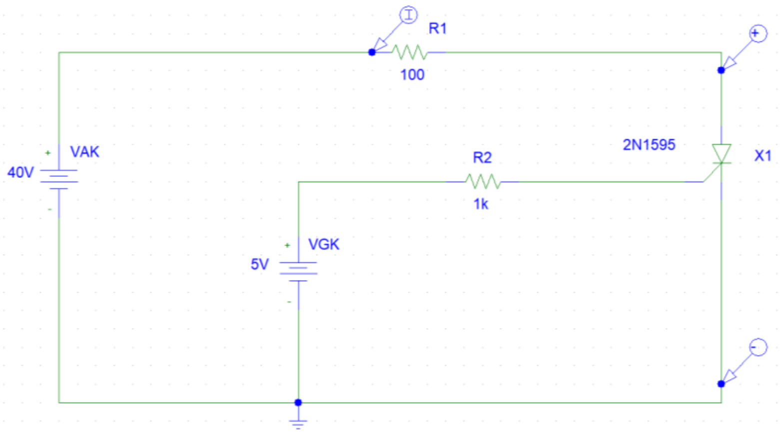
EXPT. NO.1.A

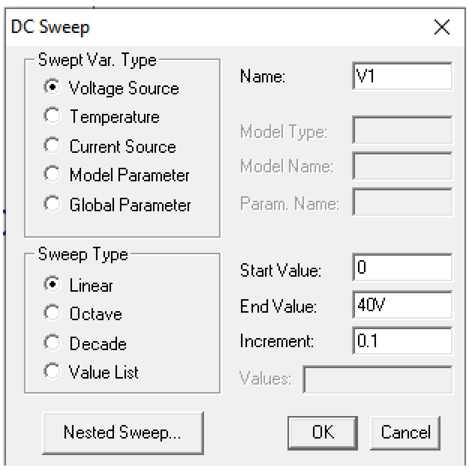
Simulation of Static Characteristics of SCR in PSPICE

AIM: SIMULATION OF STATIC CHARACTERISTICS OF SCR.

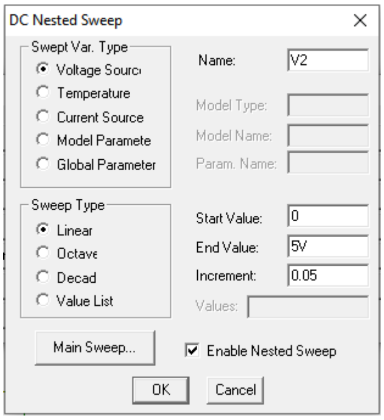


PROCEDURE: (For Schematics)

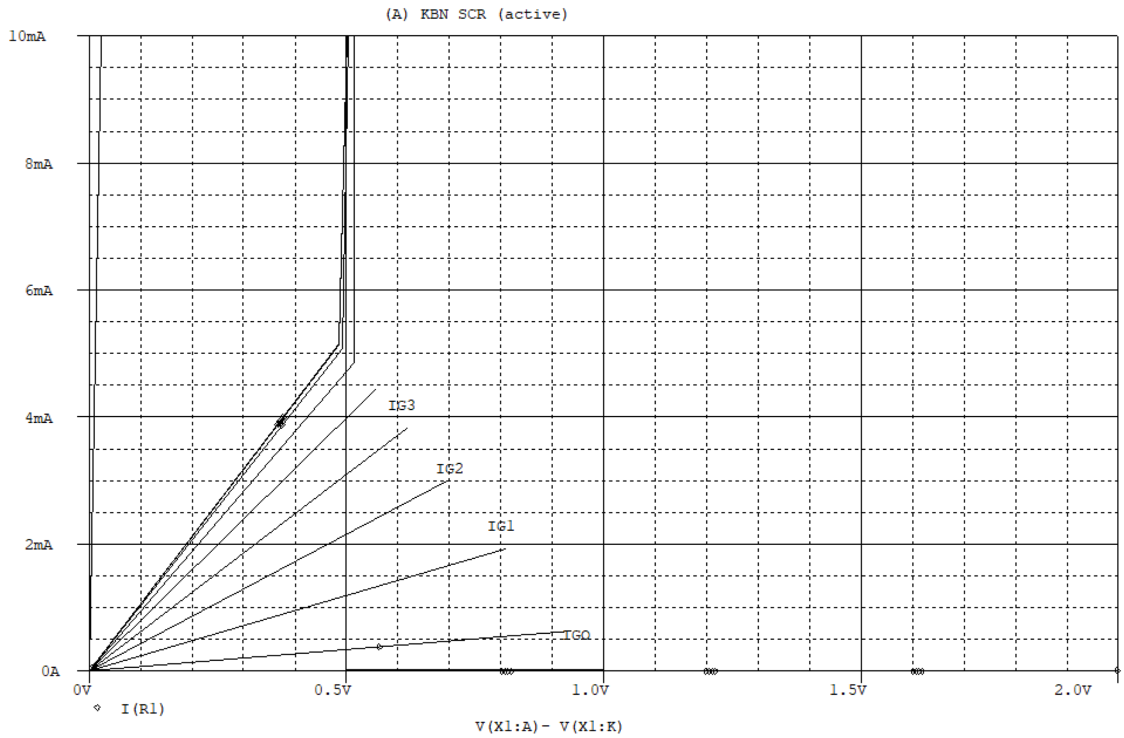
1. Double click on Pspice icon.
2. Go to **File** menu & click on **New**.
3. Draw the above circuit using following steps.
   - Go to **Get New Part** menu.
   - Select the components that you need & connect with **wire**.
4. Click on $\mathbf{V_{DC}}$ symbol and set **VAK** =40V and **VGK** =5V
5. For $\mathbf{R_1}$ set VALUE=100, $\mathbf{R_2}$ set VALUE=1K.
6. Go to **Markers** in menu bar and click on **Mark Voltage Differential** and place it across anode and cathode of 0SCR .
7. Go to Setup Analysis menu and tick the option Bias Point Detail and **DC sweep** option.
8. In **DC sweep** option do the following settings



Click on **Nested Sweep** and do the following settings



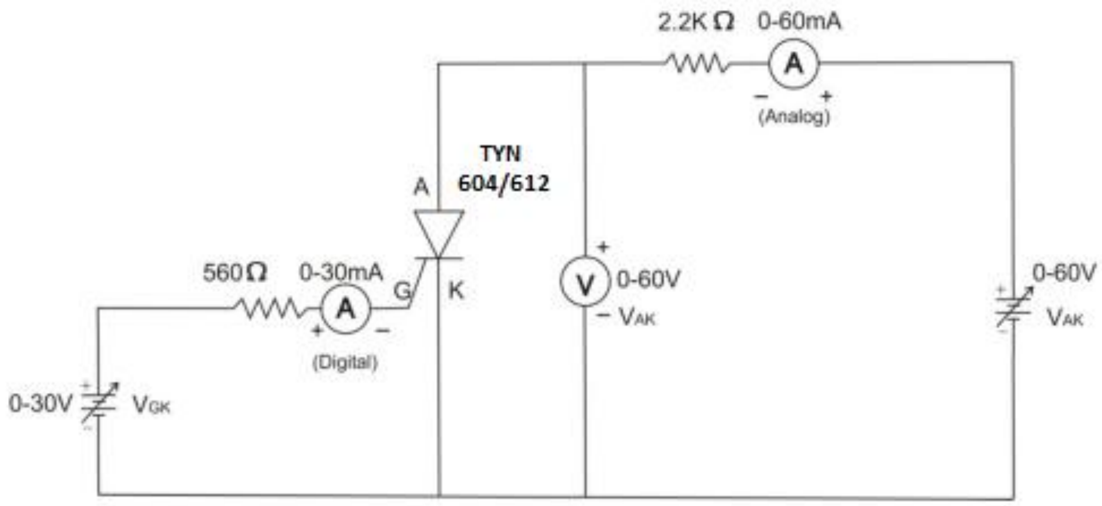
7. Click on **Simulate**. In simulation window click on **Add Trace** and select **I(R2)** and click **OK**.
8. Right click on graph and click on **settings**. In axis setting window, click on **X-Axis, Axis variable** and select **V(X1:A)-V(X1:K)** and click **OK, OK**. The SCR characteristics will be displayed.



EXPT. NO.1.B

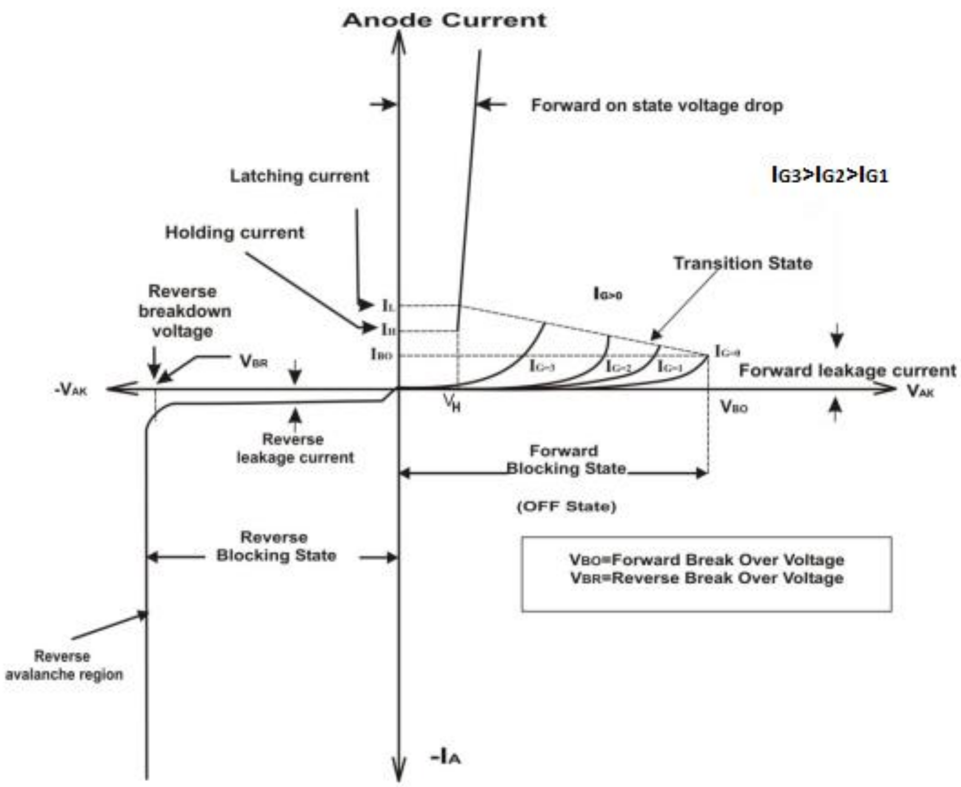
Static Characteristics of SCR

CIRCUIT DIAGRAM OF SCR CHARACTERISTICS:

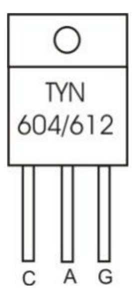


NATURE OF GRAPH:

V. I. CHARACTERISTICS OF SCR:



PIN CONFIGURATION OF SCR:



EXPT.NO.1.B: STATIC CHARACTERISTICS OF SCR

AIM: 1) To plot the static characteristics of the given SCR.

2) To find Latching and Holding current of the given SCR.

APPARATUS REQUIRED:

S.no	Apparatus	Range	Type	Qty
1	SCR	--	TY604/612	1 No
2	Resistor	2.2KΩ	Carbon	1 No
3	Resistor	560Ω	Carbon	1 No
4	Ammeter (DC)	0-60mA	MC	1 No
5	Ammeter (DC)	0-30mA	MC	1 No
6	Voltmeter (DC)	0-60V	MC	1 No
7	Regulated Power Supply	0-30V	-	3 Nos

THEORY: Refer text book

TABULAR COLUMN:

I_{G1}=____mA I_{G2}=____mA

S.no	V_{AK} in Volts	I_A in mA		S.no	V_{AK} in Volts	I_A in mA

I_L = _____mA

I_H =______mA

Note: Latching current will be more than holding current.

PROCEDURE:

A) To Plot V I Characteristics:

1. Make the connections as per the circuit diagram.
2. Switch ON the regulated power supply. Apply some constant voltage say 30V by varying V_{AK} source.
3. Gradually increase the gate current (I_{G1}) by varying V_{GK} source till the SCR becomes ON (SCR ON implies I_A increases and V_{AK} reduces). Note down the corresponding value of I_G. Then decrease V_{AK} and V_{GK} to Zero.
4. Set gate current (I_{G1}) equal to noted value in step 3 by varying V_{GK} source.
5. Gradually increase V_{AK} in steps of 2V and for each step note down the value of V_{AK} and I_A , and then reduce V_{AK} to zero.
6. Set gate current (I_{G2}) to some other value (preferably higher than that of the value set in step 3)
7. Repeat step 5.
8. Plot a graph of V_{AK} versus I_A for different values of I_G.

B) To find Latching current (I_L):

   1. Vary V_{GK} to set I_G to some constant current say 10mA.
   2. Gradually increase V_{AK} in steps and for each step switch OFF the gate source and observe the anode current I_A, If I_A goes to zero after the gate source is OFF. Then previous I_A gives the value of I_L.

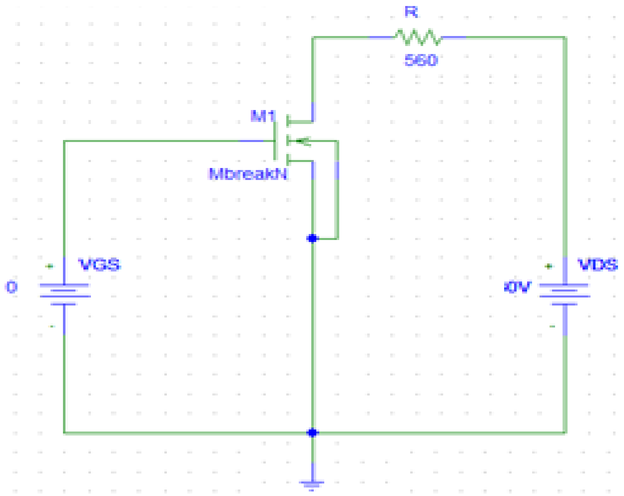
C) To Find Holding current (I_H):

   1. Make the connections as per the circuit diagram.
   2. Switch ON the regulated power supply. Apply some constant voltage say 30V by varying V_{AK} source.
   3. Varying V_{AK} to trigger SCR by gate current.
   4. Switch-Off V_{GK} source permanently. Now gradually decrease V_{AK} and note down the minimum value of I_A below which, the device suddenly falls from ON-state to OFF- state. This I_A gives the value of I_H.

EXPT. NO.2.A

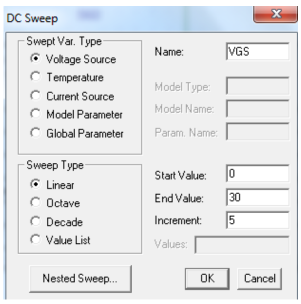
Simulation of Static Characteristics of MOSFET in PSPICE

AIM: SIMULATION OF TRANSFER AND DRAIN CHARACTERISTICS OF MOSFET.

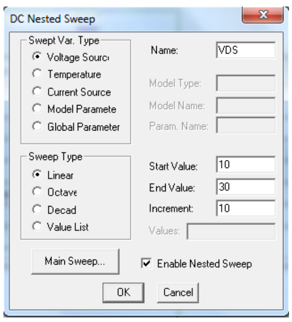


PROCEDURE: (For Schematics)

1. Double click on **Pspice** icon.
2. Go to **File** menu & click on **New**.
3. Draw the above circuit using following steps.
   - Go to **Get New Part** menu.
   - Select the components that you need & connect with **wire**.
4. Go to **Analysis**, select **setup** and tick on **Bias Point** and **DC sweep** option.
5. In **DC sweep** option do the following settings

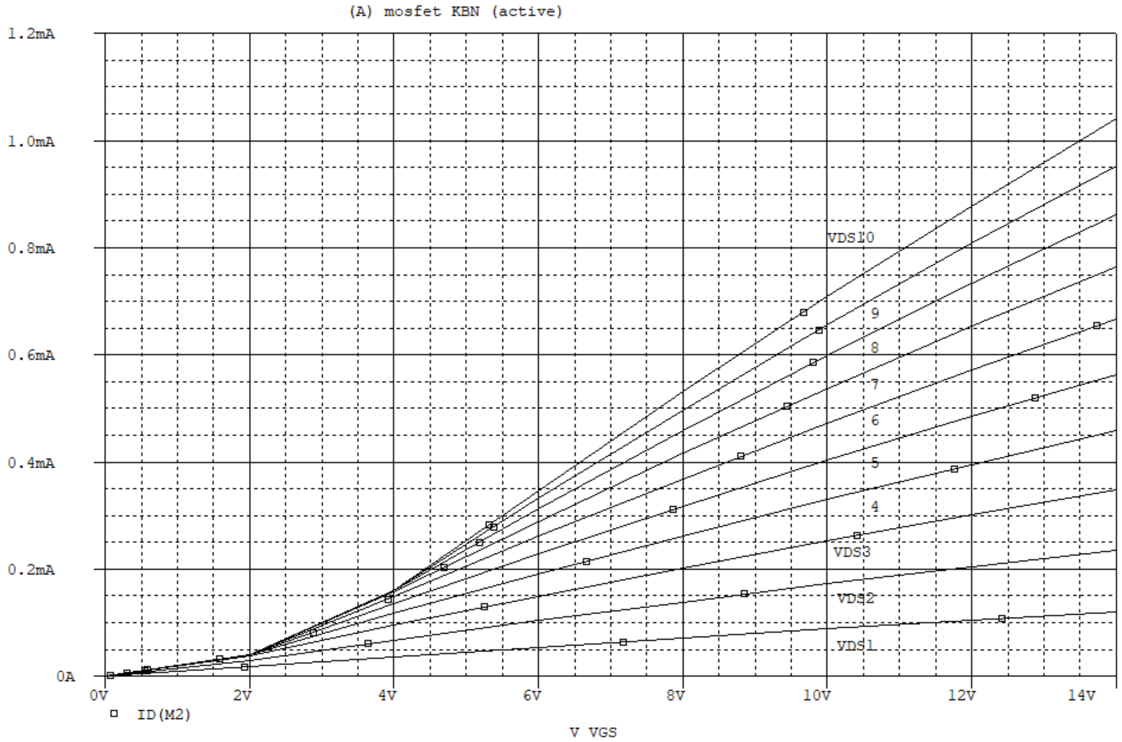


Click on Nested Sweep and do the following settings

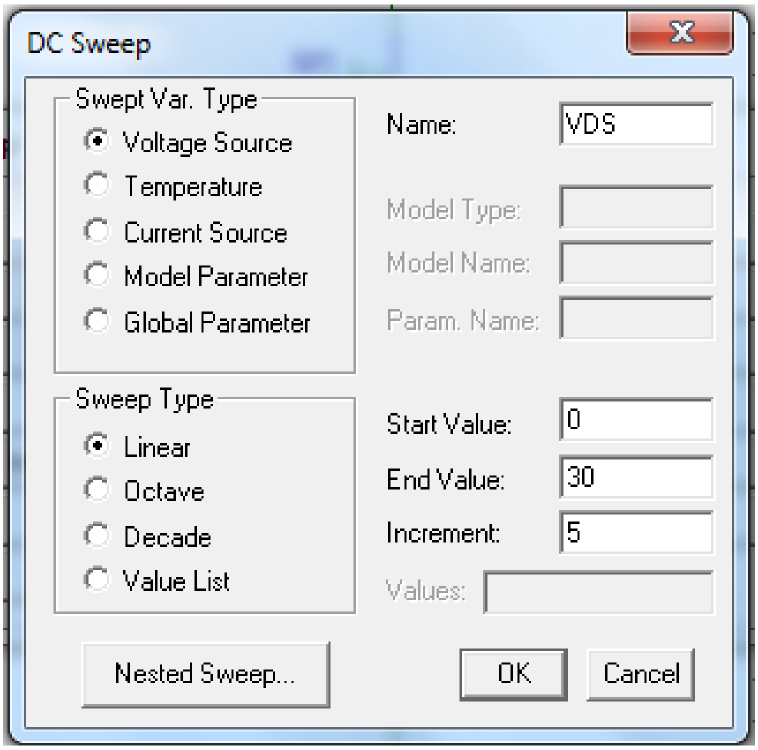


5. Click on **Simulate**. In simulation window click on **Add Trace** and select **ID(M1)** and click **OK.**

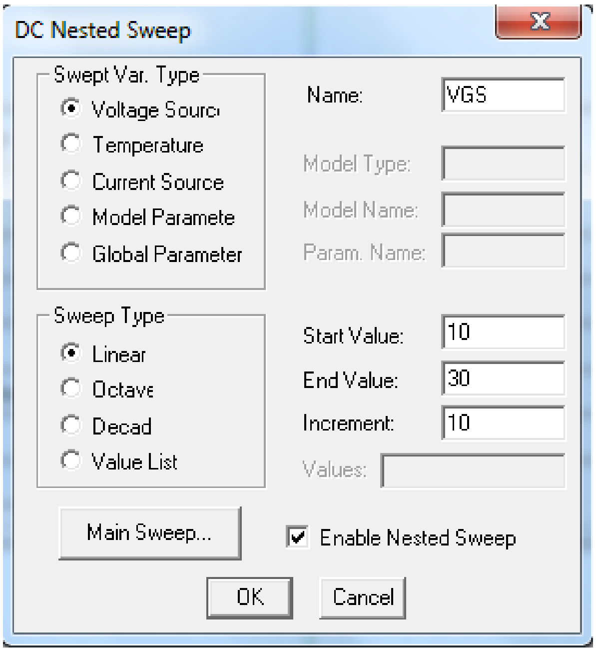
The Transfer characteristics will be displayed.



6. Go to **Analysis**, select **setup** and tick on **Bias Point** and **DC sweep** option. In **DC sweep** option do the following settings

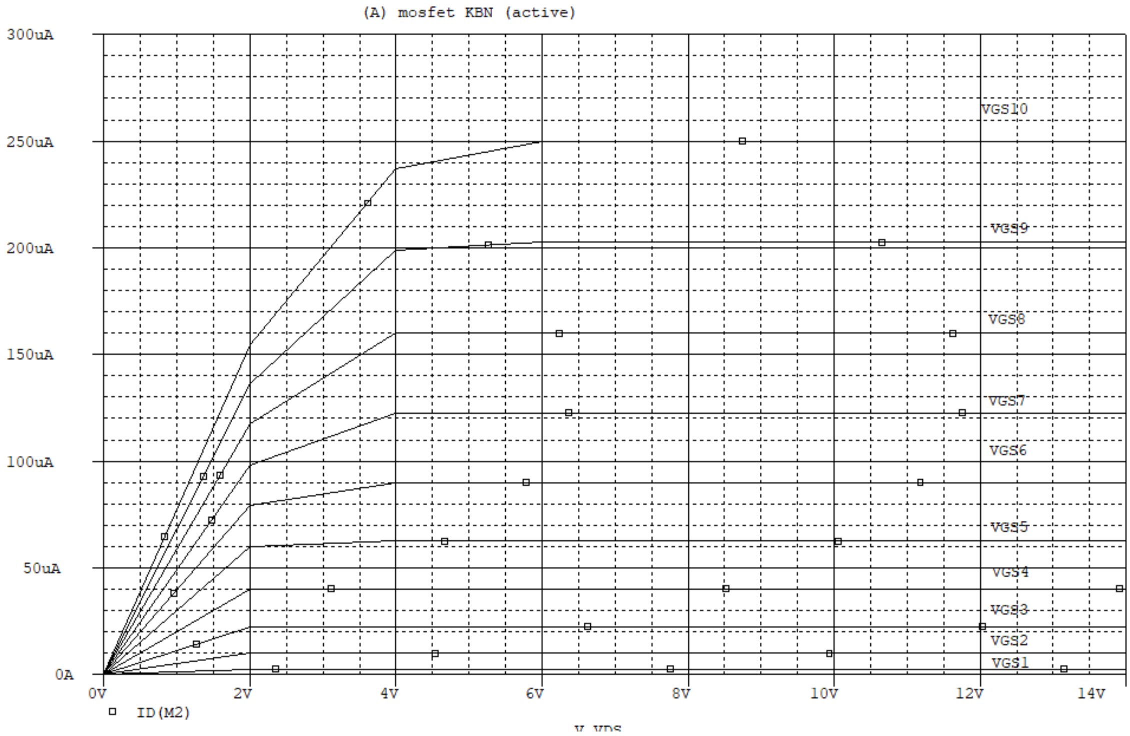


Click on **Nested Sweep** and do the following settings



7. Click on **Simulate**. In simulation window click on **Add Trace** and select **ID(M1)** and click **OK**.

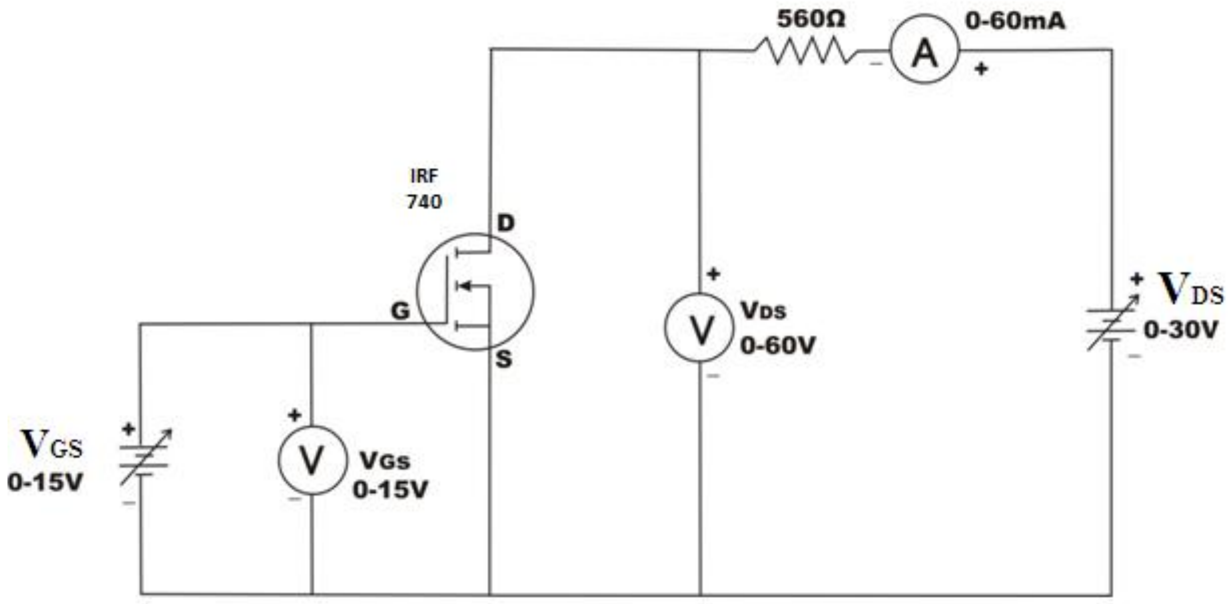
   The Drain characteristics will be displayed.



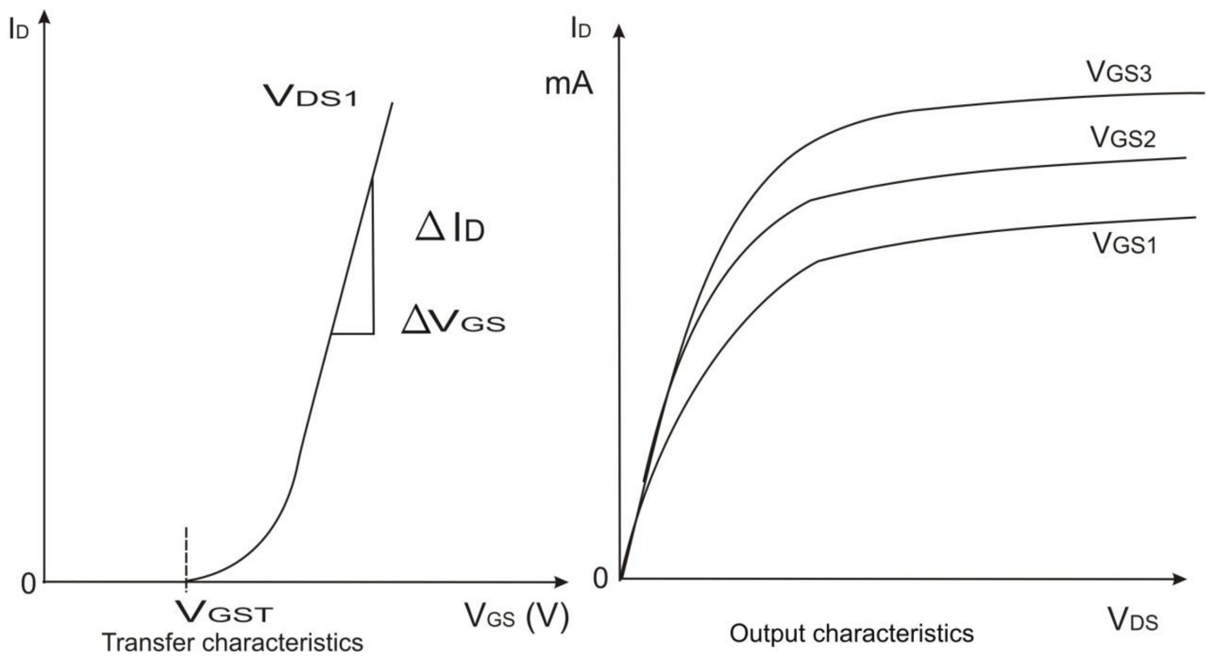
EXPT. NO.2.B

Static Characteristics of MOSFET

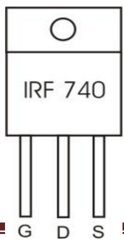
CIRCUIT DIAGRAM OF MOSFET CHARACTERISTICS:



NATURE OF GRAPH:



PIN CONFIGURATION OF MOSFET:



EXPT. NO 2.B: STATIC CHARACTERISTICS OF MOSFET

AIM: To plot the Transfer and Drain characteristics of MOSFET and determine Trans conductance and output Resistance.

APPARATUS REQUIRED:

S.No	Apparatus	Range	Type	Qty
1	MOSFET	--	IRF 740	1 No
2	Resistor	560Ω	Carbon	1 No
3	Ammeter (DC)	0-60mA	MC	1 No
4	Voltmeter (DC)	0-60V	MC	1 No
5	Voltmeter (DC)	0-30V	MC	1 No
6	Multimeter	-	Digital	1 No
7	RPS	0-30V, 3A	--	3 Nos
8	Connecting wires	-	--	Few

THEORY: Refer text book

TABULAR COLUMN:

A) Transfer Characteristics:

V_{DS1}=_____Volts		V_{DS2}=_____Volts	
V_{GS} (V)	I_D (mA)	V_{GS} (V)	I_D (mA)

B) Drain Characteristics:

V_{GS1}=_____Volts		V_{GS2}=_____Volts	
V_{DS} (V)	I_D (mA)	V_{DS} (V)	I_D (mA)

CALCULATION:

Trans conductance:

$$g_m = \left| \frac{\Delta I_D}{\Delta V_{GS}} \right| = \_\_\_\_\_\_ \text{mho at constant } V_{DS}$$

Output Resistance:

$$R_0 = \left| \frac{\Delta V_{DS}}{\Delta I_D} \right| = \_\_\_\_\_\_\_\_\_ \Omega \text{ at constant } V_{GS}$$

PROCEDURE:

A) Transfer Characteristics:

1. Make the connections as per the circuit diagram.
2. Initially keep V_1 and V_2 at zero position.
3. Switch ON the regulated power supplies. By varying V_1, set V_{DS} to some constant voltage say 5V.
4. Vary V_2 in steps of 0.5V, and at each step note down the corresponding values of V_{GS} and I_D.
5. Note down the value of V_{GS} at which I_D starts increasing as the threshold voltage.
6. Reduce V_1 and V_2 to zero.
7. By varying V_1, set V_{DS} to some other value say 10V.
8. Repeat step 4.
9. Plot a graph of V_{GS} versus I_D for different values of V_{DS}.

B) Drain or Output Characteristics:

1. Make the connections as per the circuit diagram.
2. Initially keep V_1 and V_2 at zero position.
3. By varying V_2, set V_{GS} to some constant voltage (must be more than Threshold voltage).
4. By gradually increasing V_1, note down the corresponding value of V_{DS} and I_D.

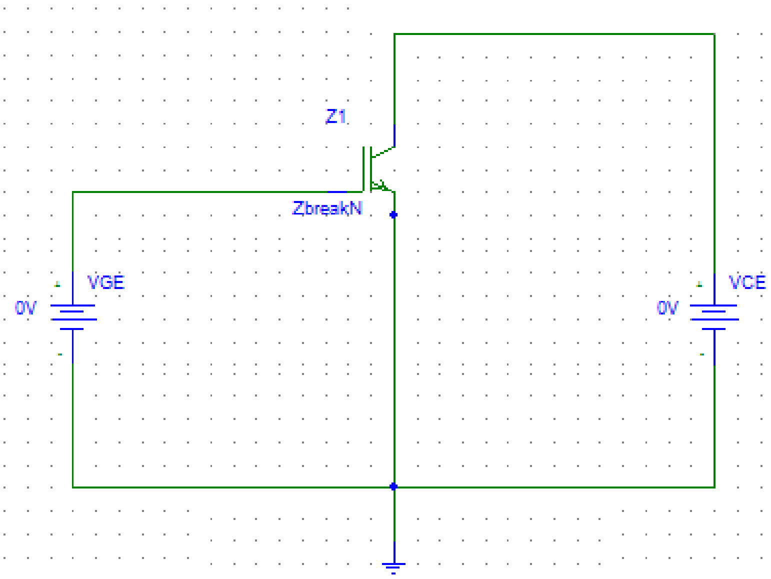
   (Note: Till the MOSFET jumps to conducting state, the voltmeter which is connected across device as V_{DS} reads approximately zero voltage. Further increase in voltage by V_1 source cannot be read by V_{DS}, so connect multimeter to measure the voltage and tabulate the readings in the tabular column).
5. Set V_{GS} to some other value (more than threshold voltage) and repeat step 4.
6. Plot a graph of V_{DS} versus I_D for different values of V_{GS}.

Note: If V_{DS} is lower than V_P (pinch-off voltage) the device works in the constant resistance region that is linear region. If V_{DS} is more than V_P, a constant I_D flows from the device and this operating region is called constant current region.

EXPT. NO.3.A

Simulation of Static Characteristics of IGBT in PSPICE

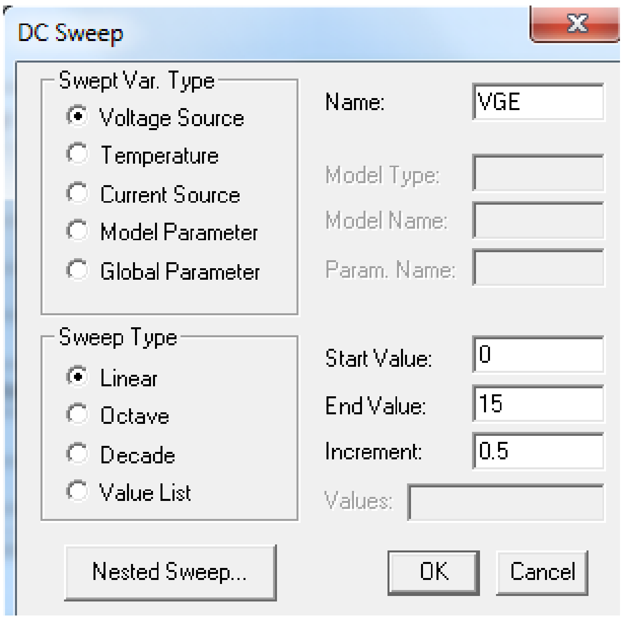
AIM: SIMULATION OF TRANSFER AND OUTPUT CHARACTERISTICS OF IGBT.



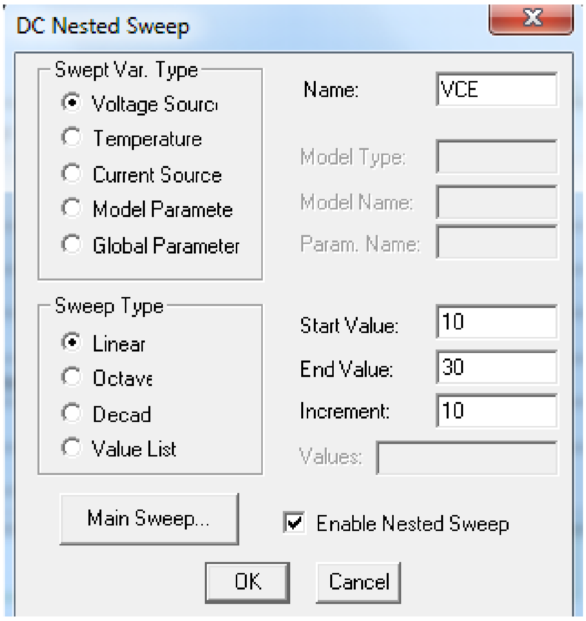
PROCEDURE:

(For Schematics)

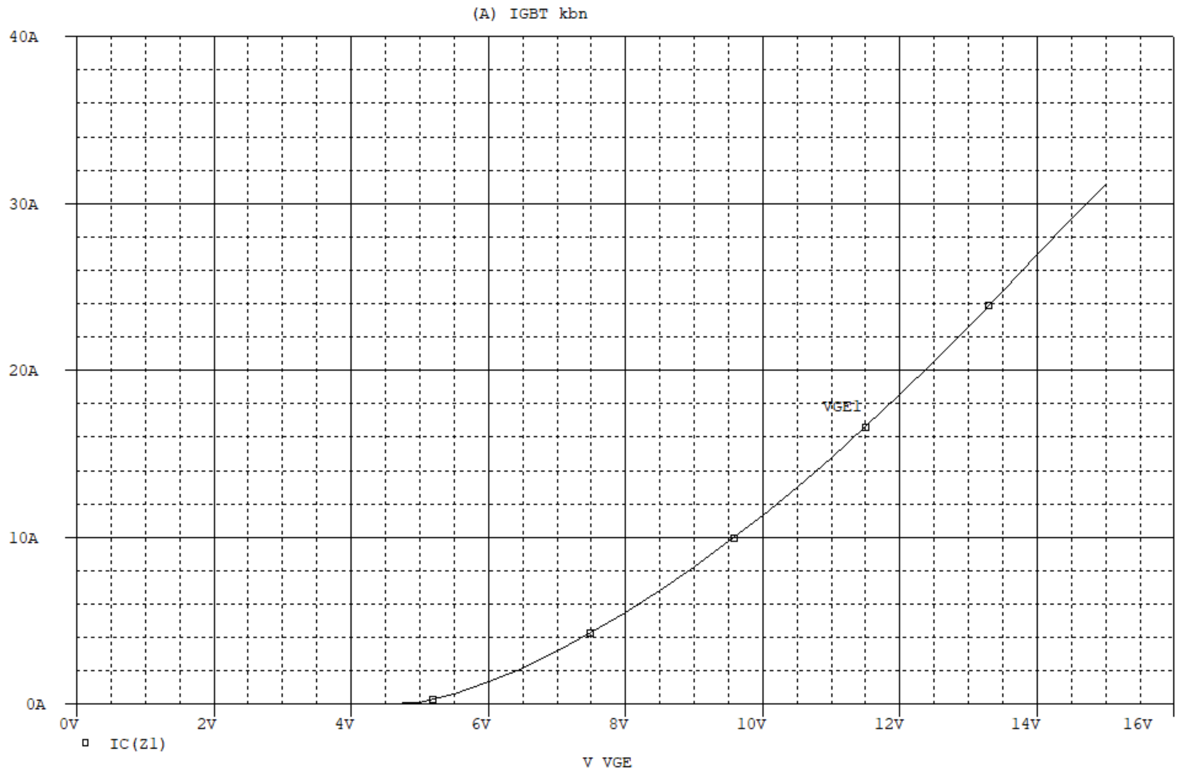
1. Double click on **Pspice** icon.
2. Go to **File** menu & click on **New**.
3. Draw the above circuit using following steps
   - Go to **Get New Part** menu
   - Select the components that you need & connect with **wire**.
4. Go to **Analysis**, select setup and tick on **Bias Point** and **DC sweep** option. In DC sweep option do the following settings.



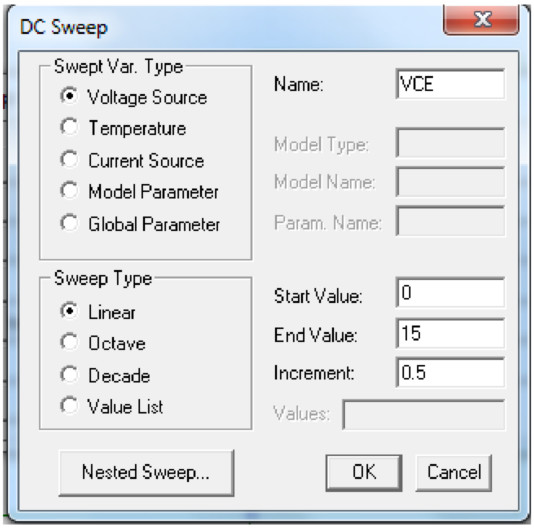
Click on **Nested Sweep** and do the following settings



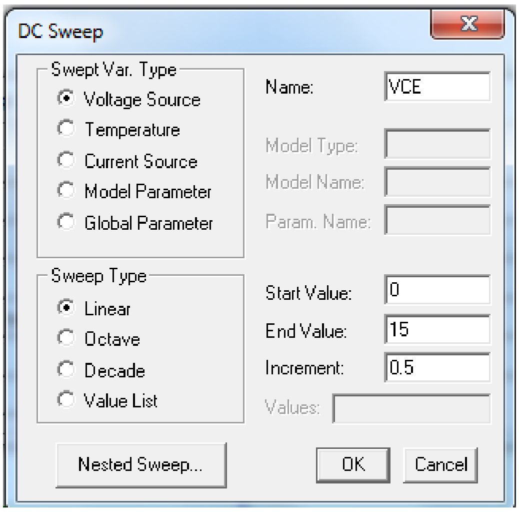
5. Click on **Simulate**. In simulation window click on **Add Trace** and select **IC(Z1)** and click **OK**. The Transfer characteristics will be displayed.



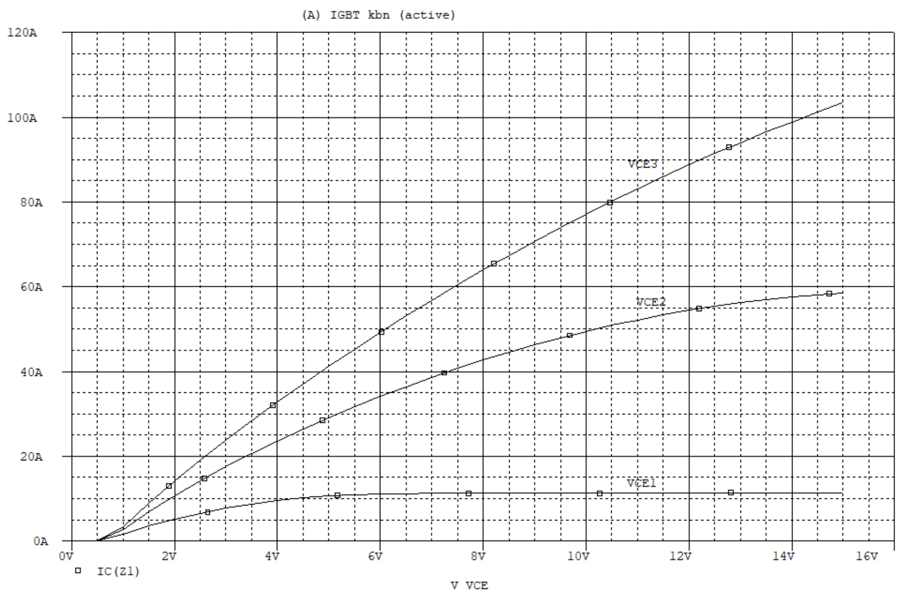
6. Go to **Analysis**, select **setup** and tick on **Bias Point** and **DC sweep** option. In DC sweep option do the following settings.



Click on **Nested Sweep** and do the following settings



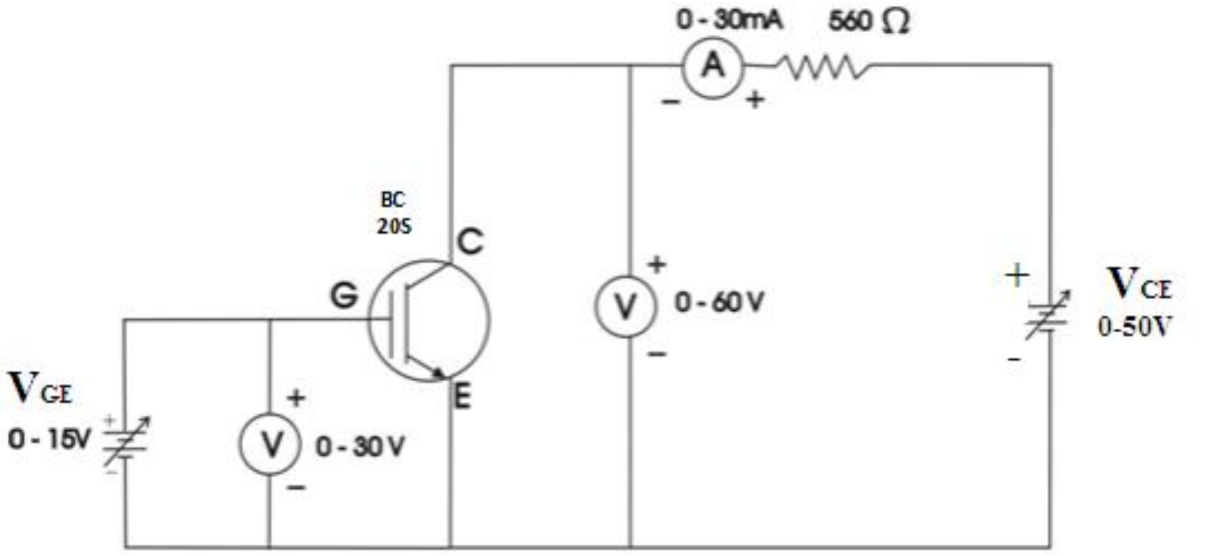
7. Click on **Simulate**. In simulation window click on **Add Trace** and select **ID(M1)** and click **OK**. The Output characteristics will be displayed.



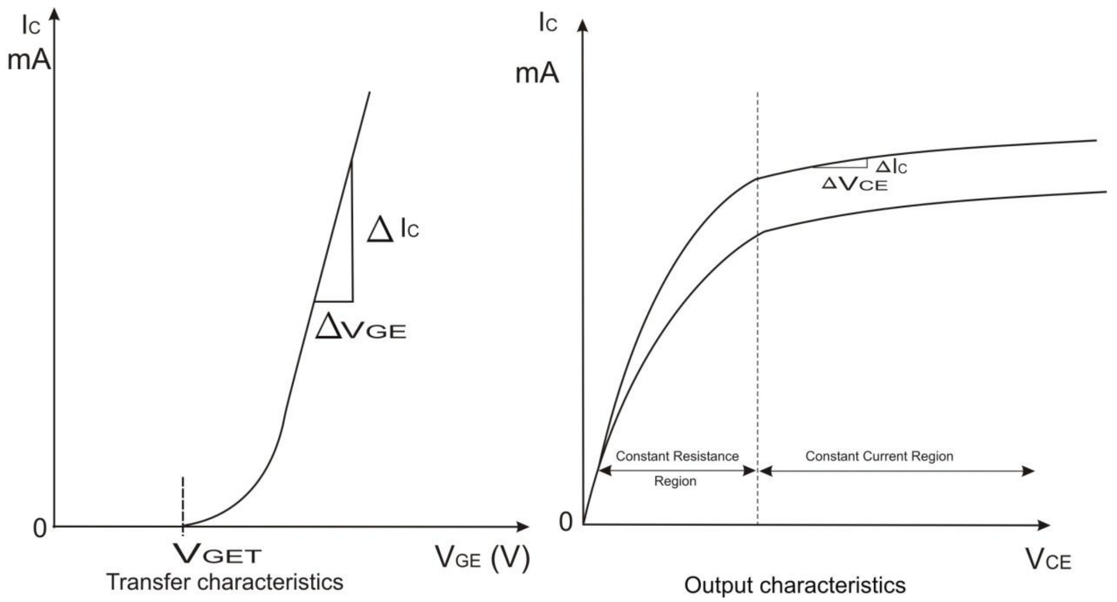
EXPT. NO.3.B

Static Characteristics of IGBT

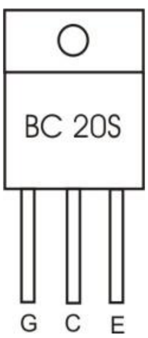
CIRCUIT DIAGRAM OF IGBT CHARACTERISTICS



NATURE OF GRAPH:



PIN CONFIGURATION OF IGBT:



EXPT.NO.3.B: STATIC CHATACTERISTICS OF IGBT

AIM: To plot the Transfer and output characteristics of an IGBT and determine Trans-conductance and output resistance.

APPARATUS REQUIRED:

S.no	Apparatus	Range	Type	Qty
1	IGBT	-	BC 20S	1 No
2	Resistor	560Ω	Carbon	1 No
3	Ammeter (DC)	0-60mA	MC	1 No
4	Voltmeter (DC)	0-60V	MC	1 No
5	Voltmeter (DC)	0-30V	MC	1 No
6	Multimeter	-	MC	1 No
7	Regulated Power Supply	0-30V	--	3 Nos
8	Connecting wires	-	Tined	Few

THEORY: Refer and write the required theory for the above experiment

TABULAR COLUMN:

A) Transfer Characteristics:

V_{CE1}=____Volts		V_{CE2}=____Volts	
V_{GE} (V)	I_C(mA)	V_{GE} (V)	I_C(mA)

B) Output Characteristics:

V_{GE1}=____Volts		V_{GE2}=____Volts	
V_{CE}(V)	I_C(mA)	V_{CE}(V)	I_C(mA)

CALCULATION:

Tran conductance:

$$g_m = \left| \frac{\Delta I_C}{\Delta V_{GE}} \right| = \_\_\_\_\_\_ \text{ mho at constant } V_{CE}$$

Output Resistance:

$$R_0 = \left| \frac{\Delta V_{CE}}{\Delta I_C} \right| = \_\_\_\_\_\_\_\_\_ \ \Omega \text{ at constant } V_{GE}$$

PROCEDURE:

A) Transfer Characteristics :

1. Make the connections as per the circuit diagram.
2. Initially keep V_1 and V_2 at zero position.
3. Switch ON the regulated power supplies. By varying V_1, set V_{CE} to some constant voltage say 5V.
4. Vary V_2 in steps of 0.5V, and at each step note down corresponding value of V_{GE} and I_C. (Note down the value of V_{GE} at which I_C starts increasing as Threshold voltage).
5. Reduce V_1 and V_2 to zero position.
6. By varying V_1, set V_{CE} to some other value say 10V.
7. Repeat step 4.
8. Plot a graph of V_{GE} versus I_C for different values of V_{CE}.

B) Output Characteristics:

1. Make the connections as per the circuit diagram.
2. Initially keep V_1 and V_2 at zero position.
3. By varying V_2, set V_{GE} to some constant voltage (must be more than threshold voltage).
4. By gradually varying V_1, note down the corresponding value of V_{CE} and I_C.

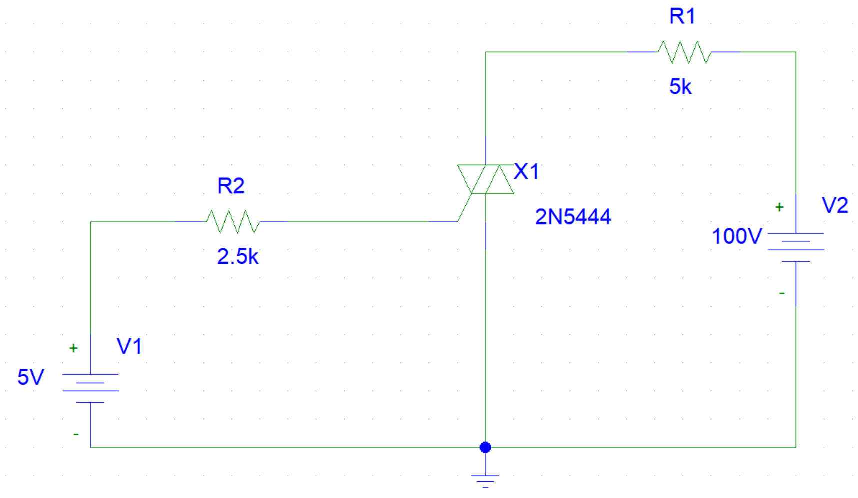
   (Note: Till the the IGBT jumps to conducting state, the voltmeter which is connected across device as V_{CE} reads approximately zero voltage. Further increase in voltage by V_1 source cannot be read by V_{CE}, so connect multimeter to measure the voltage and tabulate the readings in the tabular column).
5. Set V_{GE} to some other value (more than threshold voltage) and repeat step 4.
6. Plot a graph of V_{CE} versus I_C for different values of V_{GE}.

Note: If V_{CE} is lower than V_P (pinch-off voltage) the device works in the constant resistance region that is linear region. If V_{CE} is more than V_P, a constant I_C flows from the device and this operating region is called constant current region.

EXPT. NO.4.A

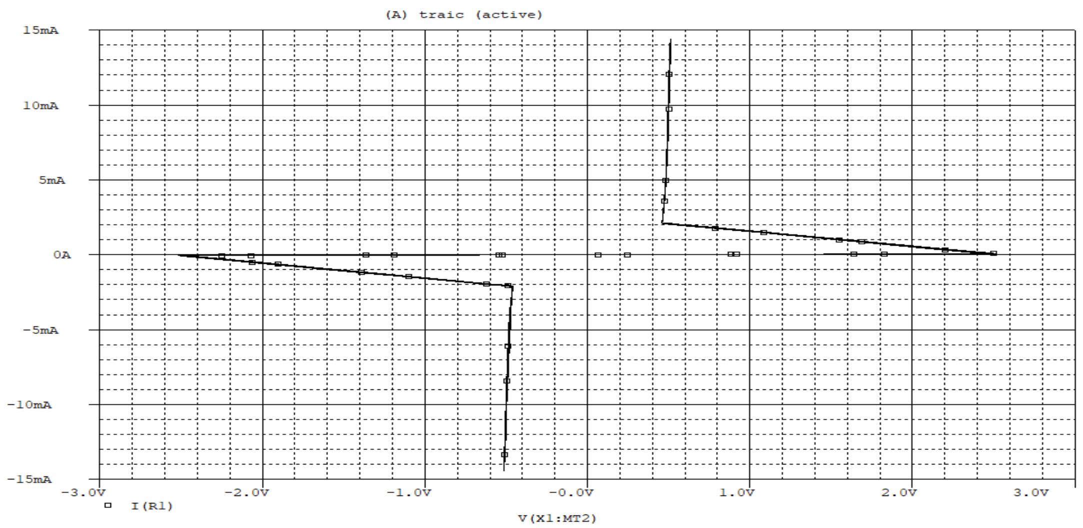
Simulation of V-I characteristics of TRIAC in PSPICE

AIM: SIMULATION OF STATIC CHARACTERISTICS OF TRIAC



PROCEDURE: (For Schematics)

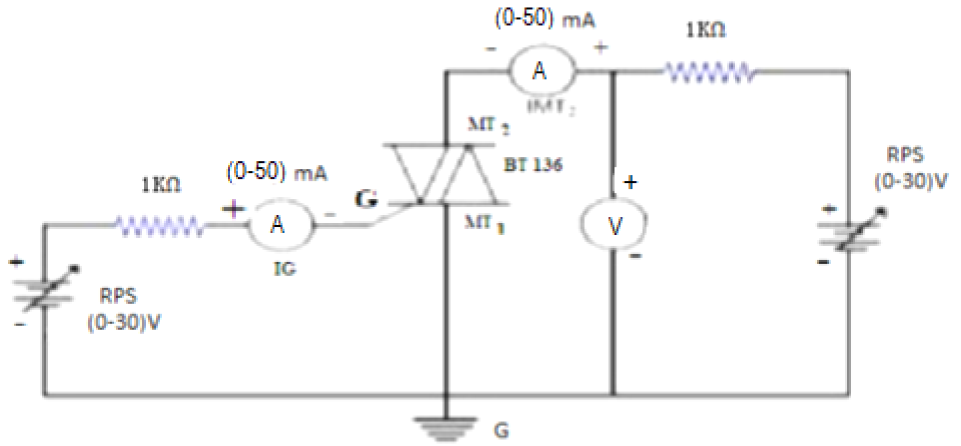
1. Double click on **Pspice** icon.
2. Go to **File** menu & click on **New**.
3. Draw the above circuit using following steps.
   - Go to **Get New Part** menu.
   - Select the components that you need.
   - Connect with **wire**.
4. Now double click on $\mathbf{V_{SIN}}$ symbol and set the following values **DC=0, AC=0, VOFF=0, VAMPL=15v, FREQ=50**. For $\mathbf{R_1}$ set VALUE=1K, $\mathbf{R_2}$ set VALUE=10.
5. Go to **Analysis**, select **setup** menu and tick on option **Bias Point** and **Transient**. In the Transient option set the Final Time at **100ms.**
6. Click on **Simulate**. In simulation window click on **Add Trace** and select **I(R1)** and click **OK.**
7. Now right click on **graph** and click on **settings**. In axis setting window, click on **X-Axis**, **Axis variable** and select **V(X1:MT2)** and click **OK, OK**. The Triac characteristics will be displayed.

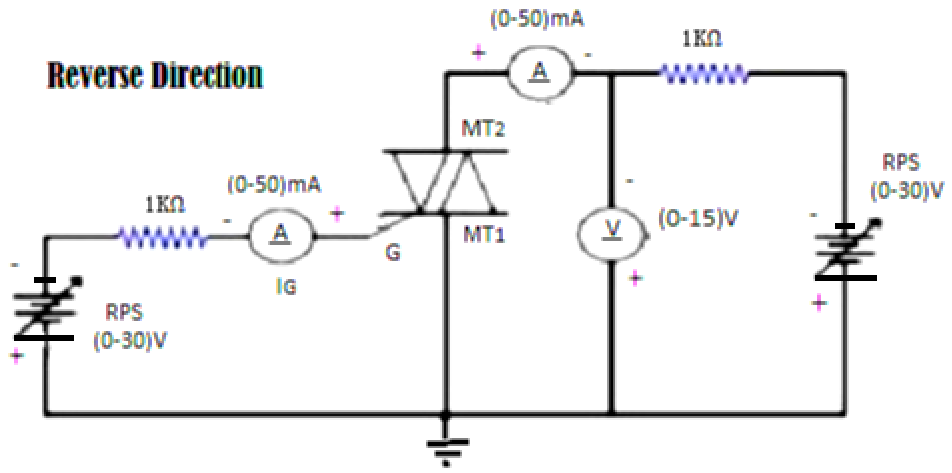


EXPT. NO 04.B

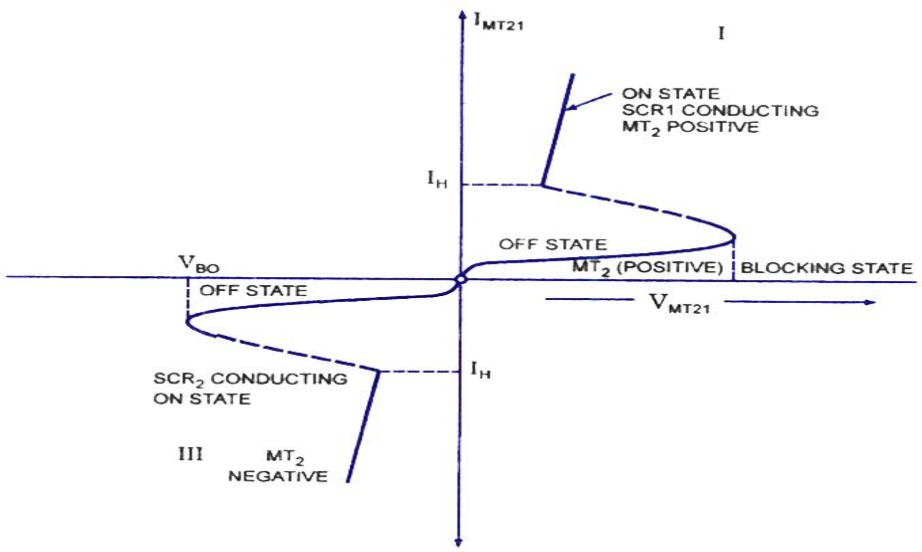
V-I characteristics of TRIAC

CIRCUIT DIAGRAM OF TRIAC CHARACTERISTICS

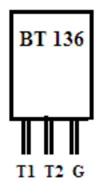




NATURE OF GRAPH:



V-I Characteristic of a Triac



PIN CONFIGURATION:

EXPT. NO.4.B: V-I CHARACTERISTICS OF TRIAC

AIM: To study the V-I characteristics of TRIAC.

APPARATUS REQUIRED:

S.no	Apparatus	Range	Type	Qty
1	Traic	BTM36/BT136		1 No
2	Resistor	1KΩ		1 No
3	Resistor	1KΩ		1 No
4	Ammeter (DC)	0-60mA		1 No
5	Ammeter (DC)	0-60mA		1 No
6	Voltmeter (DC)	0-30V		1 No
7	Regulated Power Supply	0-30V		3 Nos

THEORY: Refer text book

PROCEDURE :

TRIAC Characteristics:

1. The connections are made as shown in the circuit diagram.
2. The TRIAC is connected in forward direction and supply is switched 'ON'.
3. Apply some constant voltage say 30V by varying V_{MT1MT2}.
4. Gradually increase the gate current (IG1) by varying $\mathbf{V}_{GMT1}$ source till the TRIAC becomes ON (TRIAC ON indication is $\mathbf{I}_{MT2}$ increases and $\mathbf{V}_{MT2MT1}$ reduces). Note down the corresponding value of $I_{G.}$ Then decrease V_{MT2MT1} and V_{GMT1} to Zero.
5. Set gate current (I_{G1}) equal to noted value in step 4 by varying V_{GMT1} source.
6. The corresponding ammeter and voltmeter readings are noted and tabulated.
7. Next the TRIAC is connected in reverse direction as per the circuit diagram 2.
8. The above process is repeated.

OBSERVATIONS :

I_{G1}=

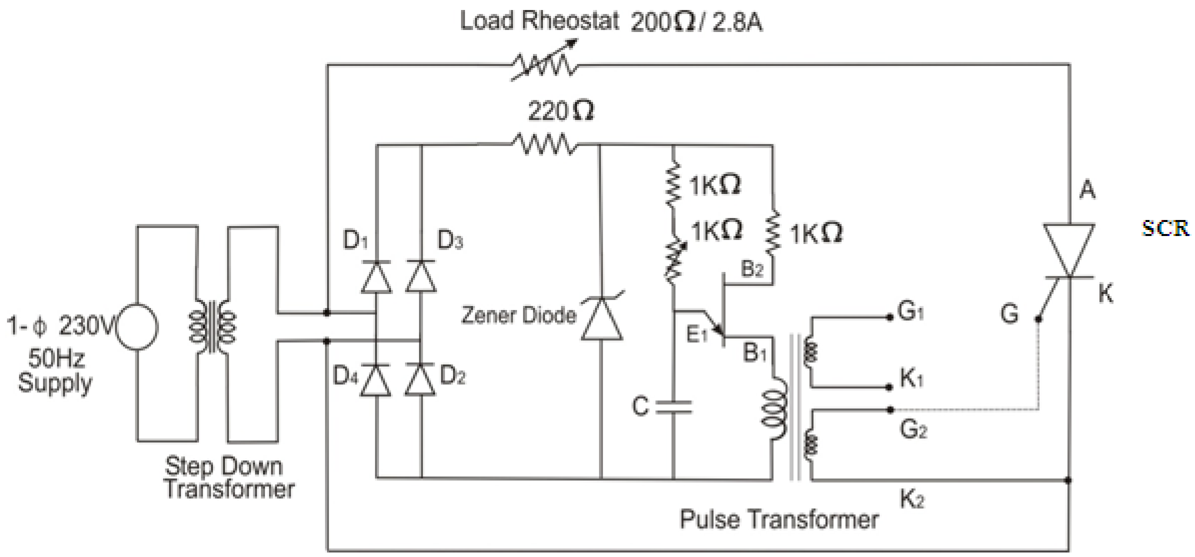
I_{G2}=

S.No.	V_{MT1MT2}(V) When TRIAC is 'ON'	I_{MT1T2} mA		V_{MT1MT2}(V) When TRIAC is 'ON'	I_{MT1T2} mA

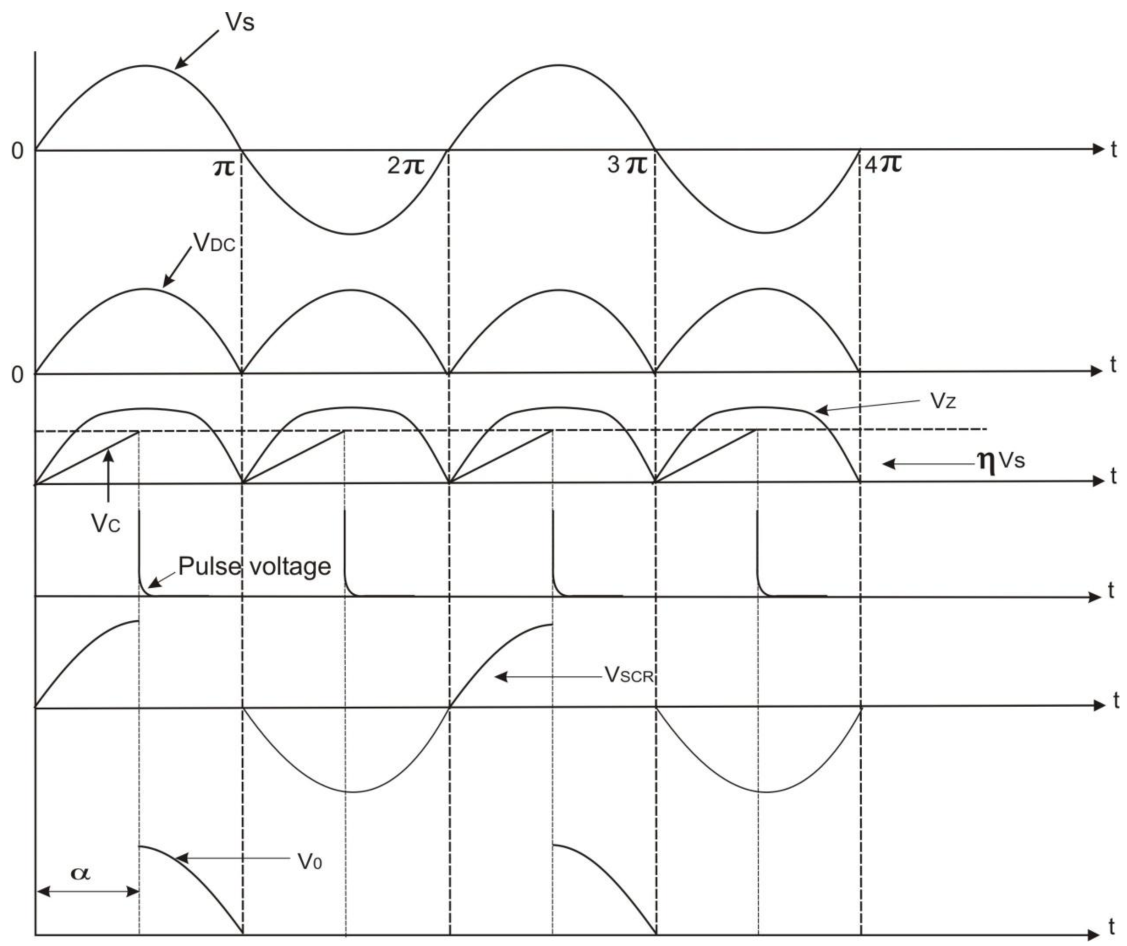
EXPT. NO.5

SCR Turn ON Circuit using Synchronized UJT

CIRCUIT DIAGRAM OF SYNCHRONIZED UJT TRIGGERING



NATURE OF GRAPH:



EXPT.NO.5: SCR TURN ON CIRCUIT USING SYNCHRONISED UJT

AIM: To Trigger the given SCR operating on AC supply using UJT relaxation oscillator in Synchronous mode.

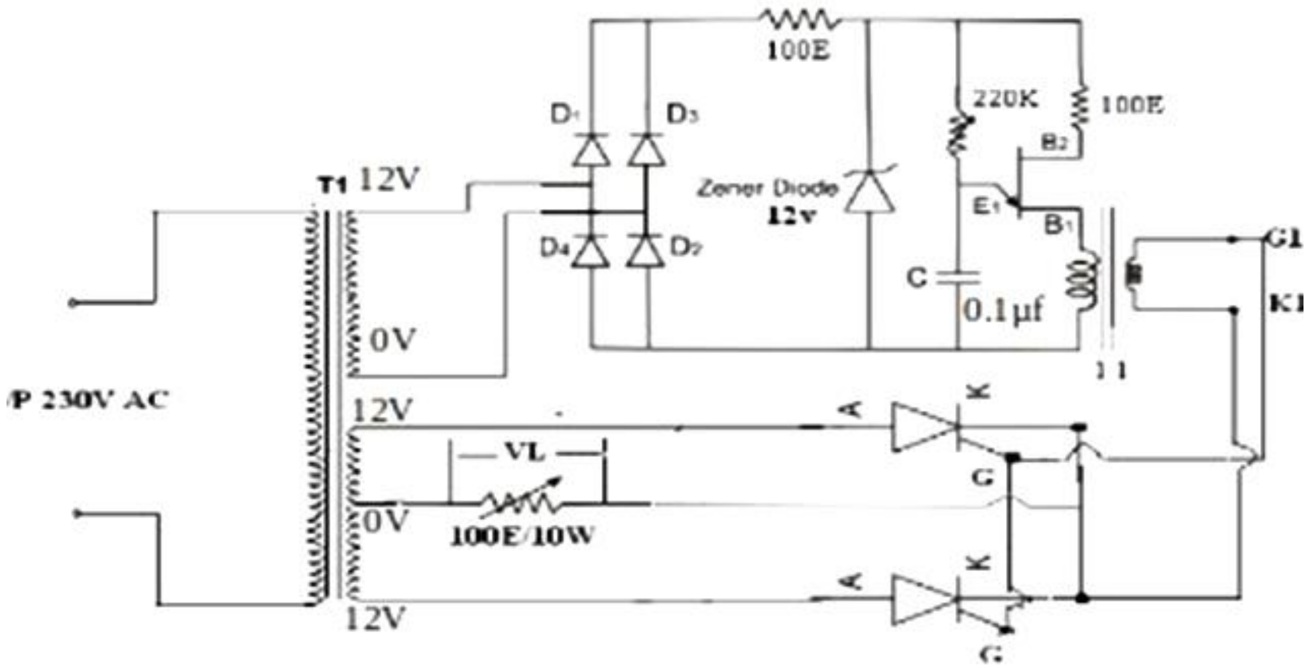
APPARATUS REQUIRED:

S.no	Apparatus	Range	Type	Qty
1	UJT firing Module	-	--	1 No
2	Rheostat	220Ω,2.8A	--	1 No
3	SCR Module	-	--	1 No
4	Auto-Transformer	230/0-270V	5A	1 No
5	Isolation Transformer	230V	2A	1 No
6	CRO and probe	-	-	1Set
7	Multimeter	-	-	1 No
8	Connecting wires	-	-	Few

THEORY: Refer text book

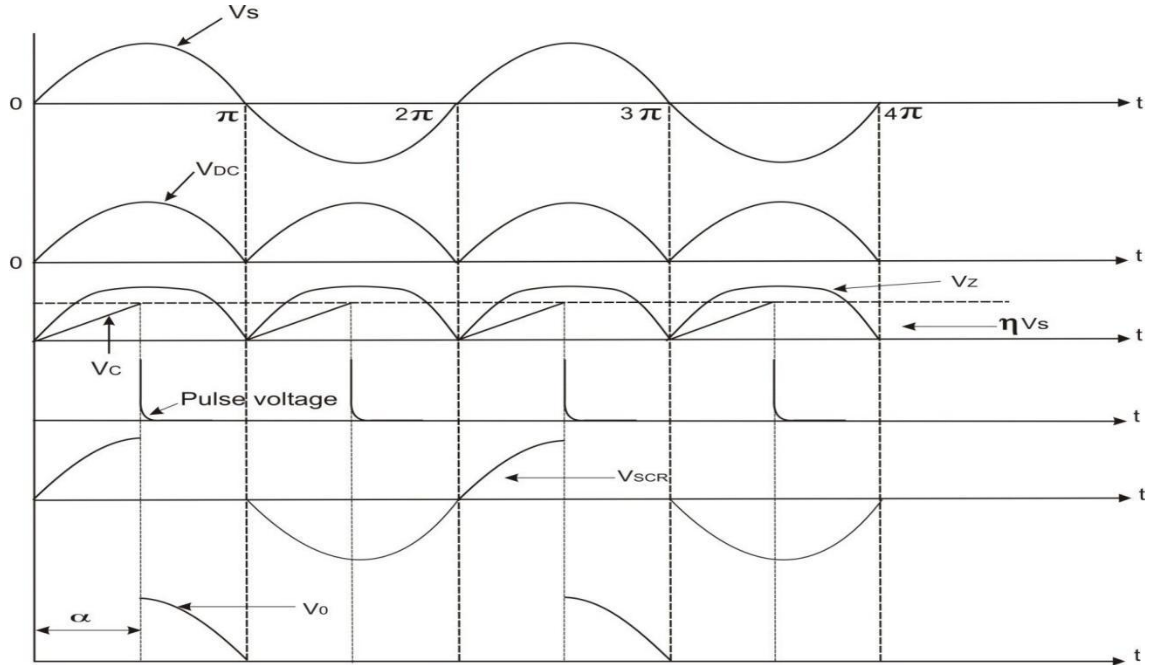
CIRCUIT DIAGRAM:

FULLWAVE RECTIFIER



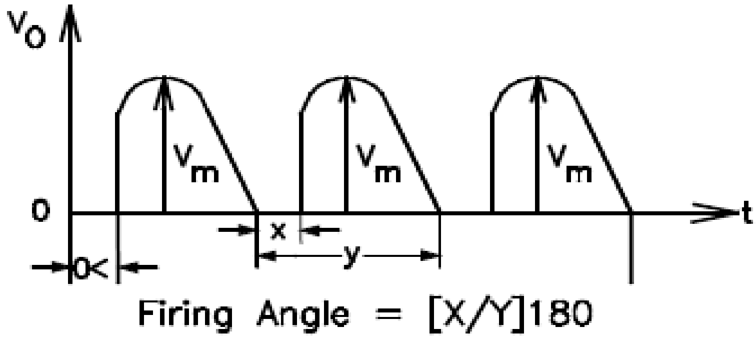
Circuit Diagram of SCR Turn ON Circuit Using Synchronized UJT Relaxation Oscillator FWR.

NATURE OF GRAPH :



PROCEDURE:

1. Make the connections as per the circuit diagram.
2. Switch ON power supply to UJT firing circuit.
3. Observe the waveform of step down AC voltage, output of bridge rectifier, the voltage across Zener diode, capacitor and across primary of pulse transformer using CRO.
4. By varying R, Observe the variation of frequency of triggering pulses at pulse transformer secondary terminals.
5. Connect the output of pulse transformer to the Gate and Cathode of SCR.
6. By varying R, observe the load voltage waveform and voltage waveform across SCR for different firing angles.



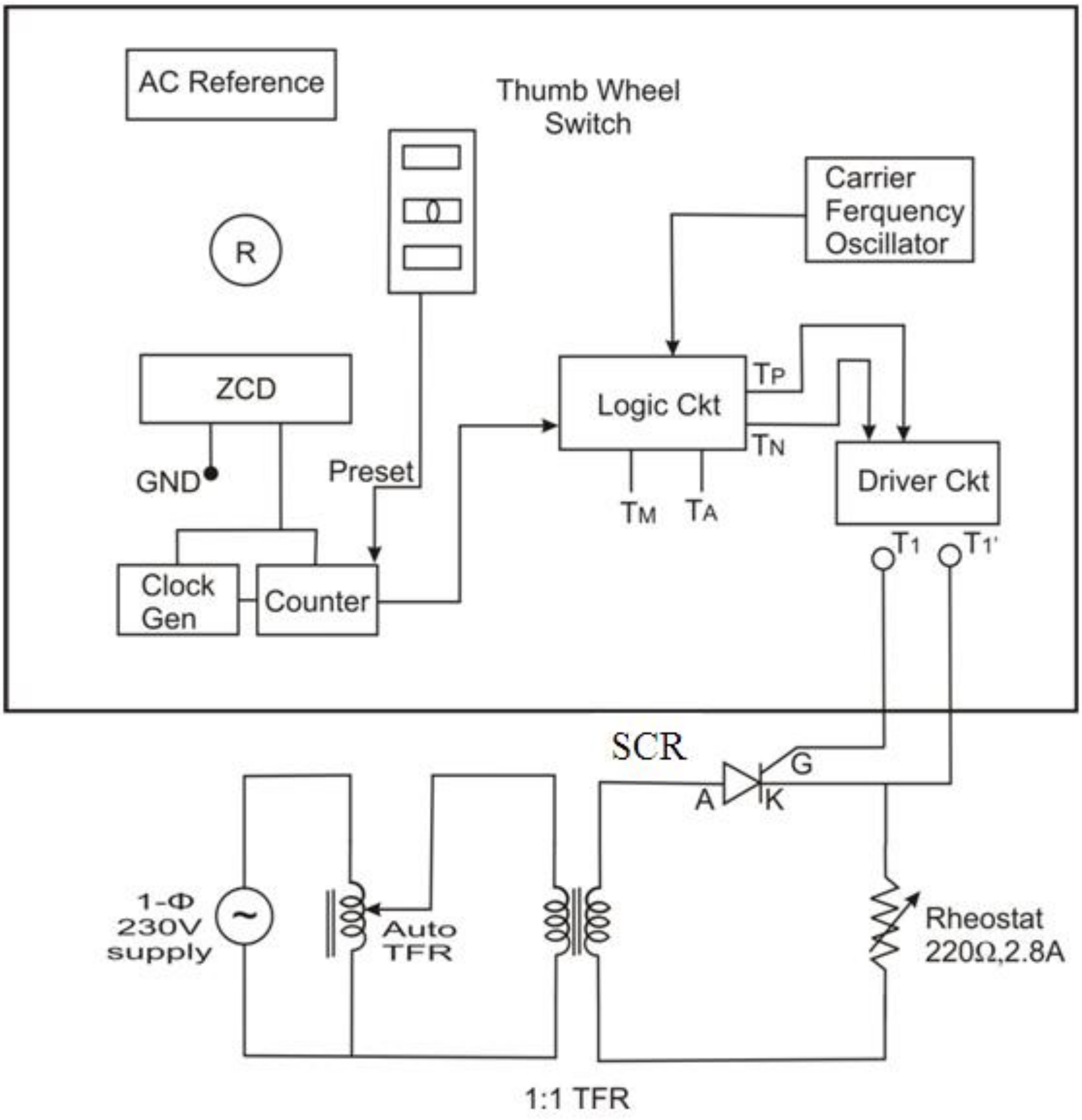
TABULAR COLUMN:

S.No	X	Y	Firing angle in Degrees	Av. Output Voltage $V_{DC(AV)} = \frac{V_m}{2\pi}(1+\cos\alpha)$	Av. Output Voltage (Practical values)
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

EXPT. NO.6

Generation of Firing signals for Thyristors using Digital Circuit

PANEL DIAGRAM FOR DIGITAL TRIGGERING MODULE



EXPT.NO.6: **GENERATION OF FIRING SIGNALS FOR THYRISTORS**

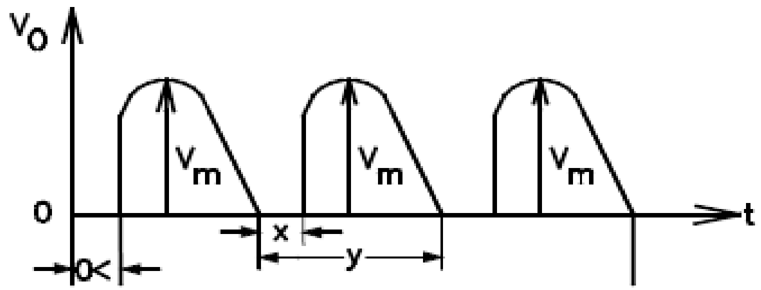
USING DIGITAL CIRCUIT

AIM: To Study SCR turn ON process using Digital Triggering for half wave rectifier.

APPARATUS REQUIRED:

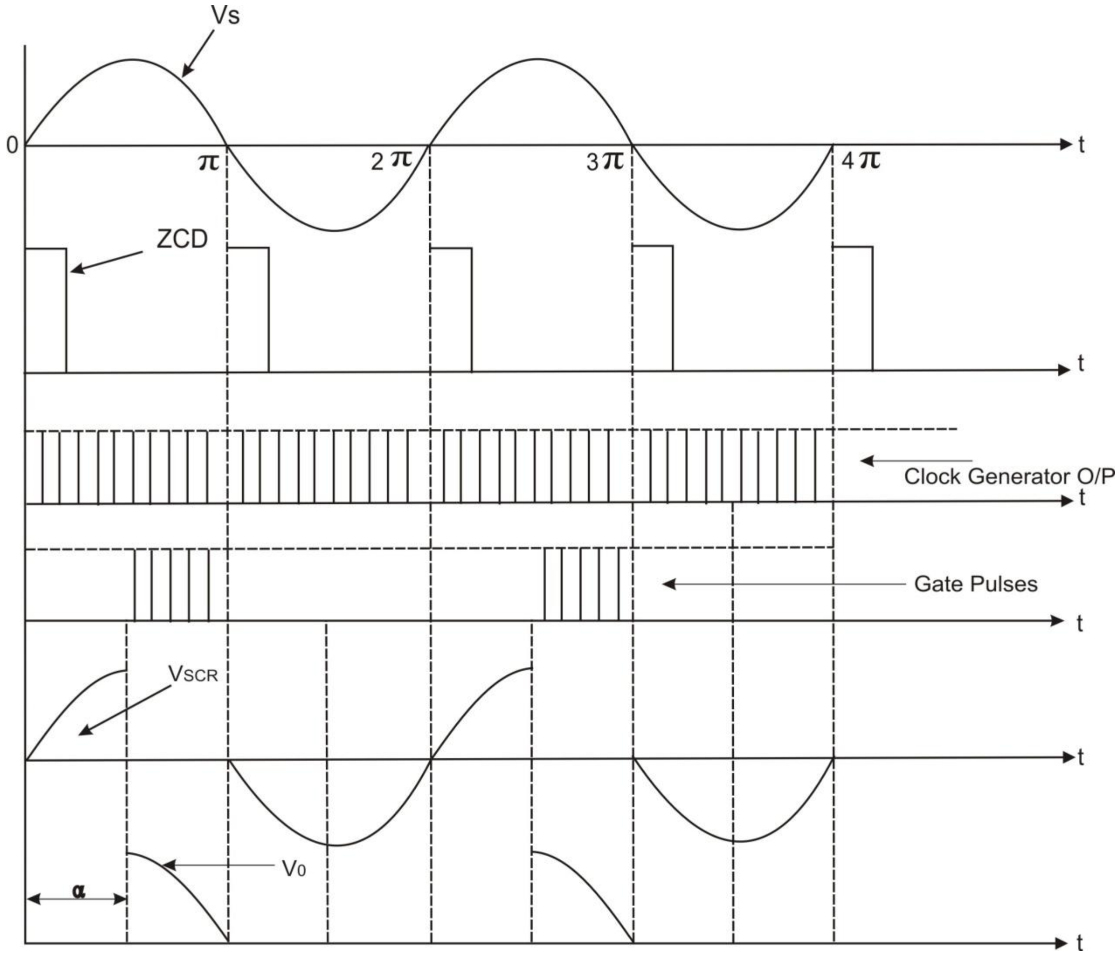
S.no	Apparatus	Range	Type	Qty
1	Digital firing Module	-	-	1No
2	Rheostat	220Ω, 2.8Amps	-	1No
3	SCR Module	-	-	1No
4	Auto-Transformer	0-260V	5A	1No
5	Isolation Transformer	230V	1:1	1No
6	CRO and probe	-	-	1Set
7	Multimeter	-	-	1 No
8	Connecting wires	-	-	Few

THEORY: Refer and write the required theory for the above experiment



Firing Angle = [X/Y]180

NATURE OF GRAPH:



Vs
0
π
2 π
3 π
4 π
t
ZCD
t
Clock Generator O/P
t
Gate Pulses
t
VSCR
t
V0
α
t

PROCEDURE:

1. Make the connections as per the circuit diagram.
2. Switch ON the power supply to Digital firing circuit.
3. Observe AC reference signal and compare it with ZCD output.
4. Connect one channel of the CRO to the AC reference terminal and other to the clock generator output terminal using CRO probes with respect to ground terminal of ZCD.
5. Adjust potentiometer ‘R’ such that, it generates 10 pulses in half cycle.
6. Set the thumb wheel switch to some number (as soon as synchronized signal crosses zero, counter starts counting clock pulses in down counting mode from the set value).
7. Observe train of pulses across T_P and T_N.
8. Connect T_1 and T'_1 of driver circuit to the gate and cathode of SCR module.
9. Switch ON power supply to SCR power circuit by keeping autotransformer knob at minimum position.
10. By varying auto transformer knob gradually, set voltage across SCR about 80V (measure set voltage using Multimeter)
11. By setting different numbers in thumb wheel switch (each step corresponds to 18° firing angle delay), Observe load voltage and SCR voltage waveform.

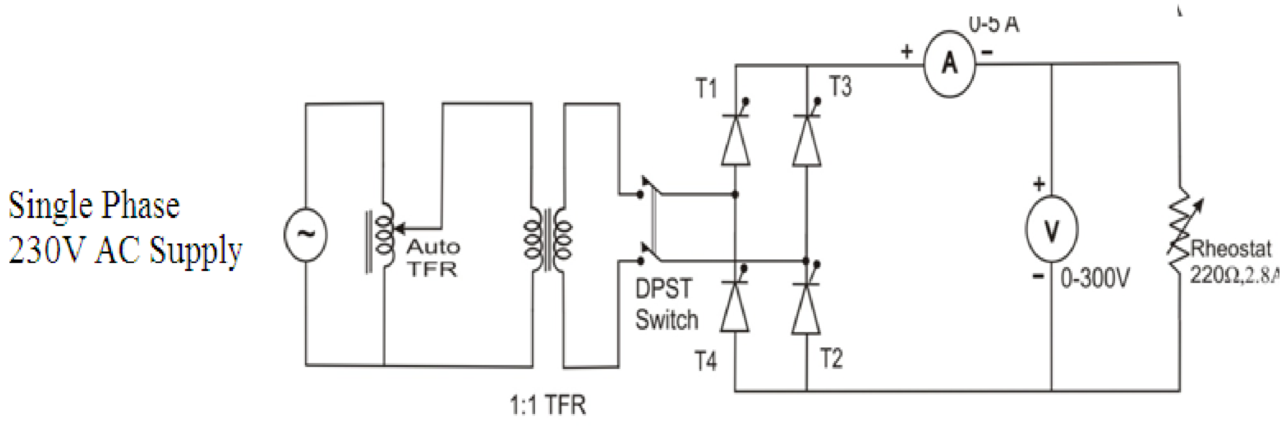
TABULAR COLUMN:

S.No	Firing angle in Degrees	Av. Output Voltage $V_{DC(AV)} = \frac{V_m}{2\pi}(1+\cos\alpha)$	Av. Output Voltage (Practical values)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

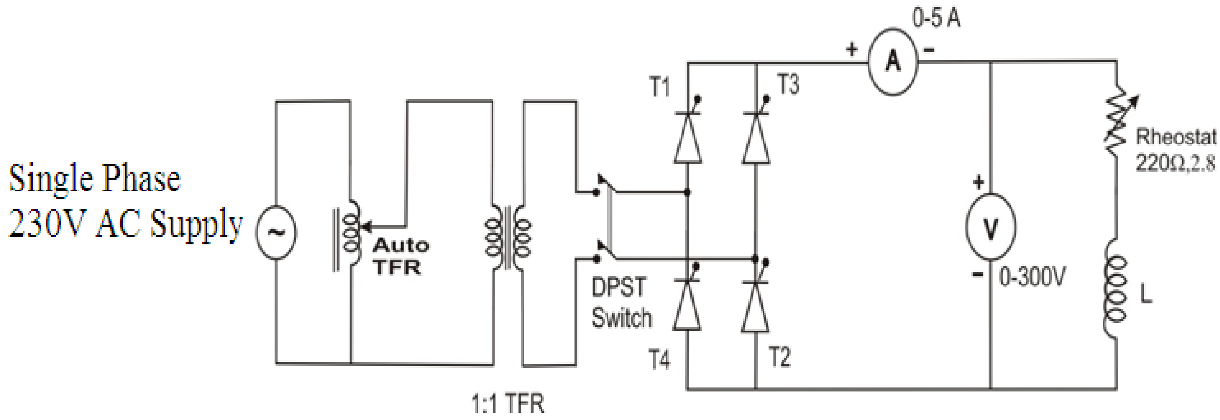
EXPT. NO.7

Single Phase Full Wave rectifier with R & R-L Load

Single Phase Full wave Rectifier with R - Load



Single Phase Full wave Rectifier with R -L Load



EXPT.NO-7: SINGLE PHASE FULL WAVE RECTIFIER WITH R & R-L LOAD

AIM: To Study the output characteristics of full wave rectifier with R and RL load.

APPARATUS REQUIRED:

S.no	Apparatus	Range	Type	Qty
1	FWR module	-	-	1No
2	CRO and probes	-	-	1Set
3	Rheostat	0-200Ω,2.8A	-	1No
4	Firing module	-	-	1No
5	Auto-transformer	230/0-260V	5A	1No
6	Isolation Transformer	230V	1:1	1No
7	Tachometer	-	Digital	1No
8	Multimeter	-	-	1No
9	Connecting Wires	-	-	Few

THEORY: Refer text book

PROCEDURE:

1. Make the connections as per the circuit diagram.
2. Connect the gate cathode terminals of SCR's to respective points on firing module.
3. Initially set auto-transformers knob and firing module knob to minimum position.
4. Switch ON the power supply to SCR power module and firing module.
5. By connecting CRO probe at appropriate terminals on firing module, check for triggering pulses.
6. Gradually increase supply voltage by varying autotransformer knob, set to some constant voltage (say 100V).
7. Observe output voltage waveform on CRO (if the output is not observed, interchange line and neutral connections at the input of single phase converter).
8. Vary firing angle potentiometer in steps of 10° (for firing angle range 0-180°) and at each step note down output voltage magnitude from waveform on CRO.

9. Calculate average output voltage theoretically using formula

$V_{DC(AV)}=\left(\frac{V_m}{\pi}\right)(1+\cos\alpha)$ – for R – Load

$V_{DC(AV)}=\frac{2V_m}{\pi}(\cos\alpha)$ – for R –L Load

10. Plot a graph of firing angle v/s average output voltage for practical values.

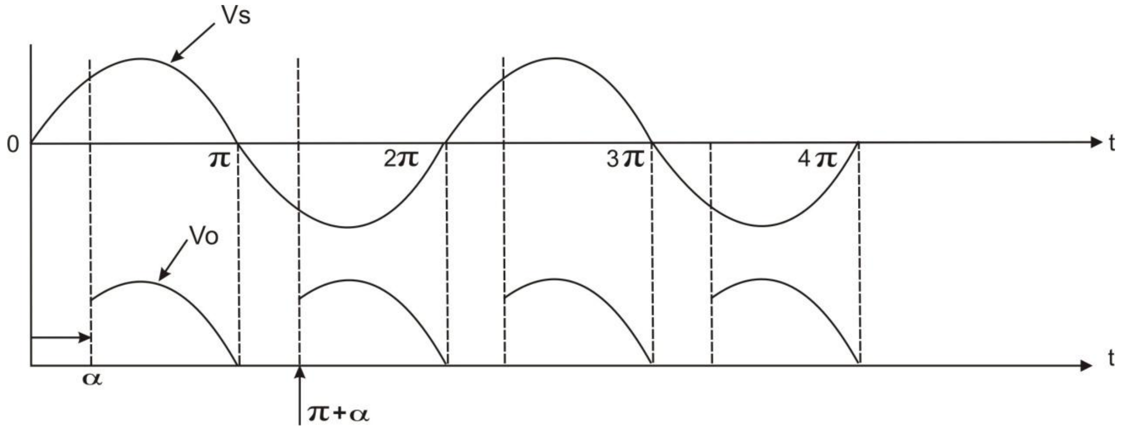
TABULAR COLUMN: FOR R- LOAD

S.No	Firing angle in Degrees	Av. Output Voltage $V_{DC(AV)}=\frac{V_m}{\pi}(1+\cos\alpha)$	Av. Output Voltage (Practical values)
1	0		
2	10		
3	20		
4	30		
5	40		
6	50		
7	60		
8	70		
9	80		
10	90		
11	100		
12	110		
13	120		
14	130		
15	140		
16	150		
17	160		
18	170		
19	180		

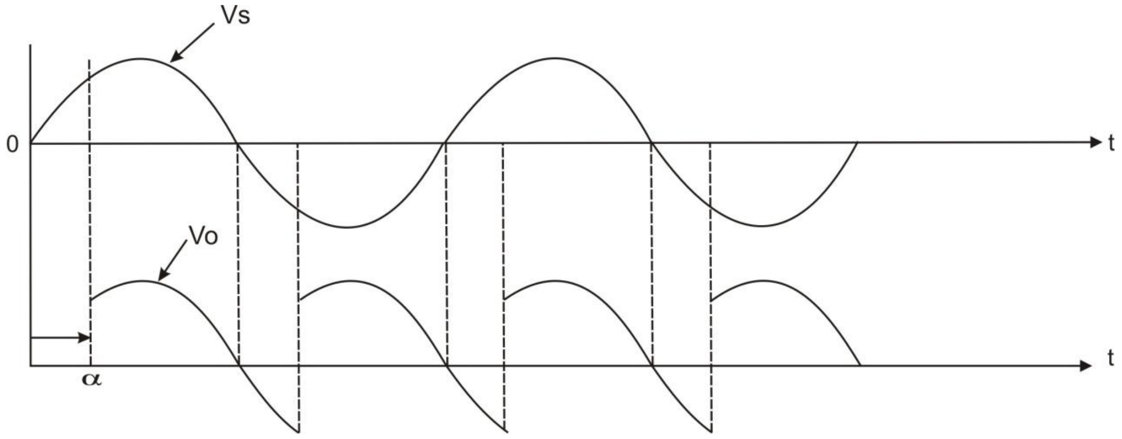
TABULAR COLUMN: FOR R –L LOAD

S.No	Firing angle in Degrees	Av. Output Voltage $V_{DC(AV)} = \frac{2V_m}{\pi}(\cos\alpha)$	Av. Output Voltage (Practical values)
1	0		
2	10		
3	20		
4	30		
5	40		
6	50		
7	60		
8	70		
9	80		
10	90		
11	100		
12	110		
13	120		
14	130		
15	140		
16	150		
17	160		
18	170		
19	180		

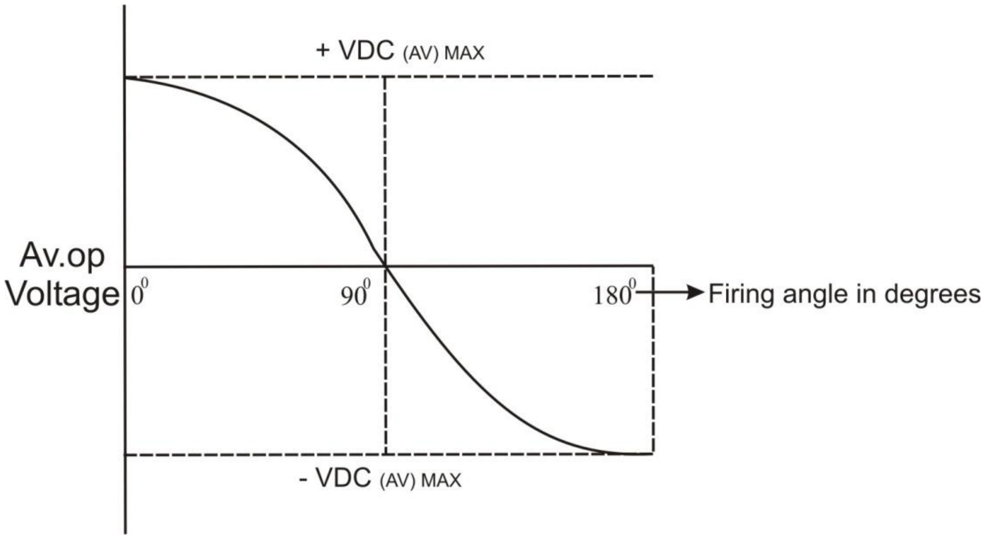
NATURE OF GRAPH: **For R LOAD**



NATURE OF GRAPH: **For R-L LOAD**



NATURE OF GRAPH: AVERAGE OUTPUT VOLTAGE VS FIRING ANGLE

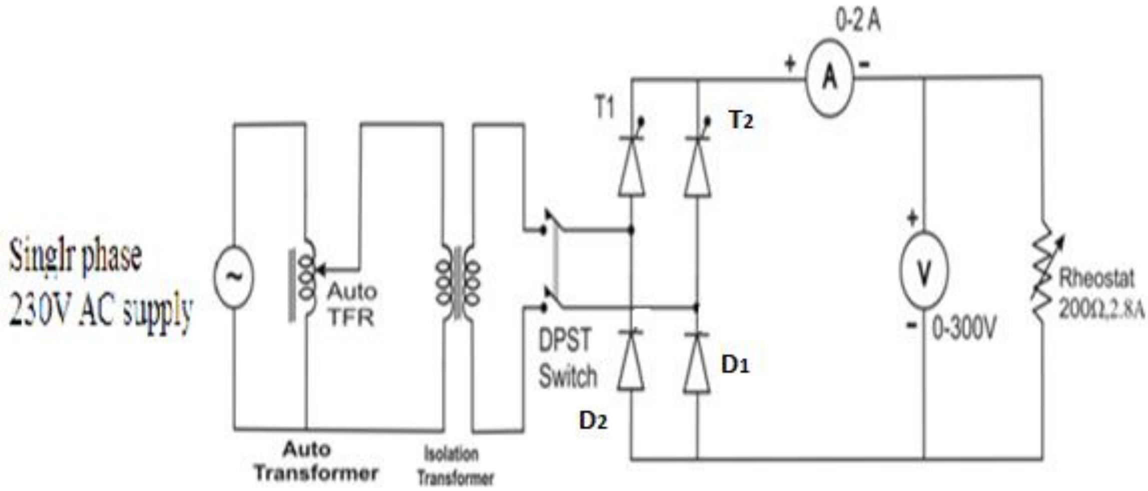


EXPT. NO.8

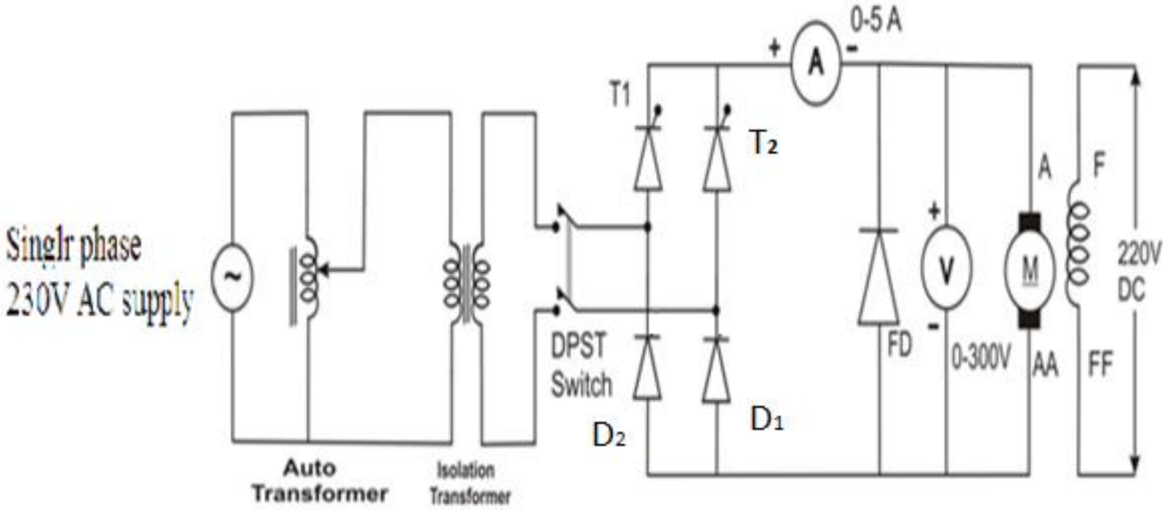
Speed control dc motor using single phase semi converter

SPEED CONTROL DC MOTOR USING SINGLE PHASE SEMI CONVERTER

CIRCUIT DIAGRAM (FOR CHECKING THE MODULE)



CIRCUIT DIAGRAM (FOR CONDUCTING THE EXPT ON THE MODULE)



EXPT.NO-8: SPEED CONTROL DC MOTOR USING SINGLE PHASE SEMI CONVERTER

AIM: To obtain speed v/s firing angle characteristics for the given DC motor using fed by Single-phase semi converter.

APPARATUS REQUIRED:

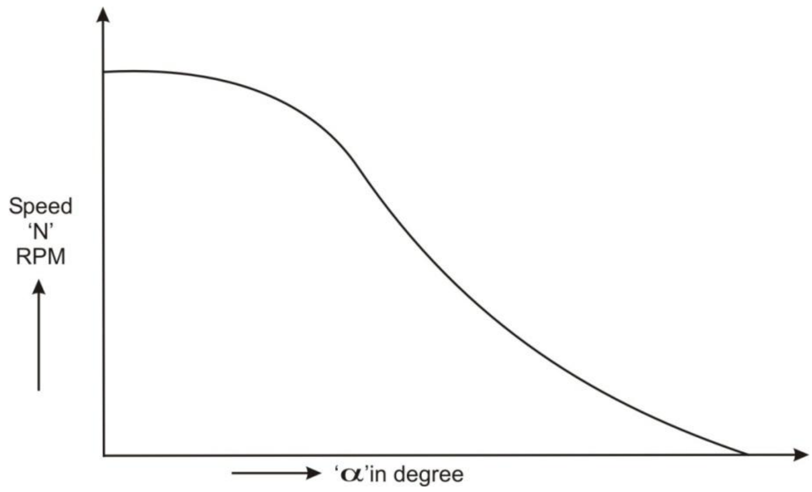
S.no	Apparatus	Range	Type	Qty
1	Semi converter module	-	-	1 No
2	CRO and probes	-	-	1 set
3	Rheostat	0-200Ω/2.8A	-	1 No
4	Firing module	-	-	1 No
5	Autotransformer	0-240V	5A	1 No
6	Isolation transformer	0-230V	2A	1 No
7	Tachometer	0-30V	Digital	1 No
8	Multimeter	-	-	01No
9	DC Motor	-	Seperately Excited	01No
10	Connecting wires	-	-	Few

THEORY: Refer text book

TABULAR COLUMN:

S.no	Firing angle in degrees	Speed in rpm

NATURE OF GRAPH:



Speed in rpm Vs firing angle in degrees

PROCEDURE:

FOR CHECKING THE MODULE:

1. Make the connections as per the circuit diagram 1.
2. Connect the gate, cathode terminals of 2 SCR's to respective points on firing module.
3. Initially set autotransformer and firing module knob to minimum position.
4. Switch ON the power supply to SCR power module and firing module.
5. By connecting CRO probe at appropriate terminal on firing module, check for Triggering pulses.
6. Gradually, increase supply voltage by varying autotransformer knob, set some constant voltage say 50V.
7. Observe output voltage waveform on CRO (if the output is not observed, interchange the line and neutral connections at the input of the single phase converter).
8. Reduce supply voltage to minimum by setting autotransformer knob at minimum position.

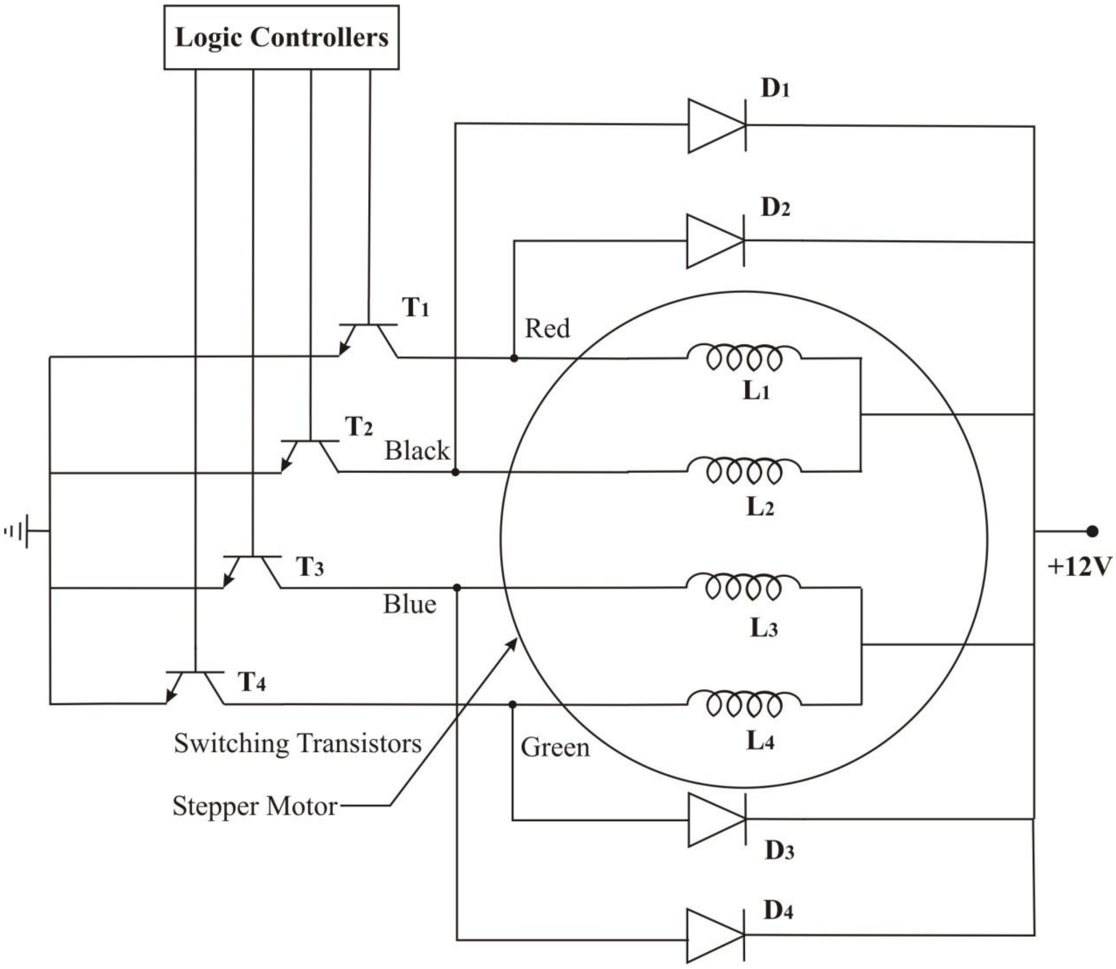
FOR CONDUCTING THE EXPERIMENT ON DC MOTOR:

1. Make the connections as per the circuit diagram-2.(After checking for proper working of power module and firing module disconnect the rheostat , then connect bridge output to armature terminals of DC motor).
2. Initially set autotransformer and firing module knob to minimum position.
3. Switch ON power supply to SCR power module and firing module.
4. Measure voltage across field terminals using multimeter in DC mode.
   (Note: In case of separately excited DC motor control, field excitation is separate. Field supply should be ON before giving armature supply and OFF only after switching OFF armature supply)
5. Gradually, increase supply voltage by varying autotransformer knob. (set to some constant voltage say 60V to observe that, whether DC motor is running properly without jerks or not by varying firing angle potentiometer, then set firing angle potentiometer at minimum position and gradually increase supply voltage to 230V)
6. Vary firing angle potentiometer in steps of 10° (for firing angle range 0-180°) and at each step note down speed of motor using tachometer.
7. Plot a graph of firing angle v/s speed in rpm.

EXPT. NO.9

Speed Control of Stepper Motor

SPEED CONTROL OF STEPPER MOTOR



EXPT.NO-9: **SPEED CONTROL OF STEPPER MOTOR**

AIM: To Study the Stepper motor operation and

i) To calculate error in speed

ii) Programming for different step.

iii) To verify truth table.

APPARATUS REQUIRED:

S.no	Apparatus	Range	Qty
1	Stepper Motor	-	1No
2	Stepper Motor control module	-	1No
3	Stop watch	-	1No
4	Connecting wires	-	few

THEORY: Refer text book

TABULAR COLUMN:

S.No	Actual revolution in Degrees 'Ra'	Indicated revolution in Degree. 'Ri'

S.No	No. of Steps	Angle in Degree.

TRUTH TABLE:

Half Step :

A1	A2	B1	B2
Red	**Black**	**Blue**	**Green**
0	1	0	1
0	0	0	1
1	0	0	1
1	0	0	0
1	0	1	0
0	0	1	0
0	1	1	0
0	1	0	0

Full Step :

A1	A2	B1	B2
Red	**Black**	**Blue**	**Green**
0	1	0	1
0	1	1	0
1	0	1	0
1	0	0	1

PROCEDURE:

To Find Error:

1. Make the connections as per the circuit diagram.
2. Switch ON the power supply to the module.
3. Press set button, select RPM/Step mode by pressing INC/DEC, then press ENT button.
4. Adjust the RPM to the particular value say 5 by pressing INC/DEC and Then press ENT button.
5. Choose directions forward / Reverse by pressing INC /DEC and then press ENT button.
6. Choose rotation in half or full step by pressing INC / DEC and then press ENT button.
7. Press RUN and switch ON stop watch.
8. Note down angle rotated in one minute.
9. Calculate % error using formula

   % Error = $[(R_a - R_i)/R_a]$ X 100

Programming for different Step:

1. Select step control.
2. Select say 10 steps by adjusting INC /DEC.
3. Select forward / Reverse.
4. Select Full / Half step.
5. Press RUN and Observe number of steps moved.

Note: One Step=1.8°

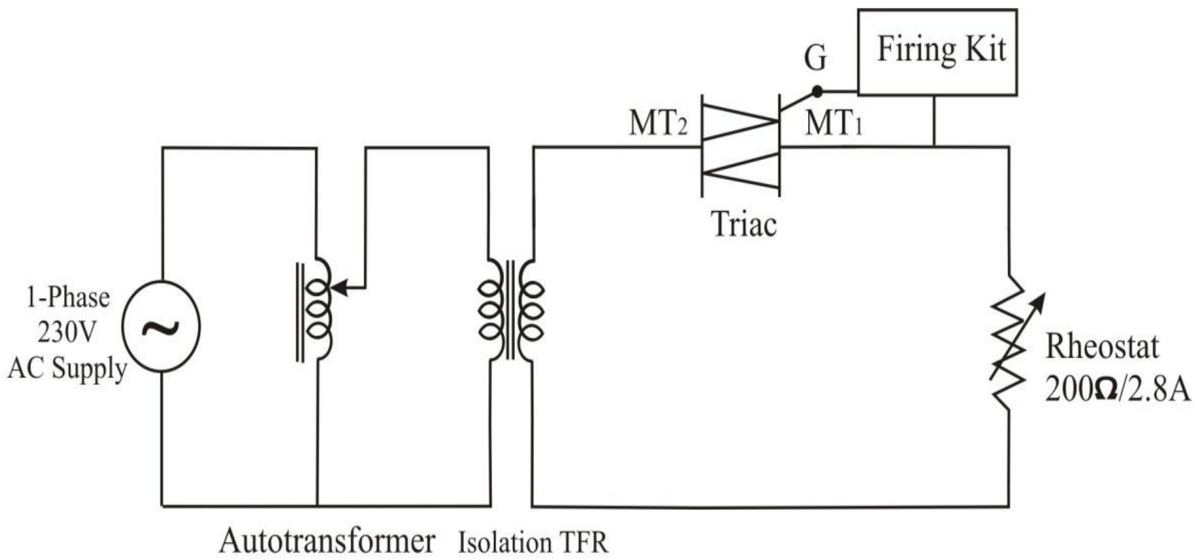
To verify Truth table:

1. Select step control.
2. Select one step by adjusting INC /DEC.
3. Select forward / Reverse.
4. Select Full / Half step.
5. Press RUN and Observe A1, B1, A2, and B2 LED's by referring respective truth table. Hence verify truth table.

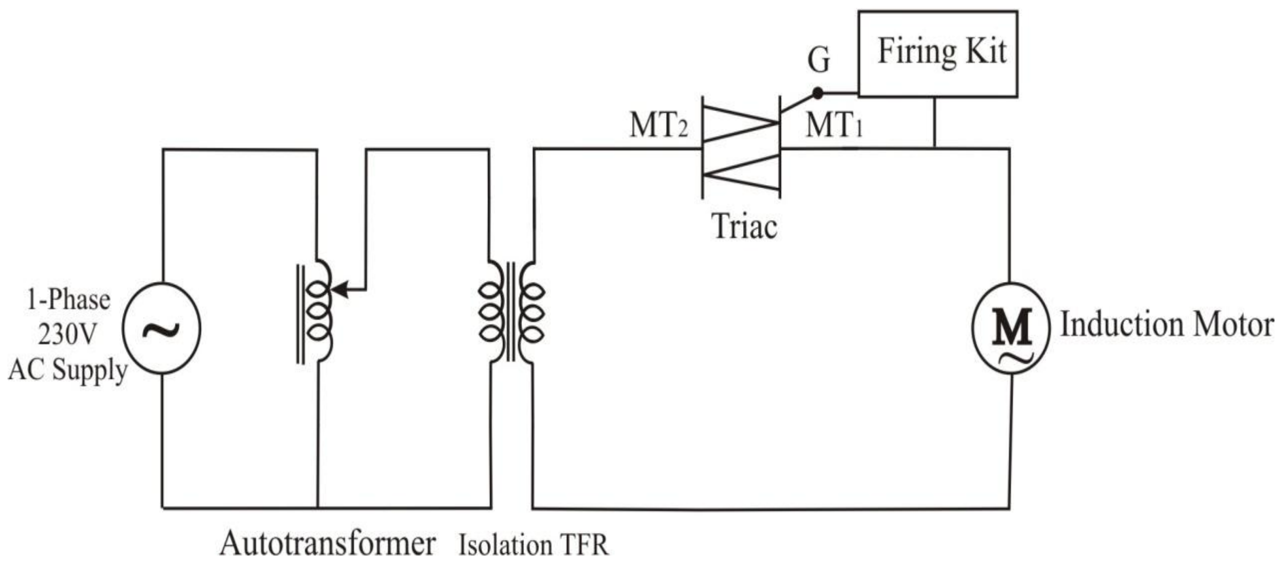
EXPT. NO.10

Speed control of single phase induction motor using a TRIAC

CIRCUIT DIAGRAM OF SPEED CONTROL OF 1-PHASE INDUCTION MOTOR



For checking the module



For conducting the experiment On Induction

EXPT.NO.10: **SPEED CONTROL OF SINGLE PHASE INDUCTION MOTOR USING A TRIAC**

AIM: To obtain speed v/s firing angle characteristics for the given single phase Induction motor using a TRIAC.

APPARATUS REQUIRED:

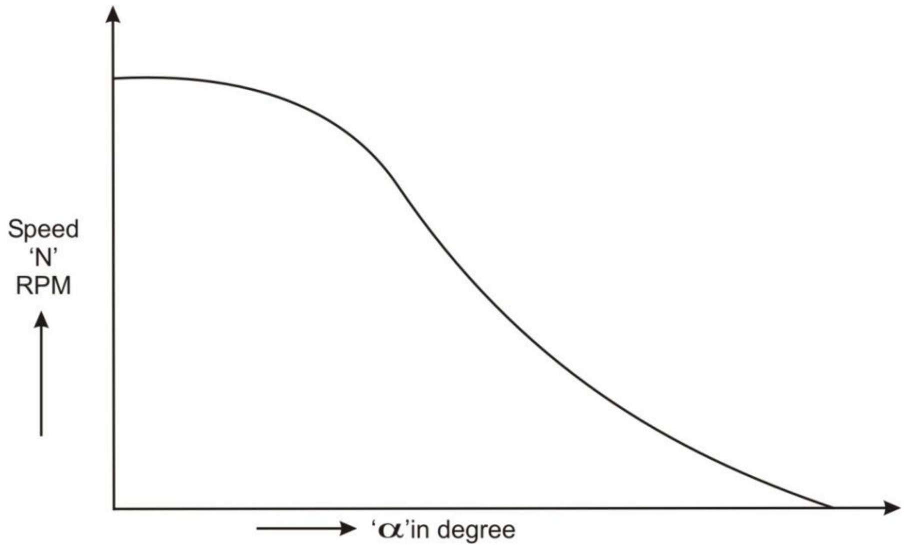
S.no	Apparatus	Range	Type	Qty
1	TRIAC module	-	-	1 No
2	CRO and probes	-	-	1 No
3	Rheostat	0-200Ω/2.8A	-	1 No
4	TRIAC firing module	-	-	1 No
5	Autotransformer	0-240V	5A	1 No
6	Isolation transformer	0-230V	2A	1 No
7	Tachometer	0-30V	Digital	1 No
8	Multimeter	-	Digital	01No
9	Single phase Induction Motor	-	-	01No
10	Connecting wires	-	-	few

THEORY: Refer text book

TABULAR COLUMN:

S.No	X	Y	Firing angle in degrees	Speed in rpm

NATURE OF GRAPH:



Speed in rpm Vs firing angle in degrees

PROCEDURE:

FOR CHECKING THE MODULE:

1. Make the connections as per the circuit diagram 1.
2. Connect the gate and main terminal MT1 to respective points on firing module.
3. Initially set autotransformer and firing module knob to minimum position.
4. Switch ON the power supply to Triac module and firing module, check for triggering pulses.
5. By connecting CRO probe at appropriate terminal on firing module, check for Triggering pulses.
6. Gradually, increase supply voltage by varying autotransformer knob, set some constant voltage say 50V.
7. Observe output voltage waveform by setting autotransformer knob at minimum position.
8. Reduce supply voltage to minimum by setting autotransformer knob at minimum position.

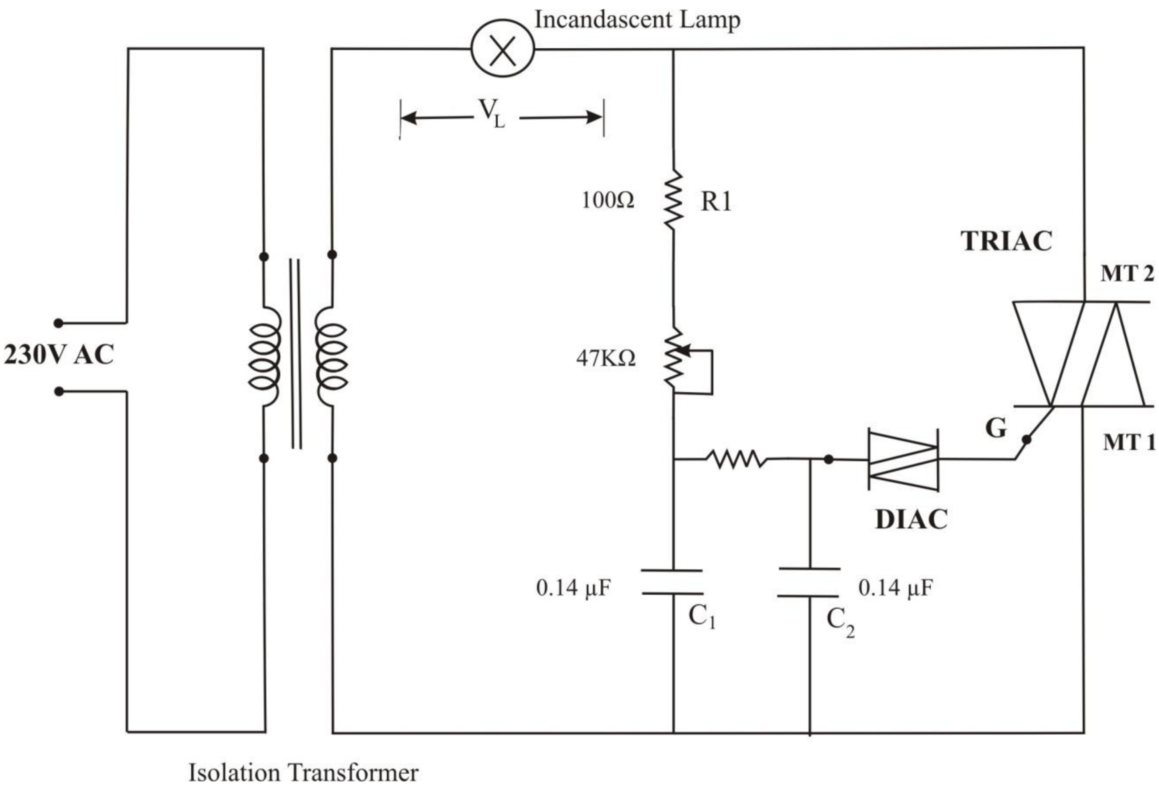
FOR CONDUCTING THE EXPERIMENT ON INDUCTION MOTOR:

1. Make the connections as per the circuit diagram-2.
   (Initially set auto-transformer and firing module knob to minimum position)
2. After checking for proper working of power module and firing module disconnect the rheostat , then connect Triac output to Induction motor.
3. Switch on power supply to Triac module and firing module.
4. Gradually, increase supply voltage by varying autotransformer (set to some constant voltage say 100V to observe that, whether Induction motor is running properly without jerks or not by varying firing angle potentiometer, then set firing angle potentiometer at minimum position and gradually increase supply voltage to 230V)
5. Vary firing angle potentiometer in steps of 10° (for firing angle range 0-180°) and at each step note down speed of motor using tachometer.
6. Plot a graph of firing angle v/s speed in rpm.

EXPT. NO.11

AC voltage controller using Diac, Triac combination

CIRCUIT DIAGRAM OF AC VOLTAGE CONTROLLER USING TRIAC DIAC:



TABULAR COLUMN:

1. Y=_______DIV

Sl. no	X	FIRING ANGLE = (X/Y) 180° In degrees	LOAD VOLTAGE Using AC Voltmeter in Volts
1			
2			
3			
4			
5			
6			

EXPT.NO.11: AC VOLTAGE CONTROLLER USING DIAC, TRIAC COMBINATION

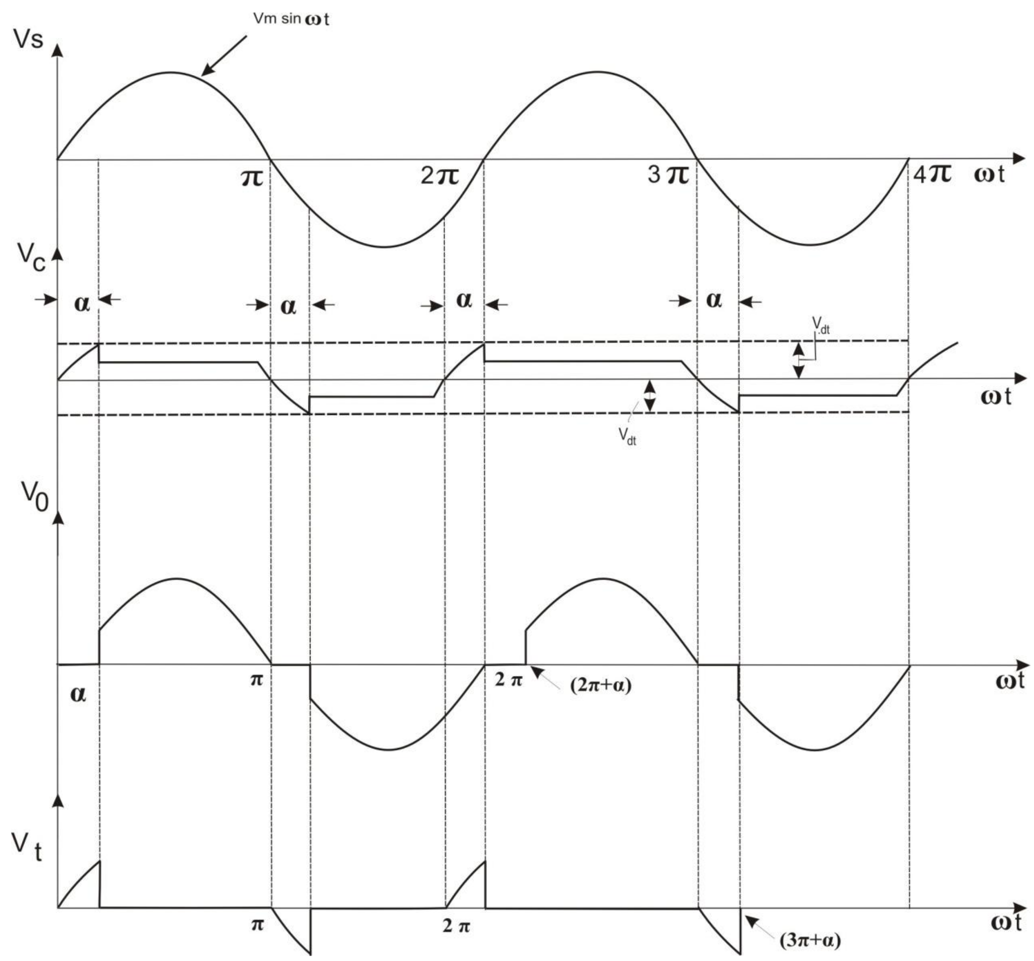
AIM: To study the phase control of triac by diac triggering method.

APPARATUS REQUIRED:

S.no	Apparatus	Range	Type	Qty
1	AC Voltage regulator module	-	-	1 No
2	Patch cords	-	-	1 No
3	CRO with probes	-	-	1 Set
4	Multimeter	-	-	1 No
5	AC Voltmeter	0-300V	MI	1 No
6	Bulb	60W	Incandescent	

THEORY: Refer text book

NATURE OF GRAPH:



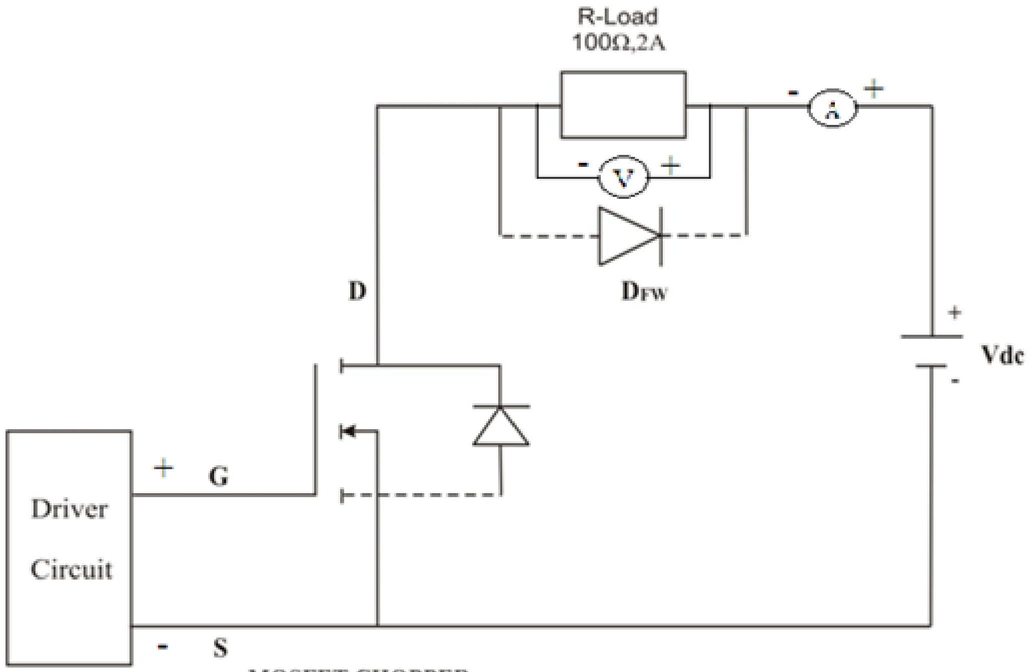
PROCEDURE:

1. Make the connections as per the circuit diagram.
2. Initially set auto-transformer and firing module knob to minimum position.
3. Connect multimeter or AC voltmeter across load.
4. Observe load voltage waveform on CRO.
5. Gradually vary potentiometer, note down firing angle and corresponding load voltage using multimeter or voltmeter.
6. Plot a graph of firing angle α verses load voltages.

EXPT. NO.12

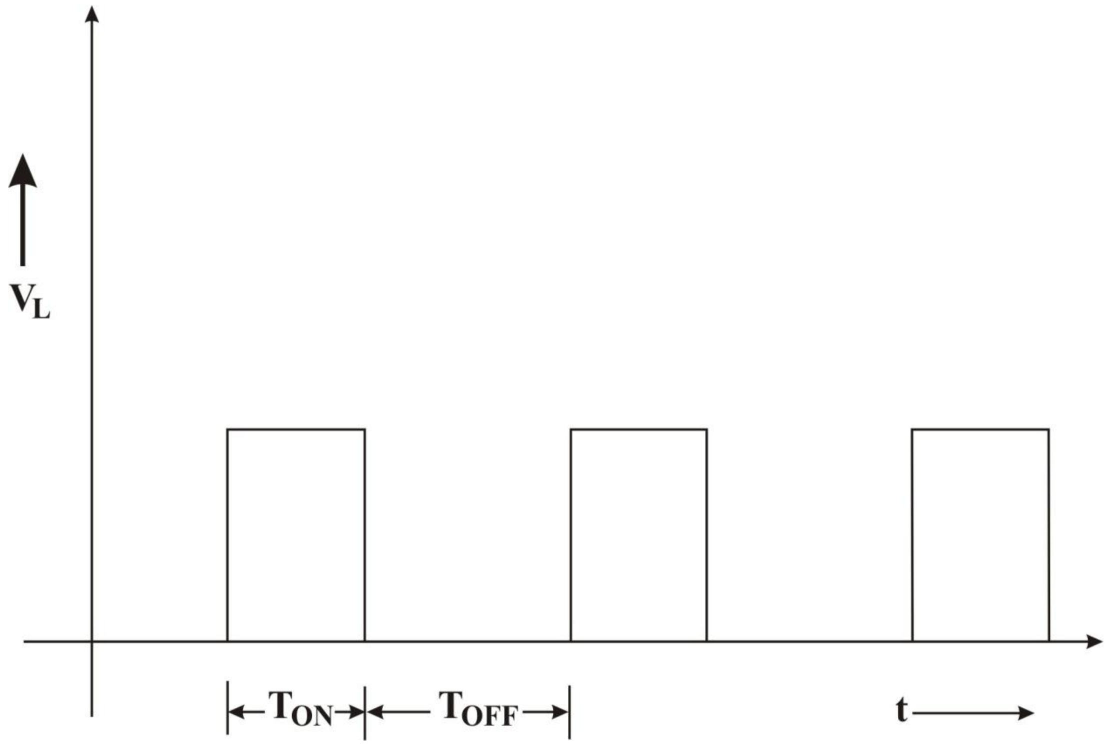
DC Motor speed control (Using power MOSFET/IGBT Chopper)

CIRCUIT DIAGRAM:



MOSFET CHOPPER

OUTPUT WAVEFORM:



EXPT.NO:12: SEPERATELY EXCITED DC-MOTOR SPEED CONTROL USING POWER MOSFET/ IGBT CHOPPER

AIM: To study the phase control of triac by diac triggering method.

APPARATUS REQUIRED:

S.no	Apparatus	Range	Type	Qty
1	Power MOSFET/IGBT Module	-	-	1 No
2	DC Motor	-	Separately excited	1 No
3	Tachometer	-	Digital	1 Set
4	Connecting wires	-		1 No

THEORY: Refer text book

Front Panel Details:

1. V_{dc} : Digital Voltmeter to measure DC Voltage.
2. A_{dc}: Digital Ammeter to measure DC current.
3. IGBT: Insulated Gate Bipolar Transistor –IRGPH20KD , Collector, gate, Emitter terminals..
4. MOSFET: IRF460, Drain, Source, gate terminals.
5. Dfw: Freewheeling diode, SPR 12PB, cathode, Anode terminals.
6. Field 220V DC : Field supply 220V ±10% @ 2Amps for field of DC shunt motor with neon lamp indicator.
7. Volt-Selector: Rotary switch to select DC supply as follows.
    a. OFF:DC supply is OFF.
    b. 1: 24V DC
    c. 2: 48V DC
    d. 110V DC
    e. 220V DC
8. Transformer: Step down transformer with tapings @ 20V, 40V, 80V and 170V to get different DC output Voltages.
9. Rectifier: Diode bridge rectifier – 10Amps/ 600V to rectify input AC supply to DC supply.
10. C: Capacitor filter.

B) <u>Control Circuit</u>: The control circuit is 89C51 microcontroller based to accurately generate the control output. The duty cycle can be varied from 0-100%, Frequency of the chopper can be varied from 50Hz to 500Hz.

2 Line X 16 character LCD display to indicate the parameters and their values. 4 keys to increment and decrement the chopper frequency or Duty cycle and to Run/Stop the output wirh soft start and stop feature. Opto coupler based driver circuit to drive MOSFET/ IGBT.

<u>Front Panel Details</u>:

1. Mains: Power ON/OFF switch to the unit with built-in indicator.
2. LCD display: 2 line x 16 characters LCD display to display the parameters.
3. Key board:
    a. FRQ/DCY: Key to select the variable parameter- Frequency/Duty cycle.
    b. INC: Key to increment the selected parameter value.
    c. DEC: Key to decrement the selected parameter value.
    d. RUN/STOP: key to RUN/STOP the chopper with soft start feature.
4. Driver Output + & - :
   Driver output terminals to be connected to Gate/Emitter of IGBT or Gate/Source of MOSFET.

<u>Back Panel Details</u>:

1. 3 pin mains socket: Power inlet point to the unit with built in fuse holder.
2. Glass fuse holder: One for MOSFET, One for IGBT.

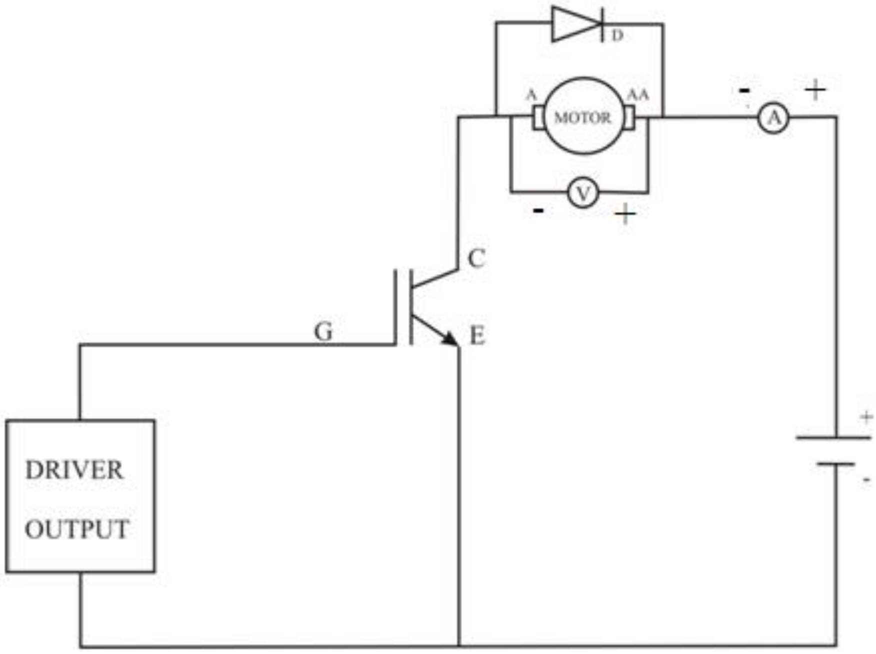
<u>TABULATION:</u>

Sl.no	V_{in} Volts	Frequency Hz	Duty cycle %	V_{out} Volts	I_0 Amps

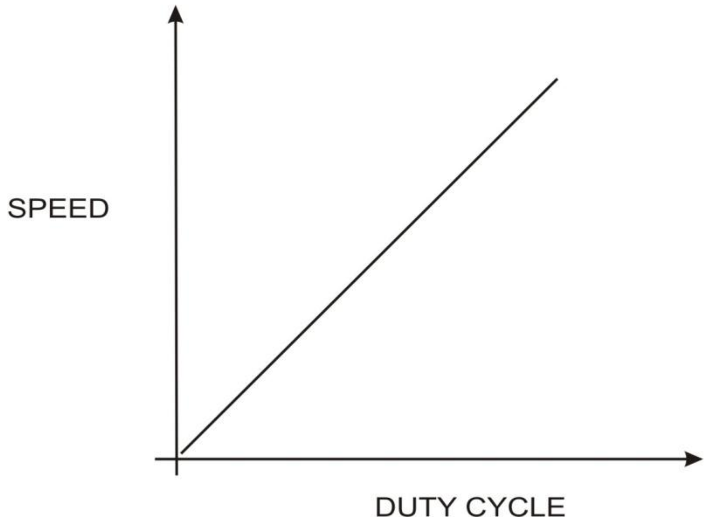
Draw the graph of Duty Cycle V/s V0

<u>Note</u>: Since the DC supply is unregulated DC supply, the input will slightly drop as current increases.

CIRCUIT DIAGRAM FOR DC MOTOR CONTROLLER USING IGBT:



IDEAL GRAPH FOR DC MOTOR CONTROLLER:



PROCEDURE:

1. Make the connections as per the circuit diagram.
2. Ensure selector switch knob at minimum position.
3. Keep the volt-selector switch at OFF position. Switch on the mains supply to the unit. The LCD display shows- Power MOSFET/IGBT chopper

   OFF DCY- 0 FRQ 50

   Digital voltmeter and ammeter shows 000-000
4. Measure the field voltage using digital voltmeter. It should be 220V ±10% approximately and the neon lamp glows.
5. Now keep the voltage select switch at position 1 and measure the voltage at VDC terminals. It should be 24 Volts. The output voltage should be 48 volts when VOLT-Select switch at position-2, 110 volts when the VOLT-Select switch at position-3, 220 volts when the volt select switch is at position 4 approximately.
6. Make sure that the DC supply is correct. Now observe the driver output using a CRO

   By varying duty cycle and frequency.
7. Make sure that the driver output is proper before connecting to the gate/emitter or gate/source of IGBT or MOSFET.
8. Now all the outputs are proper. Make the connections as given in the circuit diagram.
9. Select 48V DC.
10. Apply the driver output pulses.
11. Vary the duty cycle and observe the load voltage and tabulate the Voltmeter and Ammeter readings.
12. Now change the frequency to some other value and change the duty cycle and note down the readings.
13. Repeat the same procedure for 48Volts. 110V and 220V.
14. In case of DC shunt motor experiment, connect field supply to the field terminals before connecting to the armature supply. And the field supply should be removed only after switch OFF the armature supply.
15. Use higher value of Rheostat-470 Ohm/1Amps to work at 110V/220V DC supply.
16. External DC supply can be used as input to the chopper to get regulated DC supply.

POWER ELECTRONICS LAB VIVA-VOCE QUESTIONS

1. Sketch the V-I characteristics of an SCR without gate current and with gate current.
2. What is the advantage of SCR over power Transistor?
3. What is the constructional difference in an inverter Thyristor and converter grade Thyristor?
4. List the methods of turning ON of SCR.
5. Define latching current, Holding current, Break over voltage. Show these on the V-I characteristics of SCR.
6. What is the turn-on time of a Thyristor?
7. What is the turn-off time of a Thyristor?
8. Why is SCR called as latching device?
9. Why pulse triggering of SCR is preferred over single or DC triggering?
10. List the important ratings of SCR.
11. What purpose a resistor in series with gate serves?
12. Sketch the characteristics of Triac.
13. What are the terminals of Triac?
14. Explain the operation of Triac in different modes.
15. In which modes is the Triac more sensitive?
16. What are the applications of Triac?
17. What is a MOSFET?
18. What are the types of MOSFET?
19. What are the differences between enhancement type and depletion type MOSFET?
20. What is pinch-off voltage of MOSFETs?
21. What is threshold voltage of MOSFET?
22. What are the transfer characteristics of MOSFET?
23. What are the output characteristics of MOSFET?
24. Why do the MOSFETs not require negative gate voltage during turn-off?
25. What is the turn-on time of a MOSFETs and IGBTs?
26. What is the turn-off time of a MOSFETs and IGBTs?
27. What do you mean by commutation?
28. Distinguish between natural commutation and forced commutation.
29. How are the forced turn-off methods classified?
30. State the conditions under which a load carrying SCR can be successfully commutated.

31. What are the purposes of commutation circuit?
32. What is forced commutation?
33. What are the different methods of commutation schemes?
34. What is DC chopper?
35. What is pulse width modulation control of a chopper?
36. What is frequency modulation control of a chopper?
37. What do you mean by auxiliary commutation?
38. What do you mean by permanent magnet stepper motor?
39. What do you mean by half step and full step motor?
40. What are applications of stepper motor?
41. What are various means of speed control of a induction motor?
42. What is a duty cycle?
43. What is the purpose of a converter in dc drives?
44. What are the parameters to be varied for speed control of separately excited dc motors
45. What do you mean by line commutation?
46. What is one-quadrant DC drive?
47. What is two-quadrant DC drive?
48. What is four-quadrant DC drive?
49. What are the advantages of UJT triggering circuit?
50. What is a converter?
51. What is the principle of ac-dc conversion?
52. What are the performance parameters of rectifier?
53. What is the difference between a half controlled and fully controlled converter?
54. In a fully controlled single phase bridge, why does negative part of the input voltage cycle appear across load, if load is inductive but not with resistive load?.