

# V-I CHARACTERISTICS OF SCR

## **AIM:**

To obtain V-I characteristics and to find on-state forward resistance of given SCR.

To determine holding, latching current and break over voltage of given SCR.

**APPARATUS REQUIRED:** Trainer kit, Patch cards, Multimeters.

## **CIRCUIT DIAGRAM:**

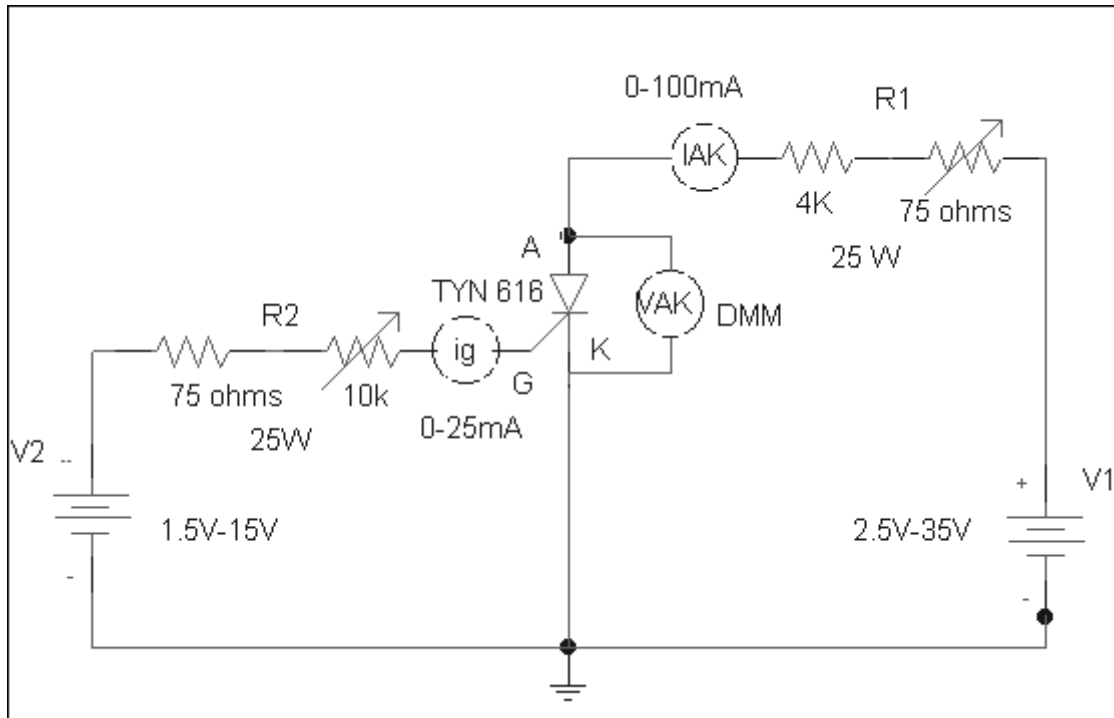


Fig 1.1(a) Circuit diagram for VI characteristics of SCR.

VBO = Forward break over voltage

VBR = Reverse break over voltage

$I_g$  = Gate current

## **Characteristic curve:**

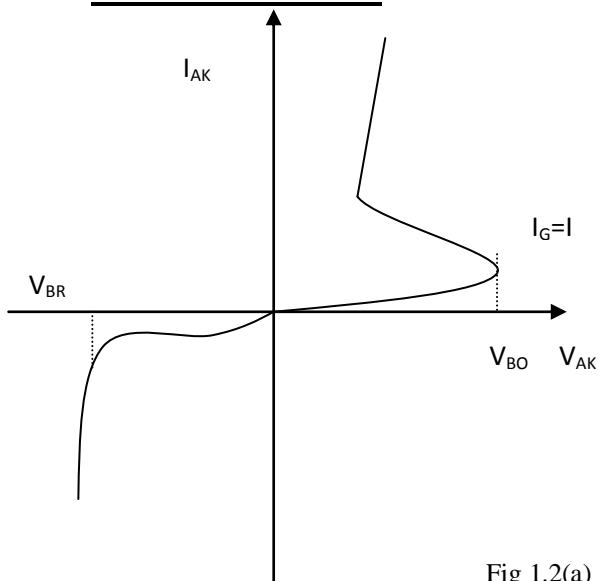


Fig 1.2(a) Static characteristic of SCR.

**TABULAR COLUMN:**

Gate current  $I_G = I_{G1} = \dots \text{mA}$

$V_{AK}$ (Volts)	$I_A$ (mA)

**PROCEDURE:**

- Connections are made as shown in the circuit diagram.  
Set  $R_1$  and  $R_2$  to mid position and  $V_1$  and  $V_2$  to minimum
- Set the gate current  $I_G = I_{G1}$  (such that forward break over voltage is between 15 to 20 V), by varying  $R_2$  and  $V_2$ .
- Slowly vary  $V_1$  in steps of 2V and note down  $V_{AK}$  and  $I_{AK}$  at each step till SCR conducts. (Note down maximum  $V_{AK}$ , which is forward break over voltage just before SCR conducts).

**FINDING LATCHING CURRENT:**

- Ensure that the SCR is in the state of conduction.
- Start reducing ( $V_{AK}$ ) anode voltage in steps of 2V; simultaneously check the state of SCR by switching off gate supply  $V_2$ . If SCR switches off just by removing gate terminal, and switches on by connecting gate supply, then the corresponding anode current  $I_A$  is the latching current ( $I_L$ ) for the SCR.

**FINDING HOLDING CURRENT:**

- Ensure that the SCR is in the state of conduction.
- Switch off the gate supply permanently.
- Start reducing ( $V_{AK}$ ) anode voltage in steps of 2V; simultaneously check the state of SCR. If SCR switches off. Note down the anode current ( $I_A$ ) just before it drops to zero, which will be  $I_H$ .
- Reverse the anode voltage polarity.
- Vary  $V_{AK}$  in steps of 5V till 25V and note down  $V_{AK}$  and  $I_A$  values at each step
- Plot forward and reverse characteristics using the above-tabulated values. Find the SCR forward resistance using the graph.
- Repeat the above procedure for the forward and reverse characteristics of SCR for a gate current  $I_g = I_{g2}$ .

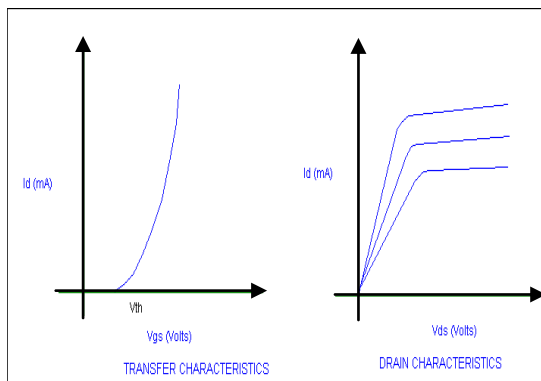
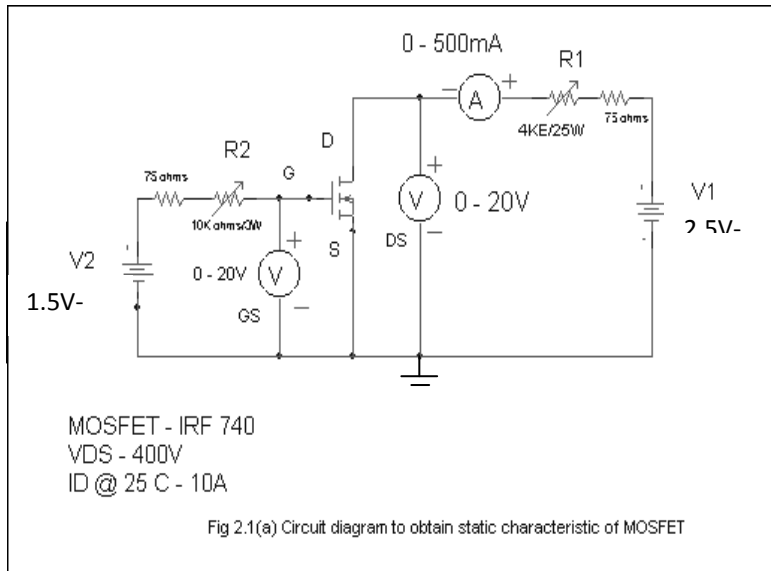
**RESULT:** The values of  $V_{AK}$  and  $I_{AK}$  are noted down, plotted and SCR forward resistance is found. The values obtained are verified.

# CHARACTERISTICS OF MOSFET

**AIM:** To draw static characteristic of MOSFET and hence to determine the output resistance and Trans conductance.

**APPARATUS REQUIRED:** MOSFET module, Multimeters, patch chords.

**CIRCUIT DIAGRAM:**



1. Connect the circuit as shown in the fig 2.1 (a).
2. Set V<sub>DS</sub> = 10V by varying V1. Keep R1 slightly more than ¼ of the total value.
3. Vary V<sub>GS</sub> by varying V2 (keep R2 to minimum position) and note down I<sub>DS</sub> for every 0.5V variation of V<sub>GS</sub> till 5V of V<sub>GS</sub>.
4. Min V<sub>GS</sub> voltage that is required for conduction is "Threshold voltage" (V<sub>TH</sub>).
5. Repeat the above experiment for different values of V<sub>DS</sub> = 15V.

**Tabular Column:**

$V_1 = V_{DS1} = 10V$	
$V_{GS}$ V	$I_{DS}$ (mA)
0V	
8V(Max)	

$V_1 = V_{DS2} = 15V \text{ or } 12V$	
$V_{GS}$ V	$I_{DS}$ (mA)
0V	
8V(Max)	

**(b) Drain Characteristics:**

- Rig up the circuit as shown in the fig 2.1(a).
- Adjust  $V_G$  by varying  $V_2$  to  $V_{TH}$ .
- Vary  $V_{DS}$  by varying  $V_1$  in steps of 0.5v and note down  $I_{DS}$  (Till  $I_{DS}$  is constant).
- Repeat the above procedure for different values of  $V_{GS2} = V_{TH} \pm 0.1 V$ .

**TABULAR COLUMN:**

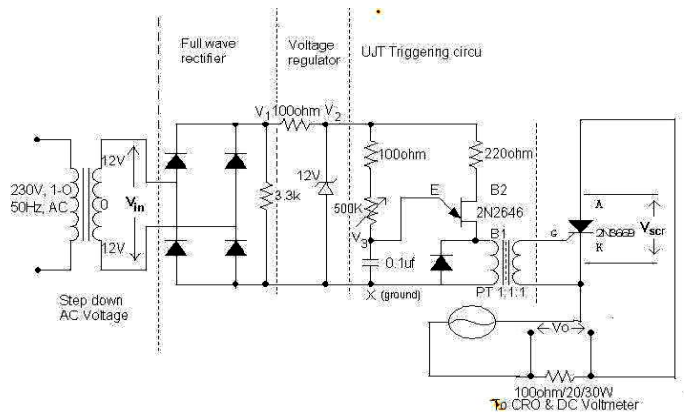
$V_{GS} = V_{GS1} = V_{TH}$	
$V_{DS}$ (V)	$I_{DS}$ (mA)

$V_{GS} = V_{GS2} = V_{TH} \pm 0.1 V.$	
$V_{DS}$ (V)	$I_{DS}$ (mA)

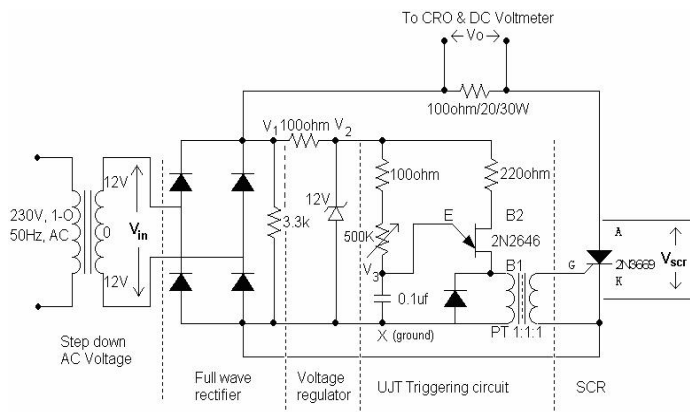
**RESULT:** The transfer characteristics & collector characteristics are obtained and their respective graphs are plotted and output resistance and Trans conductance are found.

## UJT firing circuit for HWR and FWR circuits.

### HWR



### FWR



AIM: - To study the performance & waveforms of U.J.T triggering of S.C.R.

APPARATUS REQUIRED: CRO probes, Patch cords, UJT trainer kit, Digital Multimeters.

#### PROCEDURE:

1. Connections are made as shown in the circuit diagram
2. By varying a resistance R gradually in step by step, note down the corresponding values of  $V_n$  &  $V_m$  from CRO and  $V_{dc}$  ( $V_{oPractical}$ ) from D.C voltmeter. The readings are tabulated in the tabular column.
3. If firing angle ranges from  $0$  to  $90^\circ$ , then firing angle can be calculated

From

$$\alpha = \sin^{-1}(V_n/V_m) \text{ in degrees}$$

If firing angle ranges from  $90^\circ$  to  $180^\circ$ , then firing angle can be calculated by using a formula,

$$\beta = 180 - \sin^{-1}(V_n/V_m) \text{ in degrees}$$

4. The conduction angle  $\beta$  can be calculated by using a formula,

$$\beta = 180 - \alpha \text{ in degrees}$$

5. The current & power is calculated by

$$I_{dc} = V_{dc} / R \text{ Amps}$$

$$P_{dc} = V_{dc}^2 / R \text{ Watts}$$

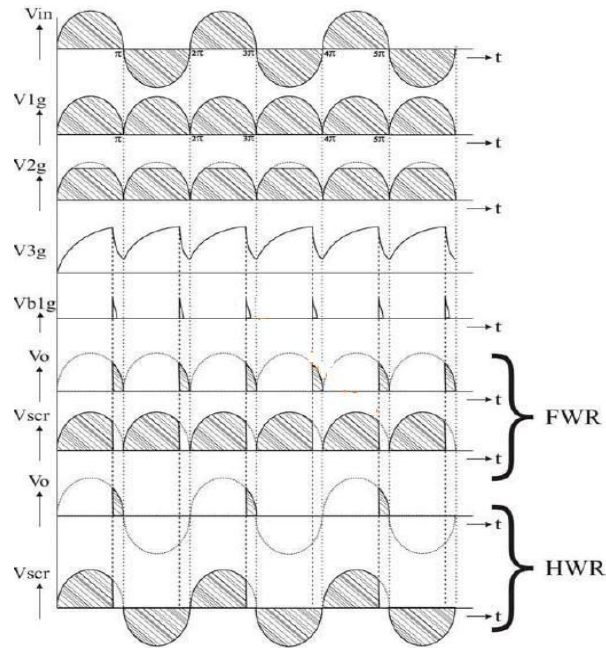
Compare  $V_{oth}$  with  $V_{oPractical}$

where  $V_{oth}(HWR) = (V_m / 2\pi)(1 + \cos \alpha)$

$$V_{oth}(FWR) = (V_m / \pi)(1 + \cos \alpha)$$

6. A graph of  $V_{dc}$  v/s  $\alpha$ ,  $V_{dc}$  v/s  $\beta$ ,  $I_{dc}$  v/s  $\alpha$ ,  $I_{dc}$  v/s  $\beta$ ,  $P_{dc}$  v/s  $\alpha$ , and  $P_{dc}$  v/s  $\beta$  are to be plotted on a graph sheet.

IDEAL WAVEFORMS



TABULAR COLUMN

Draw the table HWR & FWR Wave form

Sl. No	FROM C.R.O								$V_{dc} = \frac{V_{load}}{R}$ volts	$I_{dc} = \frac{V_{dc}}{R}$ A	$P_{dc} = \frac{V_{dc}^2}{R}$ Watts	$V_{oth}$
	0 TO 90°				90° TO 180°							
	$V_n$ volts	$V_m$ volts	$\alpha = \sin^{-1}\left(\frac{V_n}{V_m}\right)$	$\beta = 180 - \alpha$	$V^n$ volts	$V^m$ volts	$\alpha = 180 - \sin^{-1}\left(\frac{V}{V_m}\right)$	$\beta = 180 - \alpha$				

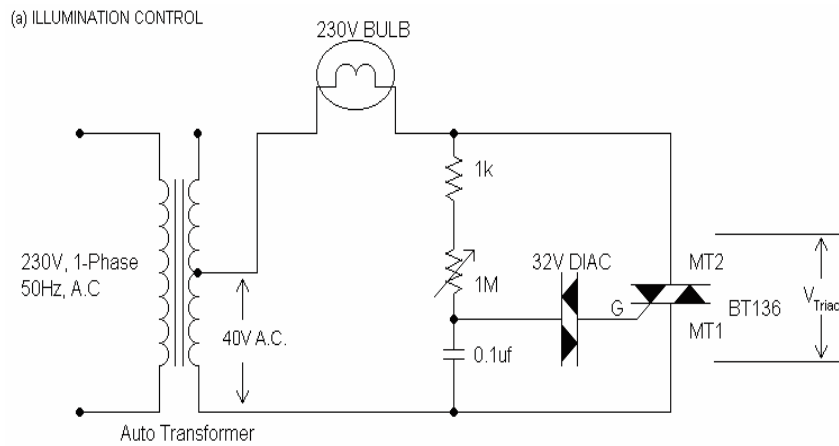
Graph:-



VIVA QUESTIONS: -

1. Explain the working operation of U.J.T. triggering circuit waveforms?
2. Why U.J.T. Triggering circuit is superior when compared to R & RC triggering circuit?
3. What is the use of pulse transformer?
4. Explain the design part of UJT?
5. Write equivalent circuit of UJT and show that  $V_{peak} = V_{emitter} = V_{\gamma} + \eta V_{BB}$ .
6. Why do we require turn-on circuits for thyristors?
7. Why do we require turn-off circuits for thyristors?
8. Comment on Forced & Natural Commutation techniques.

## AC Voltage Control by using TRIAC-DIAC Combination



**AIM:** - To study the AC voltage control by using TRIAC-DIAC combination

**APPARATUS REQUIRED:** Patch cords, Multimeters, Isolation Transformer, 10:1 probes, lamp, Triac Module.

**PROCEDURE:** -

A.

1. Connections are made as shown in the circuit diagram
2. By varying the variable resistance R1 in step by step, observe the variation of intensity of light.

B.

1. Connections are made as shown in the circuit diagram
2. By varying the resistance R, in step-by-step note down the corresponding values of  $V_n$  &  $V_m$  from C.R.O. and  $V_{a.c.}(V_{oPractical})$  from A.C. voltmeter the readings are tabulated in the tabular column
3. If firing angle ranges from  $0$  to  $90^\circ$ , then firing angle can be calculated  
From  $\alpha = \sin^{-1}(V_n/V_m)$  in degrees
- If firing angle ranges from  $90^\circ$  to  $180^\circ$ , then firing angle can be calculated by using a formula,  $\beta = 180 - \sin^{-1}(V_n/V_m)$  in degrees
4. The conduction angle  $\beta$  can be calculated by using a formula,

$$\beta = 180 - \alpha \text{ in degrees}$$

5. The current & power is calculated by

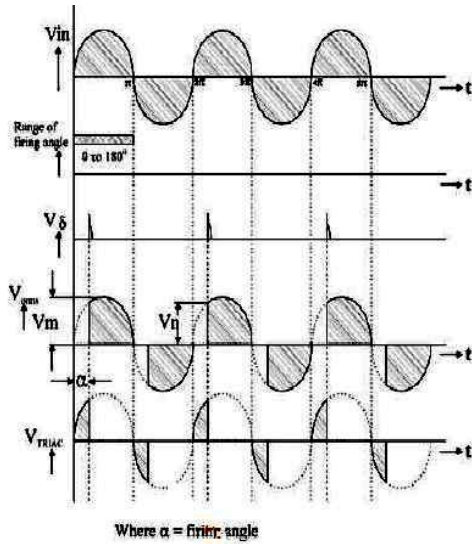
$$I_{dc} = V_{dc} / R \text{ Amps}$$

$$P_{dc} = V_{dc}^2 / R \text{ Watts}$$

Compare  $V_{oth}$  with  $V_{oPractical}$  where  $V_{oth} = V_{inrms} \sqrt{(1/\pi) (\pi - \alpha + \sin(\frac{2\alpha}{2}))}$

6. A graph of  $I_{ac}$  v/s  $\alpha$ ,  $V_{ac}$  or load voltage v/s  $\alpha$  are to be plotted are to be plotted on a graph sheet.

IDEAL WAVEFORMS



TABULAR COLUMN

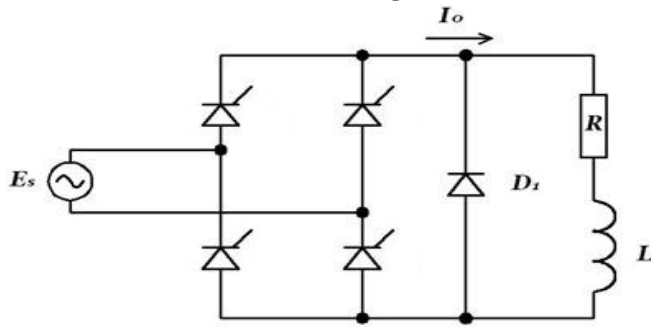
Sl. No	FROM C.R.O								$V_{oc}$ ( $V_{load}$ ) volts	$I_{dc} =$ $V_{dc}/R$ A	$P_{dc} =$ $V_{dc}^2/R$ Watts	$V_{oth}$
	0 TO 90°				90° TO 180°							
	$V_n$ volts	$V_m$ volts	$\alpha = \sin^{-1}\left(\frac{V_n}{V_m}\right)$	$\beta = 180 - \alpha$	$V^n$ volts	$V^m$ volts	$\alpha = 180 - \sin^{-1}\left(\frac{V^n}{V^m}\right)$	$\beta = 180 - \alpha$				

VIVA QUESTIONS: -

1. Explain the features of TRIAC?
2. Explain the working operation of illumination control & various voltage output waveforms by using TRIAC?
3. Compare S.C.R, DIAC & TRIAC?
4. What is universal motor?
5. Comment on the different graphs of this experiment?
6. Mention the applications of TRIAC?



## Single Phase Full Wave Controlled Rectifier



**AIM: -**

1. To study the performance and waveforms of full wave controlled rectifier with Resistance load and Inductive load
2. Plot a graph of VO v/s for R-load

**APPARATUS REQUIRED:** Trainer module, Multimeters, CRO ,Patch cords Rheostat, inductor.

**PROCEDURE:**

1. Connections are made as shown in the circuit diagram
2. By varying a resistance R gradually in step by step, note down the corresponding values of Vn & Vm from CRO and  $V_{Odc}(V_{oPractical})$  from D.C voltmeter. The readings are tabulated in the tabular column.

3. If firing angle ranges from  $0$  to  $90^\circ$ , then firing angle can be calculated From

$$\alpha = \sin^{-1}(V_n/V_m) \text{ in degrees}$$

If firing angle ranges from  $90^\circ$  to  $180^\circ$ , then firing angle can be calculated by using a formula,

$$\beta = 180 - \sin^{-1}(V_n/V_m) \text{ in degrees}$$

4. The conduction angle  $\beta$  can be calculated by using a formula,

$$\beta = 180 - \alpha \text{ in degrees}$$

5. The current & power is calculated by

$$I_{dc} = V_{dc} / R \text{ Amps}$$

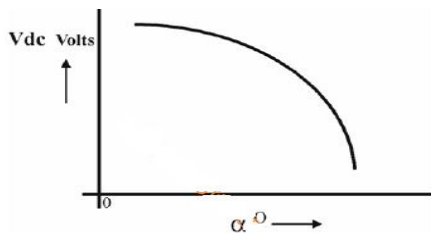
$$P_{dc} = V_{dc}^2 / R \text{ Watts}$$

Compare  $V_{oth}$  with  $V_{oPractical}$  where  $V_{oth} = (V_m / \pi)(1 + \cos \alpha)$

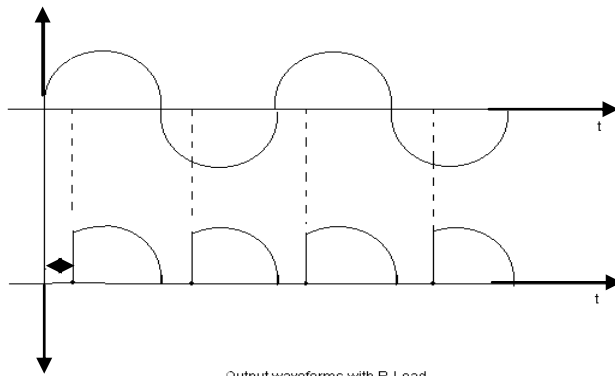
6. A graph of Vdc v/s  $\alpha$ , Vdc v/s  $\beta$ , Idc v/s  $\alpha$ , Idc v/s  $\beta$ , Pdc v/s  $\alpha$ , and Pdc v/s  $\beta$  are to be plotted on a graph sheet.

7. Plot a graph of VDC or Vload or VO v/s firing angle  $\alpha$ , with R load, R-L load without freewheeling diode, R L with Free wheeling diode.

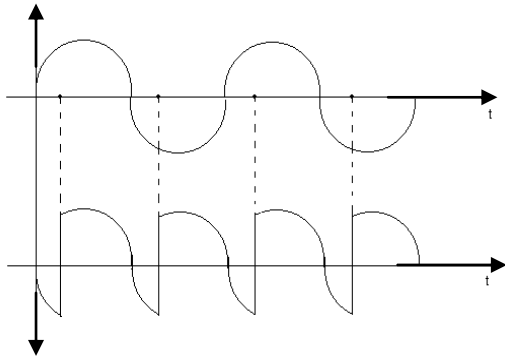
**Graph**



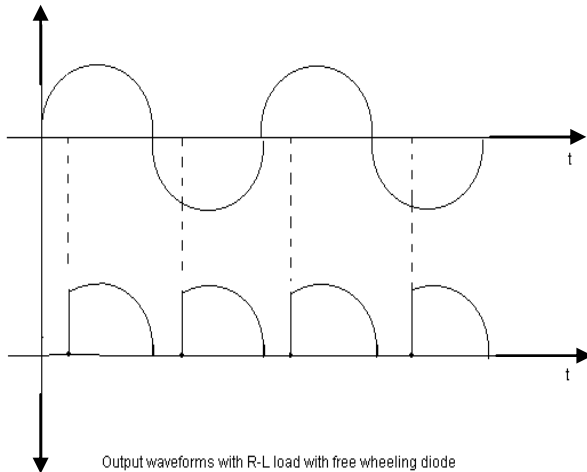
**Expected Wave forms:**



Output wave form with R load



Output waveforms across R-L load without freewheeling diode



Output waveforms with R-L load with free wheeling diode

Output waveforms across R-L load with freewheeling diode.

**TABULAR COLUMN**

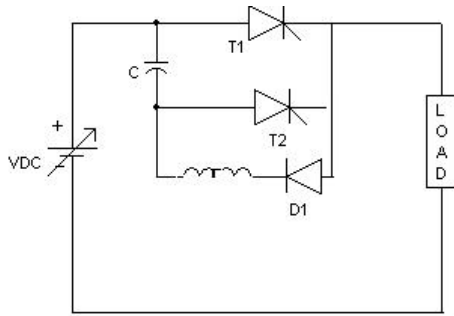
Draw the table for Output wave form with R load, Output waveforms across R-L load without freewheeling diode, R L with Free wheeling diode.

Sl. No	FROM C.R.O								$V_{dc}$ ( $V_{load}$ ) volts	$I_{dc} =$ $V_{dc}/R$ A	$P_{dc} =$ $V_{dc}^2/R$ Watts	$V_{oth}$
	0 TO 90°				90° TO 180°							
	$V_n$ volts	$V_m$ volts	$\alpha = \sin^{-1}\left(\frac{V_n}{V_m}\right)$	$\beta = 180 - \alpha$	$V^n$ volts	$V^m$ volts	$\alpha = 180 - \sin^{-1}\left(\frac{V}{V_m}\right)$	$\beta = 180 - \alpha$				

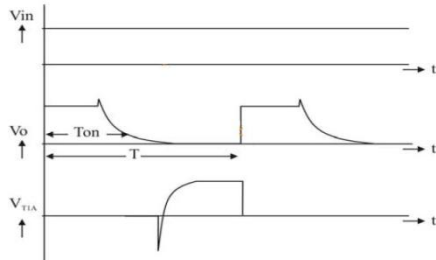
**VIVA QUESTIONS: -**

1. Explain the performance and working operation of single-phase full controlled rectifier with relevant waveforms for Resistive load, Inductive load.
2. Compare H.C.R with F.C.R
3. In cyclo-converter, why H.C.R with Inductive load cannot be implemented

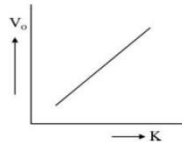
## AUXILLARY COMMUTATION MODULE



**Wave forms:-**



**Graph:-**



*Aim-* To study SCR turn off using Auxiliary Commutation

*APPARATUS REQUIRED:* CRO probes, Patch cords, trainer kit, Digital Multimeters.

*Procedure:* -

1. Connections are made as shown in the circuit diagram.
2. Input DC voltage is set to convenient value (10v to 25v).
3. By varying duty cycle knob of triggering circuit module step by step gradually note down corresponding Ton and T from the CRO and VO from DC voltmeter and tabulate.
4. Duty cycle 'K' is calculated by using  $K = T_{ON} / T$
5. A graph of VO v/s K is plotted.
6. Observe load and device voltage waveforms.

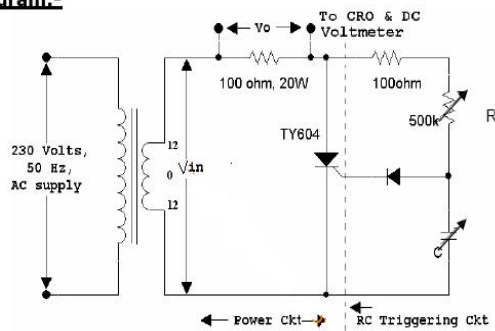
**TABULAR COLUMN**

Sl. No.	Duty Cycle knobs	T <sub>ON cRO</sub>	T <sub>CRO</sub>	K = $\frac{T_{ON}}{T}$	Vo (V)

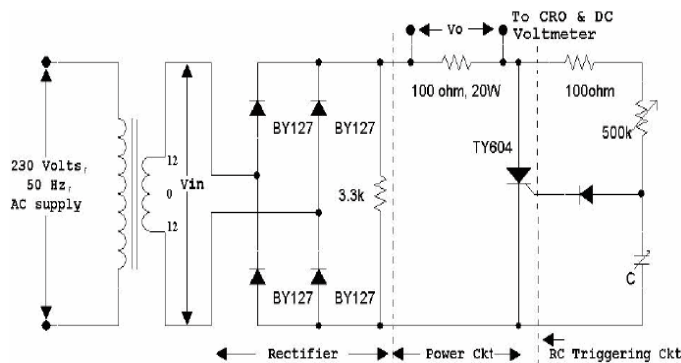
## Controlled HWR and FWR using RC triggering circuit

### HWR

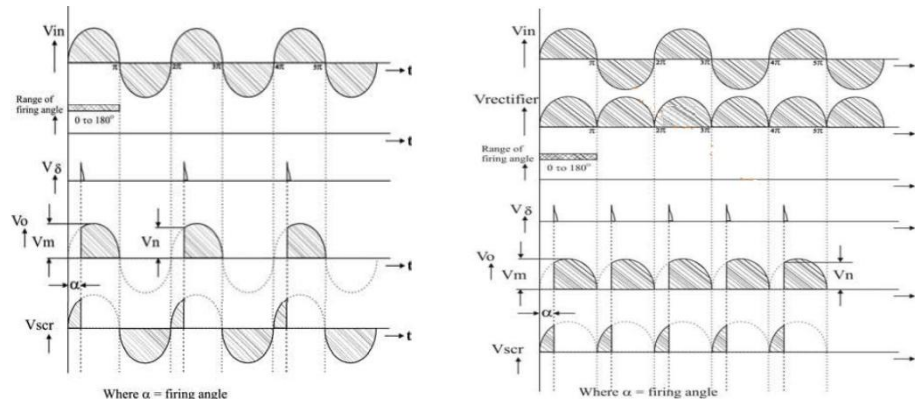
#### Circuit diagram:-



### FWR



### HWR & FWR Wave form



#### AIM: -

To study the performance & waveforms of HWR & FWR by using RC triggering Circuit

**APPARATUS REQUIRED:** CRO probes, Patch cords, trainer kit, Digital Multimeters.

#### PROCEDURE:

1. Connections are made as shown in the circuit diagram
2. By varying a resistance R gradually in step by step, note down the corresponding values of  $V_n$  &  $V_m$  from CRO and  $V_{Odc}$  ( $V_{oPractical}$ ) from D.C voltmeter. The readings are tabulated in the tabular column.
3. If firing angle ranges from 0 to  $90^\circ$ , then firing angle can be calculated

From

$$\alpha = \sin^{-1}(V_n/V_m) \text{ in degrees}$$

If firing angle ranges from  $90^\circ$  to  $180^\circ$ , then firing angle can be calculated by using a formula,

$$\beta = 180 - \sin^{-1}(V_n/V_m) \text{ in degrees}$$

4. The conduction angle  $\beta$  can be calculated by using a formula,

$$\beta = 180 - \alpha \text{ in degrees}$$

5. The current & power is calculated by

$$I_{dc} = V_{dc} / R \text{ Amps}$$

$$P_{dc} = V_{dc}^2 / R \text{ Watts}$$

Compare  $V_{oth}$  with  $V_{oPractical}$

where  $V_{oth}(HWR) = (V_m / 2\pi)(1 + \cos \alpha)$

$$V_{oth}(FWR) = (V_m / \pi)(1 + \cos \alpha)$$

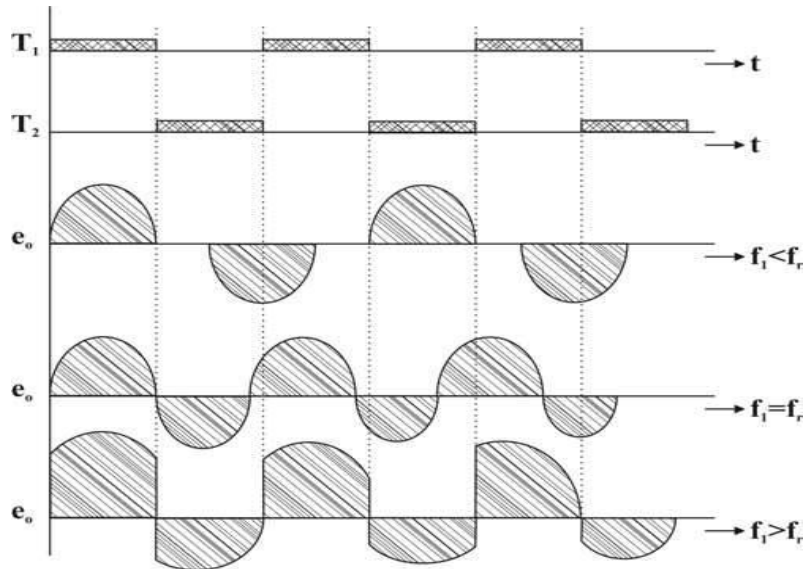
6. A graph of  $V_{dc}$  v/s  $\alpha$ ,  $V_{dc}$  v/s  $\beta$ ,  $I_{dc}$  v/s  $\alpha$ ,  $I_{dc}$  v/s  $\beta$ ,  $P_{dc}$  v/s  $\alpha$ , and  $P_{dc}$  v/s  $\beta$  are to be plotted on a graph sheet.

**TABULAR COLUMN**

Draw the table HWR & FWR Wave form

Sl. No	FROM C.R.O								$V_{dc}$ ( $V_{load}$ ) volts	$I_{dc} =$ $V_{dc}/R$ A	$P_{dc} =$ $V_{dc}^2/R$ Watts	$V_{oth}$
	0 TO 90°				90° TO 180°							
	$V_n$ volts	$V_m$ volts	$\alpha = \sin^{-1}\left(\frac{V_n}{V_m}\right)$	$\beta = 180 - \alpha$	$V^n$ volts	$V^m$ volts	$\alpha = 180 - \sin^{-1}\left(\frac{V^n}{V^m}\right)$	$\beta = 180 - \alpha$				

# Series Inverter



*Aim: -*

To obtain variable AC from DC ripple input.

**APPARATUS REQUIRED:** CRO probes, Patch cords, trainer kit, Digital Multimeters.

*Procedure: -*

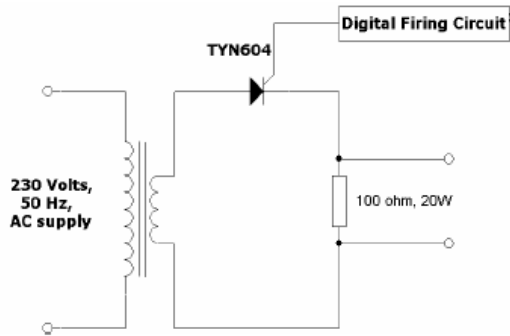
1. To begin with switch on the power supply to the firing circuit check that trigger pulses by varying the frequency.
2. Connections are made as shown in the circuit diagram.
3. Now connect trigger outputs from the firing circuits to gate and cathode of SCRs  $T_1$  &  $T_2$ .
4. Connect DC input from a 30v/2A regulated power supply and switch on the input DC supply.
5. Now apply trigger pulses to SCRs and observe voltage waveform across the load.
6. Measure Vrms & frequency of o/p voltage waveform.

**Resonance frequency: -**

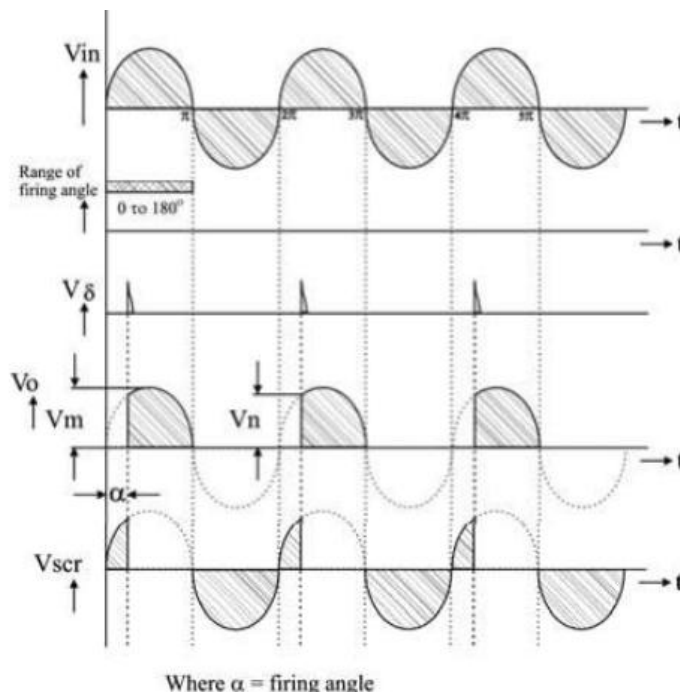
$$f_r = \frac{1}{2\pi} \sqrt{\frac{1}{LC} - \frac{R^2}{4L^2}}$$

# Digital Firing Circuit

Circuit Diagram:



Wave form:-



AIM: -

To demonstrate digital firing circuit to turn on SCR (HW) for R-Load and to plot  $V_{ODC}$  v/s  $\alpha$ .

APPARATUS REQUIRED: CRO probes, Patch cords, Digital Firing Module, Digital Multimeters.

PROCEDURE:

1. Connections are made as shown in the circuit diagram
2. By varying a resistance  $R$  gradually in step by step, note down the corresponding values of  $V_n$  &  $V_m$  from CRO and  $V_{ODC}(V_o \text{ Practical})$  from D.C voltmeter. The readings are tabulated in the tabular column.
3. If firing angle ranges from  $0$  to  $90^\circ$ , then firing angle can be calculated From

$$\alpha = \sin^{-1}(V_n/V_m) \text{ in degrees}$$

If firing angle ranges from  $90^\circ$  to  $180^\circ$ , then firing angle can be calculated by using a formula,

$$\beta = 180 - \sin^{-1}(V_n/V_m) \text{ in degrees}$$

4. The conduction angle  $\beta$  can be calculated by using a formula,

$$\beta = 180 - \alpha \text{ in degrees}$$

5. The current & power is calculated by

$$I_{dc} = V_{dc} / R \text{ Amps}$$

$$P_{dc} = V_{dc} I_{dc} \text{ Watts}$$

Compare  $V_{oth}$  with  $V_{oPractical}$

$$\text{where } V_{oth}(HWR) = (V_m / 2\pi)(1 + \cos \alpha)$$

6. A graph of  $V_{dc}$  v/s  $\alpha$  are to be plotted on a graph sheet.

*TABULAR COLUMN*

Sl. No.	Firing Angle ( $\alpha$ )	$V_{ODC}$

