1800 TT=0)
Q1 2 7 3 qmod
Q2 6 9 0 qmod
Q3 2 11 6 qmod
Q4 3 13 0 qmod
.model qmod npn(Is=6.73µF BF=416.4 CJC=3.638p CJE=4.493p)
Rg1 8 7 100

Rg2 10 9 100

Rg3 12 11 100
```

OUTPUT WAVEFORMS :

CARRIER AND REFERENCE SIGNAL :
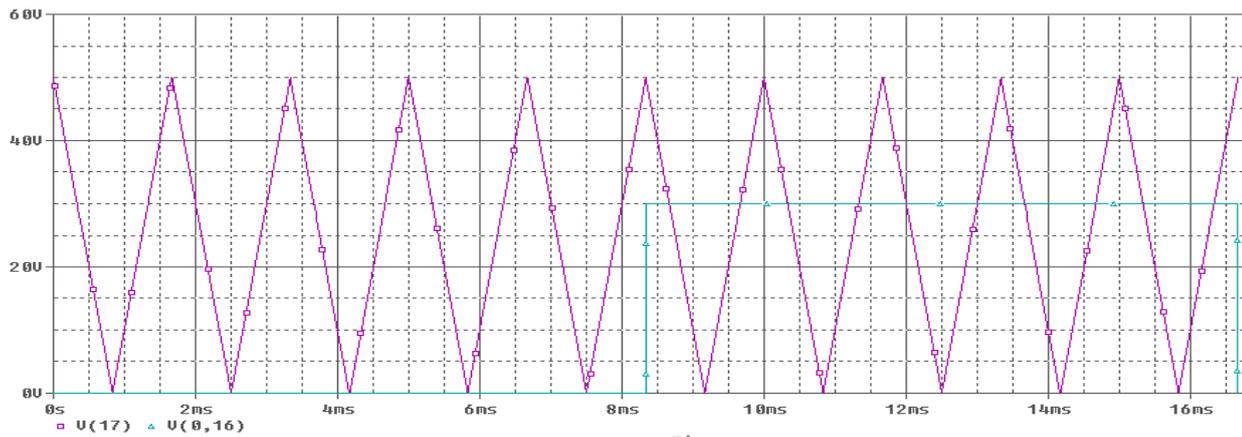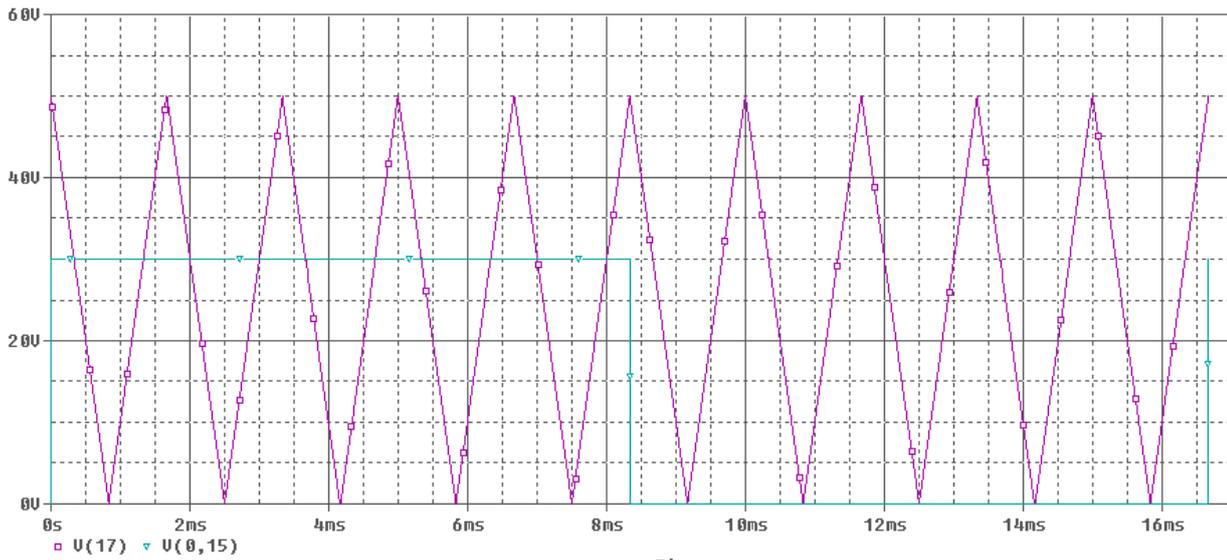
Output Voltage
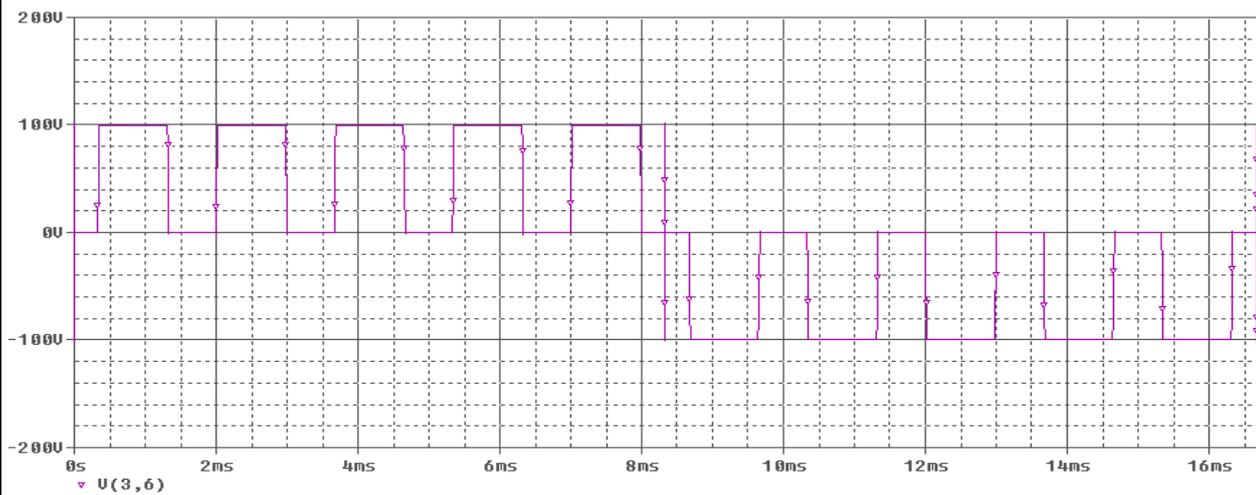
```
Rg4 14 13 100

*subckt call for pwm control
xpwm1 17 15 8 3 pwm
xpwm2 17 15 10 0 pwm
xpwm3 17 16 12 6 pwm
xpwm4 17 16 14 0 pwm
.subckt pwm 1 2 3 4
*model ref carrier +control -control
*name input input voltage voltage

R1 1 5 1k
R2 2 5 1k
Rin5 0 2meg
Rf5 3 100k
Ro 6 3 75
Co 3 4 10pf
E1 6 4 0 5.2e+5
.Endspwm
.Tran 100us 16.67ms 0 10us

.Probe
.options abstol=1.00n reltol=0.01 vntol=0.1 ITL5=20000
.Four 60 v(3,6)

.end
```

Result

CIRCUIT DIAGRAM :
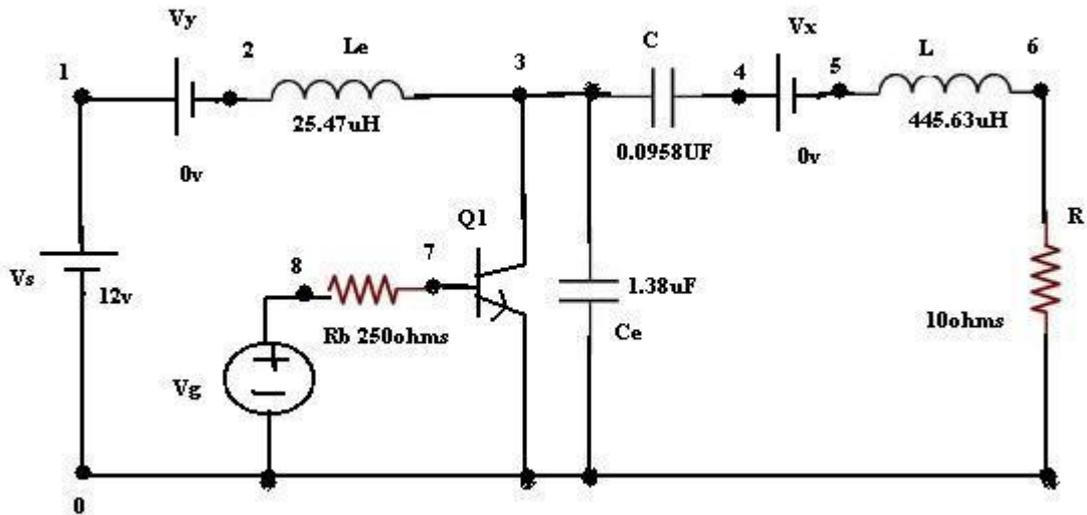
CIRCUIT DIAGRAM OF BUCK CONVERTER :
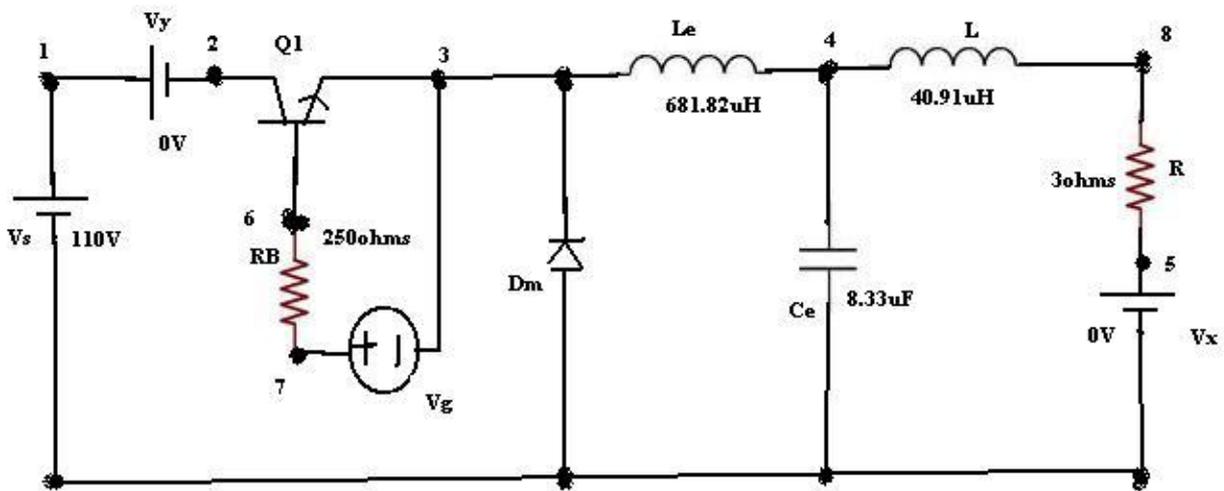
14. PSPICE SIMULATION OF RESONANT PULSE COMMUTATION AND BUCK CHOPPER

AIM : Study of resonant pulse commutation circuit and Buck chopper with PSPICE simulation.

APPARATUS : PSPICE Software

PROCEDURE :

1. Represent the nodes for the given circuit.

2. Write PSPICE program by initializing all the circuit parameters as per given flow chart.

3. From the desktop of the computer click on START menu followed by "programs" and by clicking appropriate program group as DESIGN LAB EVAL8 followed by "DESIGN MANAGER

4. Open the run text editor from microsim window and start writing PSPICE program.

5. Save the program with .cir extension.

6. Open the run spice A/D window from microsim window.

7. Open the file menu from run spice A/D window and then the saved circuit file.

8. If there are any errors,simulates will be displayed as "simulation error occurred".

9. To see the errors click on o/p file icon and open examine o/p.

10. To make changes in the program ,open the circuit file, modify ,save and run the program.

11. If there are no errorssimulation will be completed & a statement "simulation completed" will be displayed.

12. To see the o/p , click on o/p file icon and open examine o/p and note down the values.

13. If probe command is used in the program,click on o/p file icon and open run probe.Select variables to plot on graphical window and observe the output plots.

PROGRAM CODE FOR RESONANT PULSE COMMUTATION :

OUTPUT WAVEFORMS :
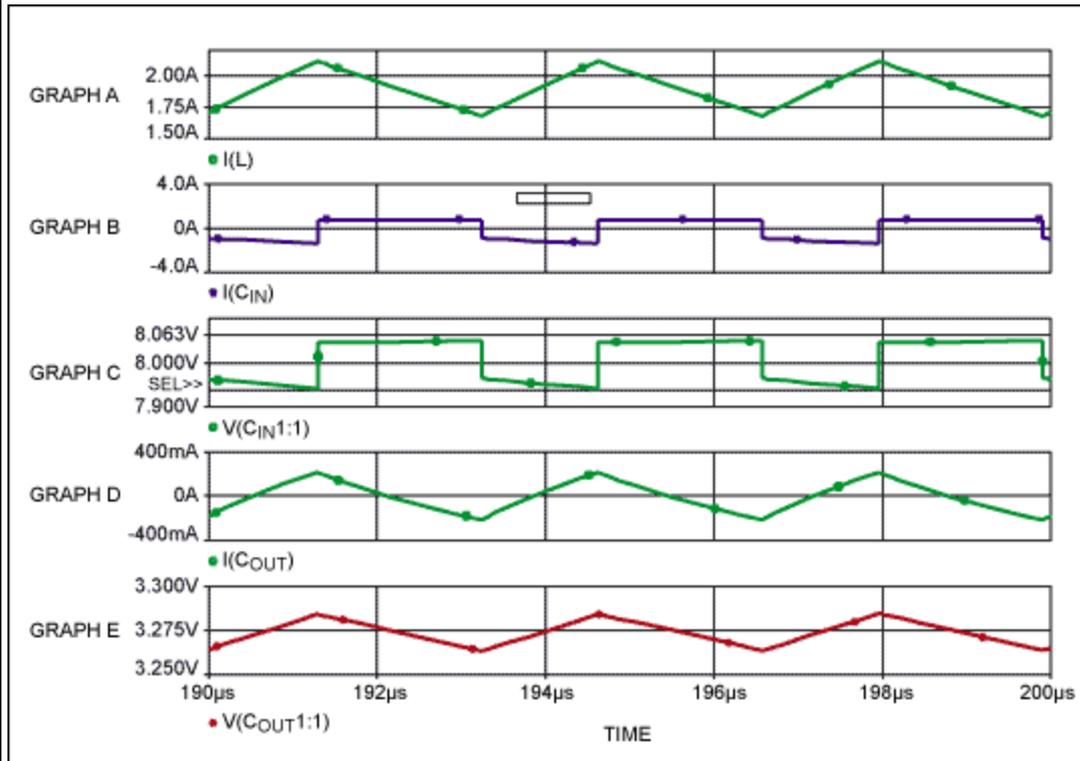
```
VS 1 0 DC 12V
VY 1 2 DC 0V
VG 8 0 PULSE(0V 20V 0 1NS 1NS 12.24US 40US)
RB 8 7 250
R 6 0 10
LE 2 3 25.47UH
CE 3 0 1.38UF
C 3 4 0.0958UF
L 5 6 445.63UH
VX 4 5 DC 0V
Q1 3 7 0 MODQ1
.MODEL MODQ1NPN (IS=6.734F BF=416.4 ISE=6.734F BR=.7371
+ CJE=3.637P MJC=0.3085 VJC=.75 CJE=4.493P MJE=.2593 VJE=.75
+ TR=239.5N TF=301.2P)
.TRAN 2US 300US 180US 1US UIC
.PROBE
.OPTIONS ABSTOL=1.00N VNTOL=0.1 ITL5=20000
.END
```

PROGRAM CODE FOR BUCK CHOPPER :

```
VS 1 0 DC 110V
VY 1 2 DC 0V
VG 7 3 PULSE (0V 20V 0 0.1NS 0.1NS 27.28US 50US
RB 7 6 250
LE 3 4 681.82UHCE 4 0 8.33UF IC=60V
L 4 8 40.91UH
R 8 5 3
VX 5 0 DC 0V
DM 0 3 DMOD
.MODEL DMOD D (IS=2.2E-15 BV=1800V TT=0)
Q1 2 6 3 QMOD
.MODEL QMOD NPN (IS=6.734F BF=416.4 BR=.7371
CJC=3.638P + CJE=4.493P TR=239.5N TF=301.2P)
.TRAN 1US 1.6MS 1US UIC
.PROBE
.OPTIONS ABSTOL=1.00N RELTOL=0.01 VNTOL=0.1 ITL5=50000
.FOUR 20KHZ I(VY)
.END
```

Result