DRONACHARYA
College of Engineering

LAB MANUAL

ELECTRICAL ENGINEERING MATERIALS & SEMICONDUCTOR DEVICES LAB
(EC-317-F)

III SEMESTER ECS

Department of Electronics & Communication Engg.
Dronacharya College of Engineering
Khentawas, Gurgaon – 123506

LIST OF EXPERIMENTS

EXPERIMENT NO. 1

AIM: To Study V-I Characteristics of a Diode.

APPARATUS REQUIRED: Diode Characteristics Kit, Power Supply, Ammeter (0-20mA), Voltmeter (0-20V), Connecting Leads.

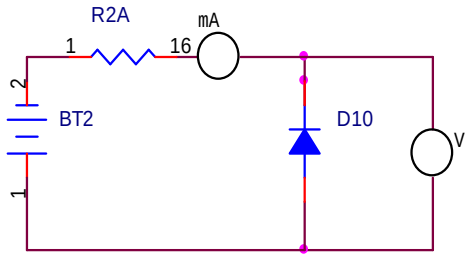
BRIEF THEORY: A P-N junction is known as Semiconductor diode or Crystal diode. It is the combination of P-type & N-type Semiconductor. This offers nearly zero resistance to current on forward biasing & nearly infinite Resistance to the flow of current when in reverse biased.

Forward biasing: When P-type semiconductor is connected to the +ve terminal and N-type to –ve terminal of voltage source. Nearly zero resistance is offered to the flow of current.

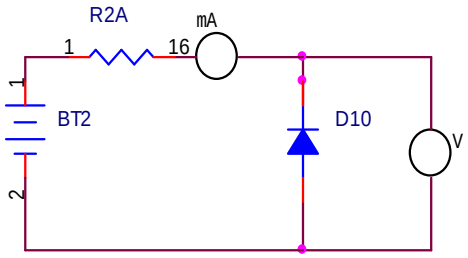
Reverse biasing: When P-type semiconductor is connected to the –ve terminal and N-type to +ve terminal. Nearly zero current flow in this condition.

CIRCUIT DIGRAM:

(1) When diode is forward biased



(2) When diode is reverse biased



PROCEDURE:

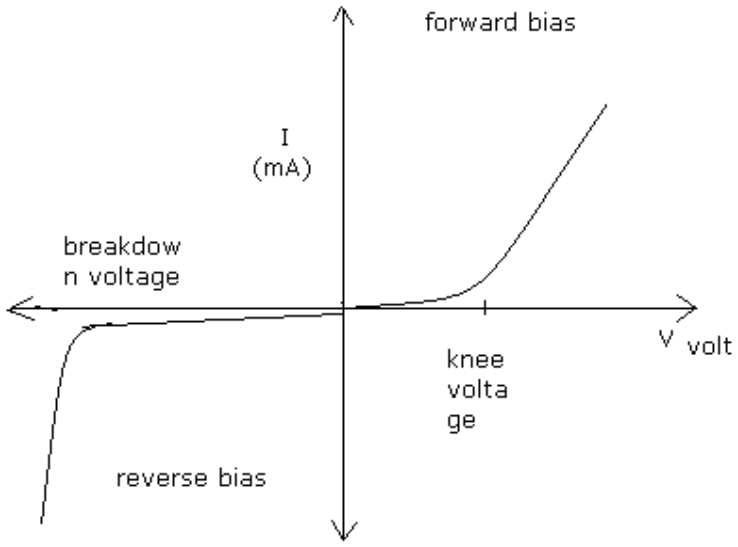
(1) Connect the circuit as shown in fig.
(2) Switch on the power supply.
(3) Vary the value of input dc supply in steps.
(4) Note down the ammeter & voltmeter readings for each step.
(5) Plot the graph of Voltage Vs Current.
(6) Connect the circuit as shown in fig.

OBSERVATION TABLE:

S.NO	When Diode Is Forward Biased		When Diode Is Reverse Biased	
	Current(mA)	Voltage(V)	Current [μA)	Voltage(V)
1.				

2.				
3.				

GRAPH:



RESULT: The graph has been plotted between voltage and current.

DISCUSSION: The diode doesn't conduct in RB state and conduct in FB state.

PRECAUTIONS:

(1)Always connect the voltmeter in parallel & ammeter in series as shown in fig.
(2)Connection should be proper & tight.
(3)Switch 'ON' the supply after completing the circuit
(4)DC supply should be increased slowly in steps
(5)Reading of voltmeter & Ammeter should be accurate.

QUIZ:

Q.1 Define semiconductor diode?
A. A PN – junction is called semiconductor diode.
Q.2 Define depletion layer?
A. The region having uncompensated acceptor and donor ions.
Q.3 what do you mean by forward biased?
A. When +ve terminal of battery is connected to P side & -ve terminal to N side of diode.
Q.4 what do you mean by reverse biased?
A. When +ve terminal of battery is connected to N side & -ve terminal to P side of diode.
Q.5 Define Knee voltage?
A. The forward voltage at which current through the junction starts increasing rapidly.
Q.6 Define breakdown voltage?
A. Reverse voltage at which PN junction breaks down with sudden rise in reverse current.
Q.7 Define max. Forward current?

A. It is highest instantaneous forward current that a PN junction can conduct without damage to Junction.

Q.8 Define max. Power rating?

A. Max. Power that can be dissipated at junction without damage to it.

Q.9. What is ideal diode?

A. Diode have been ideal if it acted as perfect conductor (resistance zero) when forward biased and as a perfect insulator (resistance infinite) when reverse biased.

Q10.What are the application of pn diodes?

Ans. As rectifiers in dc power supplies, in demodulation or detector circuits.

EXPERIMENT NO. 2

AIM: To Study the characteristics of transistor in Common Base configuration.

APPARATUS REQUIRED : Power supply, Transistor characteristics Kit, Connecting Leads, Voltmeter, Ammeter.

BRIEF THEORY: Transistor is a semiconductor device consists of two p-n junctions. It has three terminals, to handle I/P and O/P four terminals are needed. Therefore, one terminal is made common. A transistor can be connected in three Ways CB, CE, and CC.

Common base: Base is made common. I/P is connected between base & emitter and O/P is taken between base & collector.

Input charact. The curve plotted between emitter current I & the emitter-base voltage constant collector-base voltage V.

Output charact. The curve plotted between collector current I & collector-base voltage V constant emitter current I.

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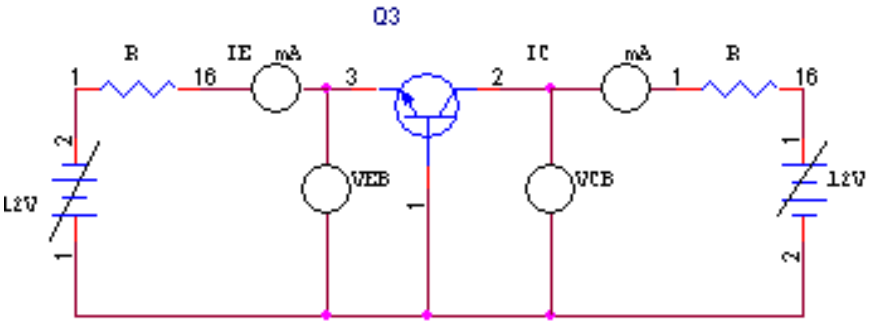
CIRCUIT DIAGRAM :



PROCEDURE:

Input charact.

(a) Make the connection as per circuit diagram .
(b) Switch 'ON' the supply & set V = 0V
(c) Vary V in step & note down the emitter current I at each step .
(d) Set V = 1V & again repeat the same procedure .
(e) Draw the graph.

Output charact.

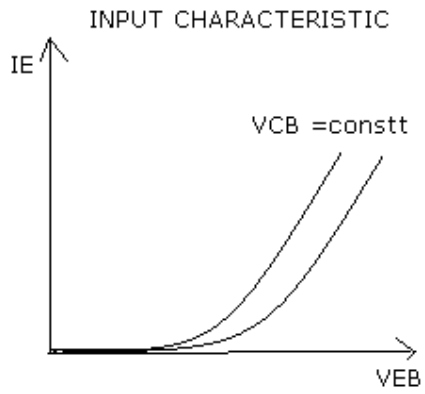
(a) Make the connection as per circuit diagram.
(b) Set the value of I = 1mA

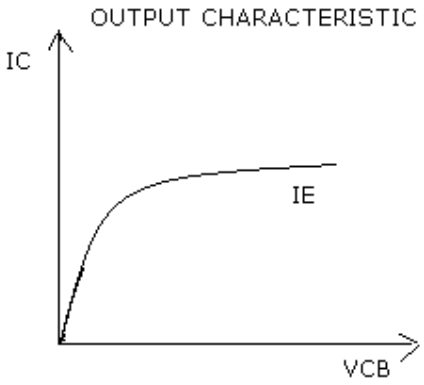
(c) Vary V in step & note down the collector current I at each step.
(d) Set I = 2mA & repeat the same procedure.
(e) Draw the graph.

OBSERVATION TABLE:

S.No	Input charact.(Vcb=Cons.)		Output charact. (Ie = Const.)	
	Ie(mA)	Veb(Volts)	Ic(mA)	Vcb(Volts)
1.				
2.				
3.				

GRAPH:





RESULT: The input and output characteristics of transformer in CB configuration has been plotted.

DISCUSSION: With the help of output characteristics we can calculate ac & dc current gain in CB configuration.

PRECAUTIONS :

1. Always connect the voltmeter in parallel & ammeter in series as shown in fig.
2. Connection should be proper & tight.
3. Switch 'ON' the supply after completing the ckt.
4. DC supply should be increased slowly in steps
5. Reading of voltmeter & Ammeter should be accurate.

QUIZ:

Q1: What do you mean by biasing of transistor?
A. When dc voltages are applied across the different terminals of transistor, it is called biasing.
Q2: What is d.c. current gain in common base configuration?
A. It is ratio of collector current(Ic) to emitter current (Ie).
Q3: What is typical value for d.c. current gain ?
A. 0.99
Q4: What is a.c. current gain in CB confifuration?

A. It is ratio of change in collector current to change in emitter current.
Q5: What are input characteristics?
A. These curves relate i/p current & i/p voltage for a given value of o/p voltage.
Q6: What are output characteristics?
A. Thes curves relate o/p voltage & o/p current for a given value of input current.
Q7: Which configuration has highest voltage gain?
A. Common Emitter.
Q8: Which configuration is most widely used?
A. Common Emitter.
Q9: What is operating point?
A. The zero signal values of Ic & Vce.
Q10: Which reigon is heavily doped in Transistot?
A. Emitter

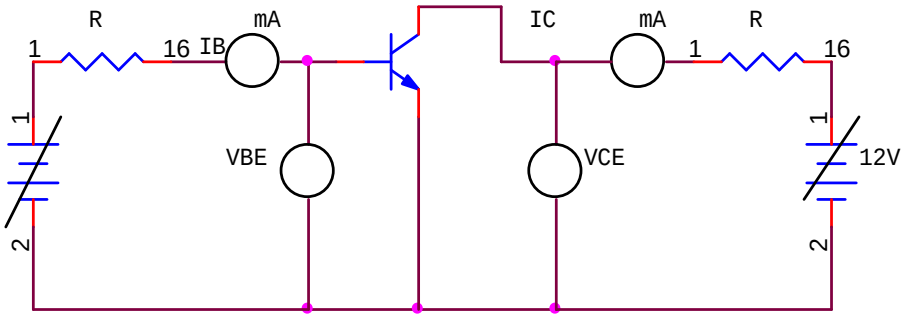
EXPERIMENT NO. 3

AIM: - To plot and study the input and output characteristics of BJT in common-emitter configuration.

APPARATUS REQUIRED: - Transistor Characteristic kit, Multimeter, Connecting leads and Power Supply.

THEORY: - In common Emitter configuration input is applied between base and emitter while the output is taken across emitter and collector. Thus the emitter forms the terminal common to doth input and output circuits. The load resistance is connected at collector.

CIRCUIT DIAGRAM:-



PROCEDURE:

(a)Connect the circuit as per the circuit diagram.

Input characteristics

a) Keep emitter - collector voltage constant.
b) Vary emitter-base voltage in steps and note down base current reading.
c) Readings are tabulated and graph is drawn.

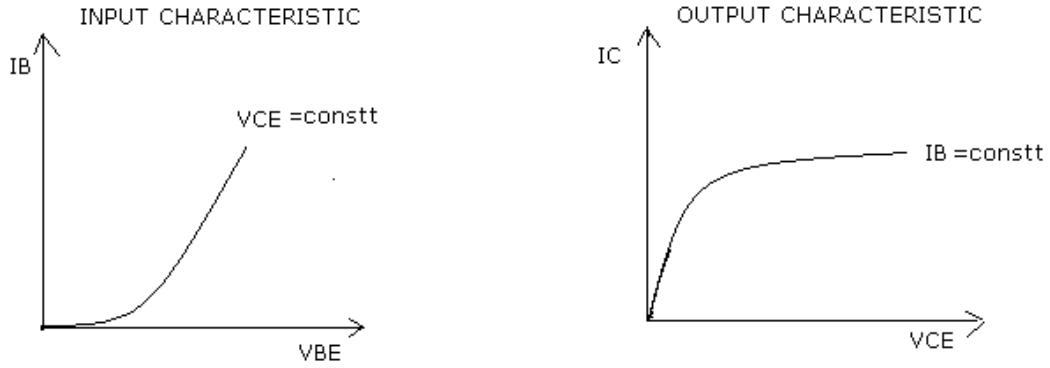
Output characteristics

a) Keep base current constant.
b) Vary collector-emitter voltage in steps and note down emitter current.
c) Readings are tabulated and graph is drawn.

OBSERVATION TABLE:

S.No	Input charact.(Vce=Cons.)		Output charact. (Ib = Const.)	
	Vbe(Volts)	Ib(mA)	Vce(Volts)	Ic(mA)
1.				
2.				
3.				

GRAPH:-



RESULT: The input and output characteristic of transistor in common emitter configuration has been plotted.

DISCUSSION: With the help of output characteristics we can calculate AC& DC current gain in common emitter configuration.

PRECAUTIONS:

a) Connections should be tight
b) Handle the equipments with care

QUIZ:

Q1: What do you mean by biasing of transistor?
A. When dc voltages are applied across the different terminals of transistor, it is called biasing.
Q2: What is d.c. current gain in common base configuration?
A. It is ratio of collector current(Ic) to emitter current (Ie).
Q3: What is typical value for d.c. current gain?
A. 0.99
Q4: What is a.c. current gain in CB configuration?
A. It is ratio of change in collector current to change in emitter current.
Q5: What are input characteristics?
A. These curves relate i/p current & i/p voltage for a given value of o/p voltage.
Q6: What are output characteristics?
A. The curves relate o/p voltage & o/p current for a given value of input current.
Q7: Which configuration has highest voltage gain?
A. Common Emitter.
Q8: Which configuration is most widely used?
A. Common Emitter.
Q9: What is operating point?
A. The zero signal values of Ic & Vce.
Q10: Which region is heavily doped in Transistor?
A. Emitter.

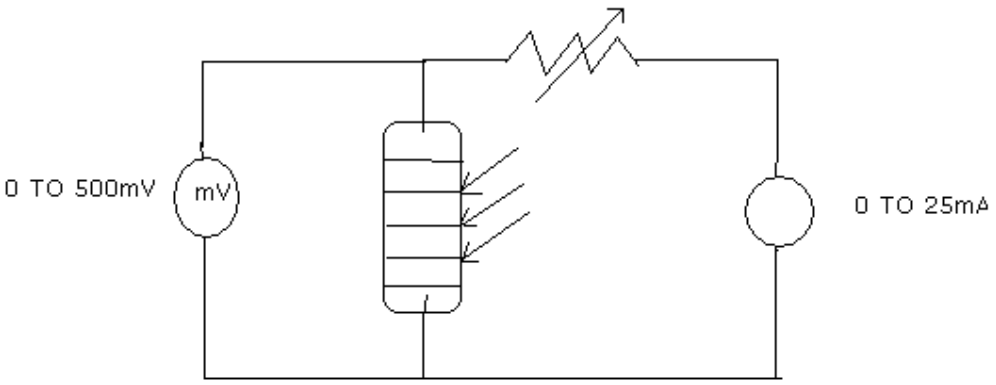
EXPERIMENT NO. 4

AIM: Study of V-I characteristic of photovoltaic cell.

APPRATUS REQUIRED: Power supply, PVC characteristic Kit, connecting leads, Voltmeter, Ammeter.

BRIEF THEORY : The silicon solar cell converts the radiant energy of the sun into electrical power . The solar cell consist of a thin slice of single crystal p-type silicon, unto 2cm square, into which a very thin(0.5 micron) layer of n-type material is diffused . The conversion efficiency depends on the spectral content & the intensity of the illumination.

CIRCUIT DIGRAM:



PROCEDURE :

(1)Connect the ckt. as shown in fig.

(2)Switch on the power supply.

(3)Vary the value of input dc supply in steps.

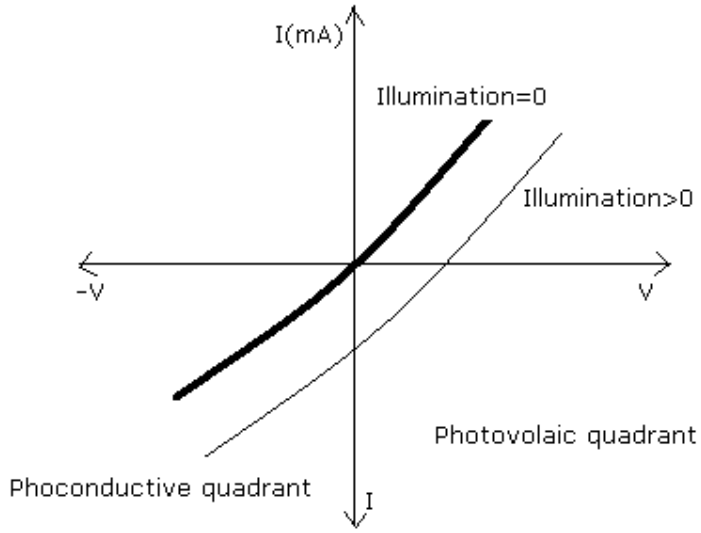
(4)Note down the ammeter & voltmeter readings for each step.

(5)Plot the graph of Voltage Vs Current.

OBSERVATION TABLE:

S.No	Voltage(Volts)	Current(mA)
1.		
2.		
3.		

GRAPH:



RESULT: The V-I characteristics of photo – voltaic cell has been plotted.

DISCUSSION: The solar cells are extensively employed as a source of power space aircrafts & the advances in solar cell technology have found their way into many earth – based applications.

PRECAUTIONS:

6. Always connect the voltmeter in parallel & ammeter in series as shown in fig.
7. Connection should be proper & tight.
8. Switch 'ON' the supply after completing the ckt.
9. DC supply should be increased slowly in steps
10. Reading of voltmeter & Ammeter should be accurate.

QUIZ:

Q1: What are photovoltaic cells?
A. These cells are semiconductor junction devices used for converting radiation energy into electrical energy.
Q2: Which material is most commonly used for these cells?
A. Selenium & Silicon.
Q3: What are advantages of these cells?
A. They have ability to generate voltage without any bias & have fast response.
Q4: Compare use of photoconductive cells and photovoltaic cells.
A Photoconductive cells cannot be successfully switched at frequencies higher than about 1 Khz , whereas photovoltaic cells can be switched successfully upto about 100 Khz and sometimes higher even.

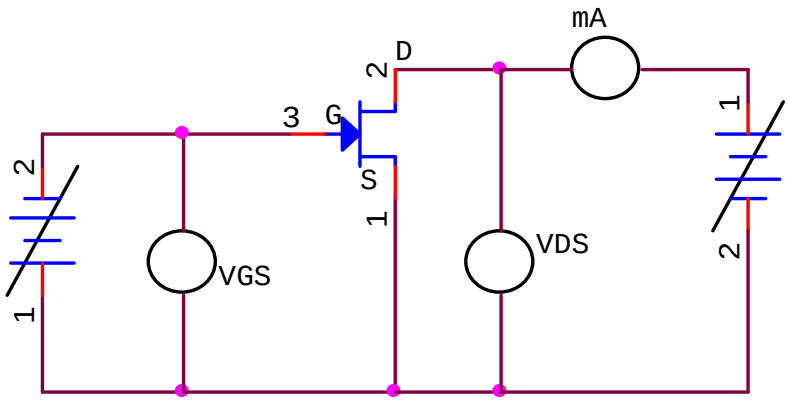
EXPERIMENT NO. 5

AIM: To study and draw the characteristics of FET in common source configuration.

APPRATUS REQUIRED: Power supply, FET characteristic Kit, connecting leads, two Multimeters.

BRIEF THEORY: A FET is a three terminal semiconductor device in which current conduction is by one type of carries & is controlled by the effect of electric field. There are two types of FET namely JFET & MOSFET. Again, a JFET can either have N-channel or P-channel. A N-channel JFET has a N-type semiconductor bar, the two ends of which make the Drain & source terminal. On the two sides of this bar, P-N junction is made. This P region makes gate. Usually, these two gates are connected Together to form a single gate .The gate is given a –ve bias w.r.t source. The Drain is given +ve potential w.r.t source.

CIRCUIT DIAGRAM:



PROCEDURE:

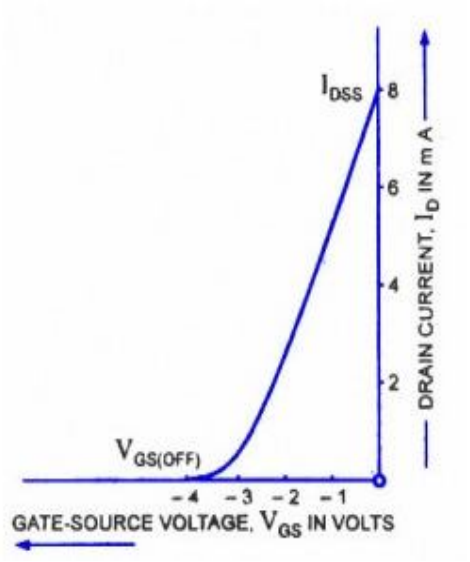
(a)Connect the circuit as per the circuit diagram

Input characteristics

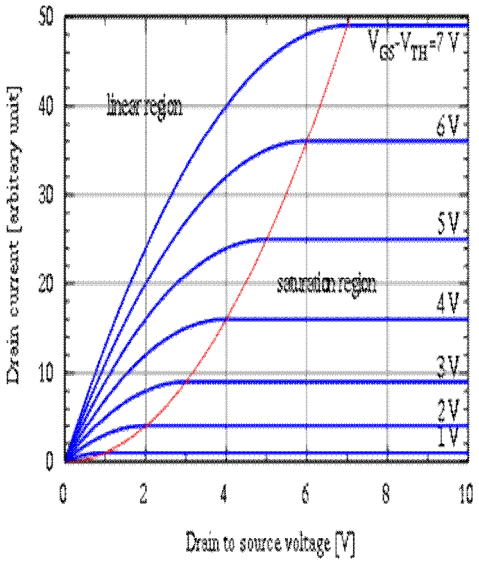
(b)Keep drain-source voltage constant
(c)Vary gate-source voltage in steps and note down drain current
(d) Readings are tabulated and graph is drawn

Output characteristics

(a)Keep gate-source voltage constant
(b)Vary drain-source voltage in steps and note down drain current.
(c) Readings are tabulated and graph is drawn



INPUT CHARACTERISTIC



OUTPUT CHARACTERISTIC

OBSERVATION TABLE:

	I/P at const. VDS		O/P at const. VGS	
S. No	**VGS (V)**	**ID (mA)**	**VDS (V)**	**ID (mA)**
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

PRECAUTIONS:

(a)Connections should be tight
(b)Handle the equipments with care

RESULT: Input and output characteristics is obtained.

QUIZ:

Q.No	QUESTION	ANSWERS
1	Define FET?	The field effect transistor is a semi-conductor device which depends for its operation on the control of current by an electric field.
2	How many types of FET's are there?	Two types (a) Junction field effect transistor (JFET). (b) Metal Oxide Semiconductor FET(MOSFET

3	Write advantages of FET over conventional Transistor?	Advantages are (a) Thermal stability. (b) Immunity to radiation (c) High input impedance.
4	Write one disadvantage of FET?	Main disadvantage is relatively small 'Gain- Band Width 'product.
5	Define Drain resistance?	Drain resistance can be defined as ratio of drain to source voltage to drain current.
6	Define Tran conductance?	Tran conductance can be defined as ratio of drain current to gate to source voltage.
7	Define transfer characteristic of FET?	The curve drawn between drain current and gate-source voltage for a given value of drain-source voltage.
8	Write applications of a FET?	Applications of FET are (A)Low noise amplifier (B) Buffer amplifier (C) Cascade amplifier (D) Analog switch (E)Chopper
9	How is Drain current controlled in JFET?	In JFET drain current is controlled by controlling the reverse bias given to its base.
10	Define pinch-off voltage?	The value of drain-source voltage at which channel is pinched off (i.e. all the free charges from the channel are removed) is called pinch-off voltage.

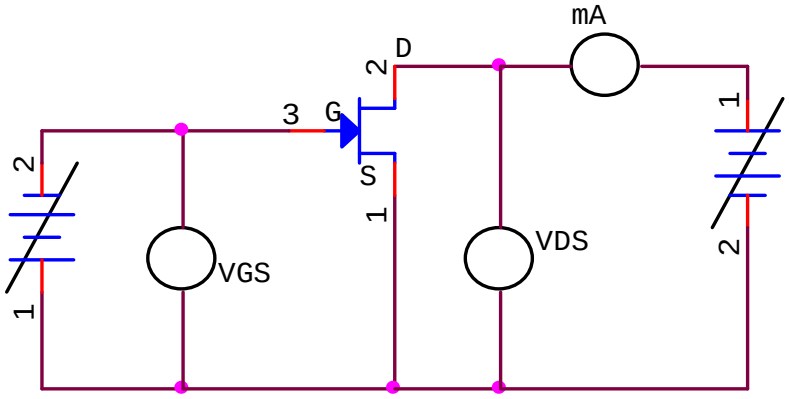
EXPERIMENT NO. 6

AIM: Study of characteristics of JFET in Common Source Configuration.

APPARATUS REQUIRED: Power Supply, FET Characteristics Kit, Connecting Leads, Voltmeter, and Ammeter.

BRIEF THEORY: A FET is a three terminal semiconductor device in which current Conduction is by one type of carriers & is controlled by the effect of electric field. There are two types of FET namely JFET & MOSFET. Again, a JFET can either have N-channel or P-channel. A N-channel JFET has a N-type semiconductor bar, the two ends of which make the Drain & source terminal. On the two sides of this bar, P-N junction are made. This P region makes gate. Usually, these two gates are connected together to form a single gate .The gate is given a –ve bias w.r.t Source. Drain is given +ve potential w.r.t Source.

CIRCUIT DIGRAM:



PROCEDURE:

Drain characteristic

(a) Connect the circuit as shown in fig. Keep V & V supplies at minimum.
(b) Switch ON power, Increase V gradually & note the max. Current as I while the V =0V
(c) Repeat the step for different values of V, & note corresponding I & V for Increment.
(d) Tabulate the results.

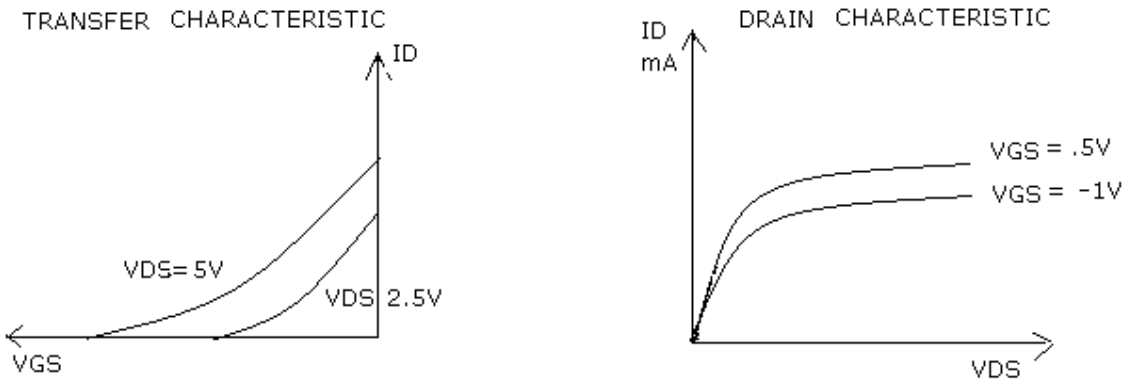
Transfer characteristic

(a) Keep V fixed at 4V.
(b) Increase V in small steps & note corresponding I for each step.
(c) Repeat step 2 for different values of V .
(d) Tabulate the results.

OBSERVATION TABLE:

S.No	Transfer charact.(Vds=Cons.)		Drain charact. (Vgs= Const.)	
	Id(mA)	Vgs(Volts)	Id(mA)	Vds(Volts)
1.				
2.				
3.				

GRAPH:



RESULT: Transfer & Drain characteristics of JFET in common source configuration have been plotted.

DISCUSSION: We observe that characteristics have 4 regions: Ohmic region, curve AB, Pinch off region& Breakdown region.

PRECAUTIONS:

1.Always connect the voltmeter in parallel & ammeter in series as shown in fig.
2.Connection should be proper & tight.
3.Switch 'ON' the supply after completing the ckt.
4.DC supply should be increased slowly in steps
5.Reading of voltmeter & Ammeter should be accurate.

QUIZ:

Q.1 Define FET ?

A It is a 3 terminal device in which current conduction is by only one type of mazority carriers.

Q.2 Define pinch off Voltage ?

A. The value of Vds at which all the free charge carriers are removed from channel.

Q.3 What is unipolar device ?

A. In which conduction is by only one type of mazority carriers.

Q.4 What is bipolar device ?

A. In which conduction is by both types of carriers.

Q.5 Write advantages of FET over conventional Transistor ?

A. It provides extremely high input impedance as compared to BJT.

Q.6 Define drain Characteristics ?

A. The curve b/w drain current & Vds with Vgs as a parameter.

Q.7 Define transfer Characteristics ?

A. The curve b/w Id & Vgs keeping Vds constt.

Q.8 Write applications of a FET ?

A. FETs are used in ICs, voltage – variable resistor in operational amplifier etc.

Q.9 Input impedance of a FET is more than a BJT , Why ?

A Because it always work in reverse biasing situation.

Q.10 Define amplification factor ?

A. Ratio of change in drain-source voltage to change in gate to source voltage at constt. Id.

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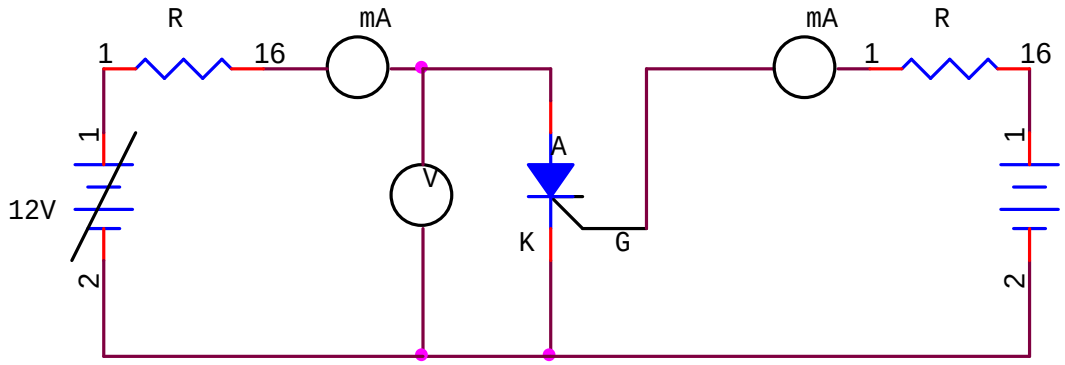
EXPERIMENT NO. 7

AIM: Study characteristics of SCR.

APPRATUS REQUIRED: Power Supply, SCR Kit. , Voltmeter, Ammeter, Connecting Leads.

BRIEF THEORY: Silicon control rectifier (SCR) is a four layer, three terminal semiconductor device, the end 'P' forms the anode & the end 'N' forms the cathode & the gate terminal 'G' is from the 'P' layer next to cathode. It is a unidirectional device. The device can exist upon either ON state or OFF state depending upon the applied voltage. When anode voltage is +ve w.r.t to cathode the SCR start Conducting. If some small gate voltage is applied, the SCR trigger at some low value of anode voltage, but it loses its all control on the SCR Current after triggering. Therefore, in order to turn the SCR to OFF position the anode voltage has to be reduced to zero.

CIRCUIT DIGRAM:



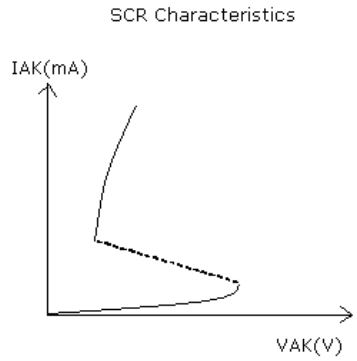
PROCEDURE:

1. Connect the circuit according to the fig.
2. First set I = 0mA , vary input voltage V gradually & measure the current I.
3. Tabulate the readings.
4. Repeat the procedure for different values of I .
5. Draw the graph between V & I .

OBSERVATION TABLE:

S.No	Vak(Volts)	Iak (mA)

GRAPH:



PRECAUTIONS:

1. Always connect the voltmeter in parallel & ammeter in series as shown in fig.
2. Connection should be proper & tight.
3. Switch 'ON' the supply after completing the circuit
4. DC supply should be increased slowly in steps
5. Reading of voltmeter & Ammeter should be accurate.

RESULT: The characteristics of thyristor have been plotted.

DISCUSSION: The SCR will not conduct until it is not triggered by gate voltage.

QUIZ:

Q.1 Define SCR?

A. It is a controlled rectifier constructed of a silicon material with third terminal for control purpose.

Q.2 Define Forward Break over Voltage?

A. It is voltage in forward conducting mode after which SCR starts conducting.

Q.3 Define reverse Break down Voltage?

A. If reverse voltage is increased beyond certain value, SCR will break & this voltage is Called reverse breakdown voltage.

Q.4 Why it is called controlled rectifier?

A. Because its operation as rectifier can be controlled by using gate terminal.

Q.5 Define peak forward Voltage?

A. It is limiting positive anode voltage above which SCR get damaged.

Q.6 Define peak reverse Voltage?

A. Max. reverse voltage that can be applied to SCR without conduction in reverse direction.

Q.7 Define Holding Current?

A. Min. forward current that must be maintained to keep SCR in conducting state.

Q.8 Define forward current Rating?

A. The max. Value of anode current that SCR con handle safely.

Q. 9 Define latching current.

A. Min. device current which must be attained by the device before gate drive is removed.

Q.10 What do you mean by commutation process?

A. Process of turning off the SCR

EXPERIMENT NO.8

AIM: Study of characteristics of UJT.

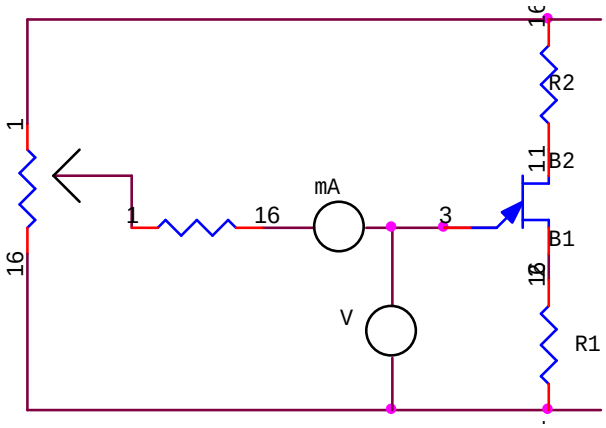
APPARATUS REQUIRED: Power supply, UJT Charact., Connecting Leads, Ammeter, Voltmeter.

BRIEF THEORY:

UJT: A Uni junction transistor is a three terminal semiconductor device having two doped regions. In the three terminals, it has one Emitter (E) & two Bases (B1&B2).It has only one junction. It Consist of an n-type silicon bar which is lightly doped. Two end connections are taken from the bar called B1 & B2. A heavily doped p-region is diffused to n-bar nearer to B2.

CIRCUIT DIGRAM:

Ckt. For UJT



PROCEDURE:

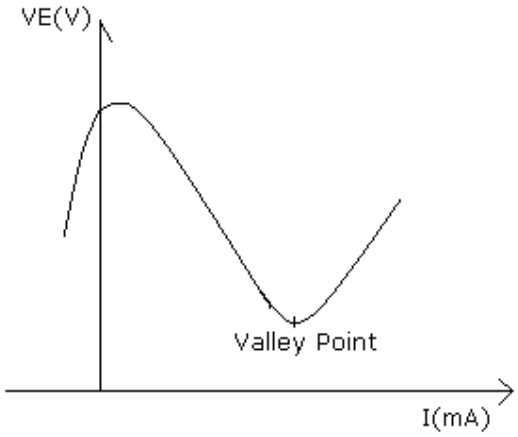
(a) Make the connection as per circuit diagram.
(b) Make sure that the potentiometer is in its minimum position.
(c) Move the potentiometer in clock wise direction & note down the value of V & I.
(d) Tabulate the value & plot the graph.

OBSERVATION TABLE:

S.No	UJT Charact.	
	I (mA)	V (Volts)
1.		
2.		
3.		

GRAPH:

UJT Charact.



RESULT: The characteristics of UJT have been plotted.

PRECAUTION:

(1) Always connect the voltmeter in parallel & ammeter in series as shown in fig.
(2)Connection should be proper & tight.
(3)Switch 'ON' the supply after completing the ckt.
(4)DC supply should be increased slowly in steps
(5)Reading of voltmeter & Ammeter should be accurate.

QUIZ:

Q.1 Define UJT?
A. It is a 2 layer, 3- terminal solid state device having only one junction.
Q.2 Write application of UJT?
A. Relaxation oscillator.
Q.3 Define inter base Resistance?
A. The total resistance of silicon bar from one end to other end.
Q.4 Mention different region of UJT?
A. Cut – off region, negative resistance region, saturation region.
Q.5 Define peak Point Emitter Current?
A. Min. current that is reqd. to trigger the device.
Q6. Define valley point Current?
A. It is the emitter current at valley point.

EXPERIMENT NO.9

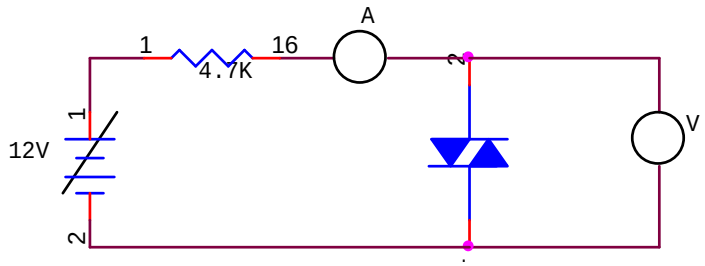
AIM: Study of characteristics of DIAC.

APPARATUS REQUIRED: Power supply, DIAC Characteristic, Connecting Leads, Ammeter, and Voltmeter.

BRIEF THEORY:

Diac: A Diac is a two terminal & four layer bi-directional semiconductor switching device.'Di means two (two terminal device) and 'ac' means alternating current hence diac is a switch .In fact, it is a device which can conduct in both the directions. Only when the applied voltage is more than its break over voltage. It is similar as if two latches are connected in parallel. During +ve half-Cycle, the right four layer diode conducts heavily. During –ve half-cycle, the left diode conducts heavily only when the supply voltage exceeds the break over voltage of the Diac.

CIRCUIT DIGRAM:



Circuit for DIAC

PROCEDURE:

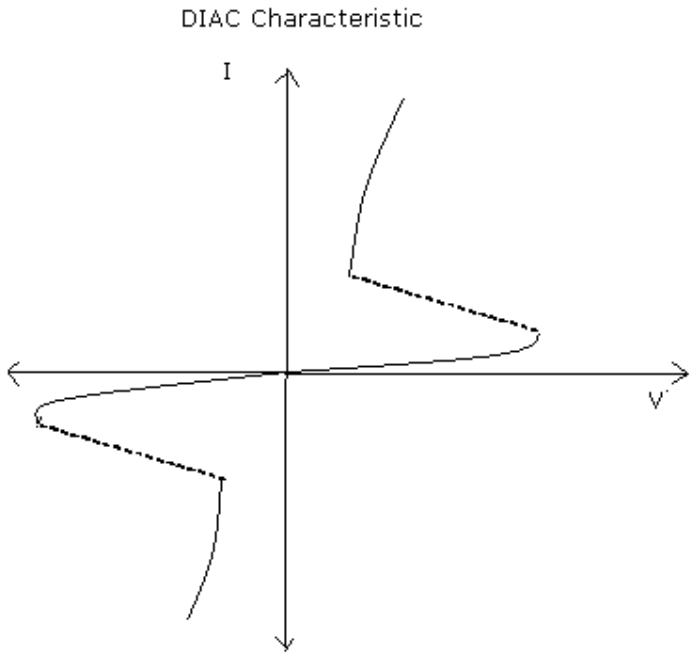
a) Make connection as per circuit diagram.
b) Apply +ve supply to the circuit.
c) Increase the voltage step by step & note down the corresponding current values.
d) After a certain voltage, the diac enter in –ve resistance region.
e) Now apply reverse polarity & repeat the whole procedure again.

OBSERVATION TABLE:

S.No.	DIAC Characteristics	
	I (mA)	V (Volts)
1.		
2.		
3.		
4.		

GRAPH:

DIAC Characteristic



RESULT: The characteristics of DIAC have been plotted.

PRECAUTION:

1. Always connect the voltmeter in parallel & ammeter in series as shown in fig.
2. Connection should be proper & tight.
3. Switch 'ON' the supply after completing the circuit
4. DC supply should be increased slowly in steps
5. Reading of voltmeter & Ammeter should be accurate.

QUIZ:

Q.1 Define DIAC?

A. It is a two electrode bidirectional avalanche diode.

Q.2 Define VBO?

A. The voltage before which DIAC acts as a open switch.

Q.3 Write application of Diac?

A. Heat control circuit..

Q.4 Define inter base Resistance?

A. The total resistance of silicon bar from one end to other end.

Q.5 Define valley Point?

A. Point beyond which if emitter current increases, device enters into saturation region.

Q.6 Define peak Point Emitter Current?

A.6 Min. current that is required to trigger the device.

Q7. What is a basic difference between thyristor,triac and a diac?
Ans. Thyristor is semiconductor device convert the stable dc to variable dc which has a three terminals anode, cathode, and gate. The diac is similar to thyristor which is bidirectional without gate terminal work on both ac & dc. The triac is known as diac with gate.
Q8. What are the applications of thyristor?
Ans. It used at mine hauler, press machine, HVDC power supply. In future bracking in automobile, regenerative braking.

Q9.  Identify the symbol:
Ans. SCS (Silicon controlled switch)
Q10. The silicon-controlled switch (SCS) is similar in construction to the
Ans. SCR

EXPERIMENT NO.10

AIM: To plot V-I characteristic of TRIAC.

APPARATUS REQUIRED: Power supply, TRIAC characteristics kit, Connecting leads, Ammeter & Voltmeter.

THEORY: The TRIAC is a three terminal AC switch that is triggered into conduction when a low energy signal is applied to its gate terminal. The TRIAC conducts in either direction when turned on either a positive or negative gate signal triggers it into conduction. Thus, the TRIAC is a three terminals, four layer bidirectional semiconductor device that5 controls ac power. Because of its bidirectional conduction property, the TRIAC is widely used in the field of power electronics for control purpose.

CIRCUIT DIAGRAM:

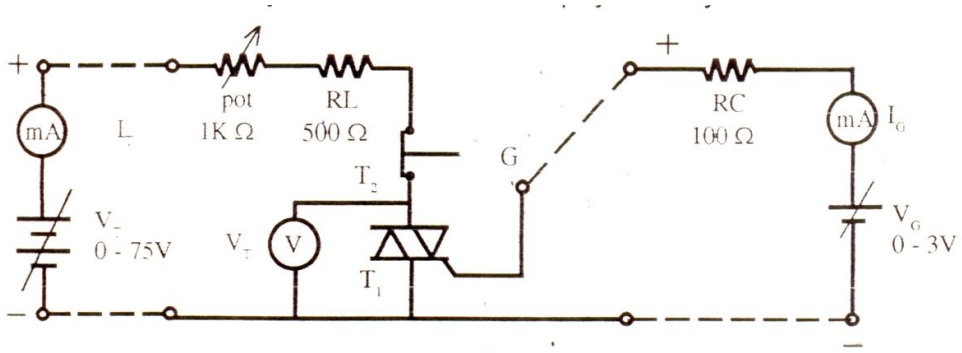


Fig 1.
Circuit diagram for quadrent I. **Dashed** line connections for I$^+$.

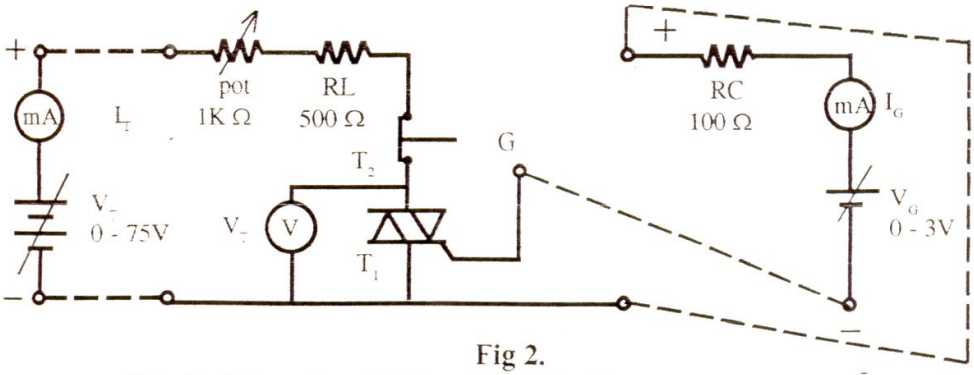


Fig 2.
Circuit diagram for quadrent I. **Dashed** line connections for I$^-$.

PROCEDURE:

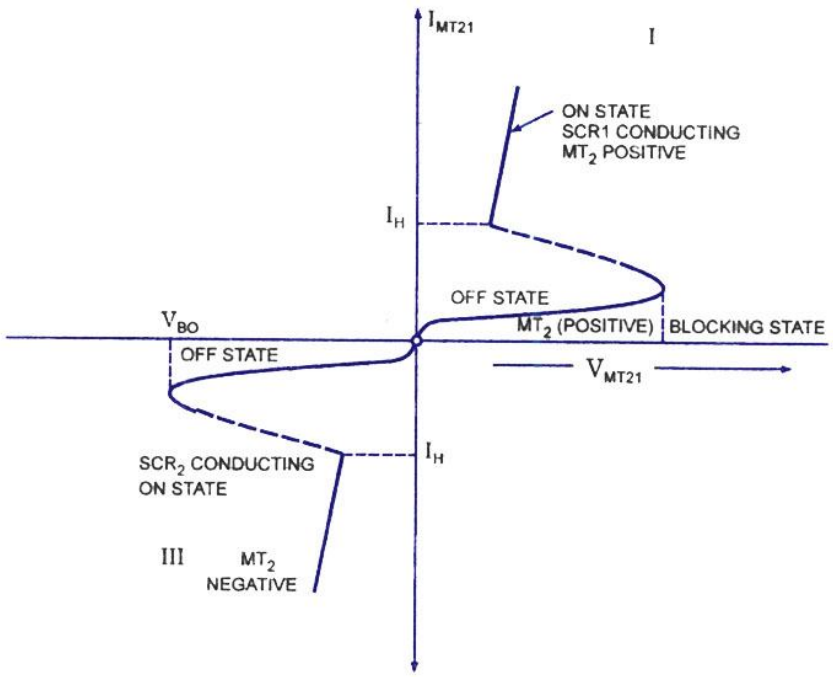
(a) Make connection as per the circuit diagram.
(b) Apply +ve supply to the circuit.

(c) Increase the voltage step by step & note down the corresponding current values.
(d) After a certain voltage, the TRIAC enters into the negative resistance region.
(e) Now apply reserve polarity & repeat the whole procedure again.

OBSERVATION TABLE:

S.NO	Volts	Current

GRAPH:



V-I Characteristic of a Triac

RESULT: The characteristic of TRIAC have been plotted.

PRECAUTIONS:

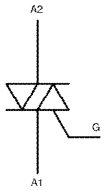
(a) Always connect the voltmeter in parallel & ammeter in series.
(b) Connection should be proper & tight.
(c) Switch 'on' the supply after completing the circuit.
(d) DC supply should be increased slowly in steps.
(e) Reading of voltmeter & ammeter should be accurate.

QUIZ/ANSWER:

Q-1 Conduction take place in triac is bidirectional or unidirectional?
Ans: Bidirectional.
Q-2 Expanded form of the word abbreviated TRIAC ?
Ans Triode and AC.
Q-3 Name three terminal of TRIAc?
Ans Main Terminal 1(MT1) ,Main Terminal 2 (MT2) and Gate 'G'.
Q-4 What are the ratings of TRIAC available in market?
Ans Voltage 1200 and Current 300A(rms).
Q-5 Give application of TRIAC?
Ans TRIACS are extensively used in :-

A. Residential lamp –dimmers.
B. Heat control
C. Speed control of small single phase series and induction motor.

Q-6 Is TRIAc have a capability to work in rectifier mode?
Ans: Yes
Q-7 By what manner TRIAC is different from SCR?
Ans 1. Bidirectional conduction.
2. TRIAC is a combination of two SCRs connected in anti parallel.
Q-8 How many layers are there in TRIAc?
Ans 5 layers.
Q-9 What is the symbol of TRIAC?

Ans 

Q-10 how TRIAC is differ from DIAC?
Ans TRIAC have gate terminal and DIAc didn't.

EXPERIMENT NO. 11

AIM: To study photo-resist in metal pattern for planner technology/PCB technology.

THEORY: The variety of manufacturing process by which IC components are fabricated take place through a single plane and hence termed as a planar technology. The principal constituent of a photo resist solution is a polymer, a semitizer & a suitable solvent system. Polymers have properties of excellent film forming & coating. Ploymers generally used are polyvinyl cinnamate, Partially cyclized isoprene family and other types are phenol formaldehyde etc.

When photo resist is exposed to light, semitizer absorbs energy and initiates chemical hanges in the resist. The sanitizers are chromophoric organic molecules they enhance cross linking of the photoresist. Typical sensitizers are carbonyl compounds, benzoin, benzoyl peroxide, benzoyl, disulphide, nitrogen compounds and halogen compounds.

The solvents are used to keep the polymers in solution are mixture of organic liquids. They include aliphatic esters such as butyl acetate and cellosolve acetate and aromatic hydrocarbon like xylene & ethylebenzene, chlorinated hydrocarbons like chlorobenzene and methylene chloride and ketenes such as cyclopean. The same solvents are used as thinners & developers.

DIAGRAM:

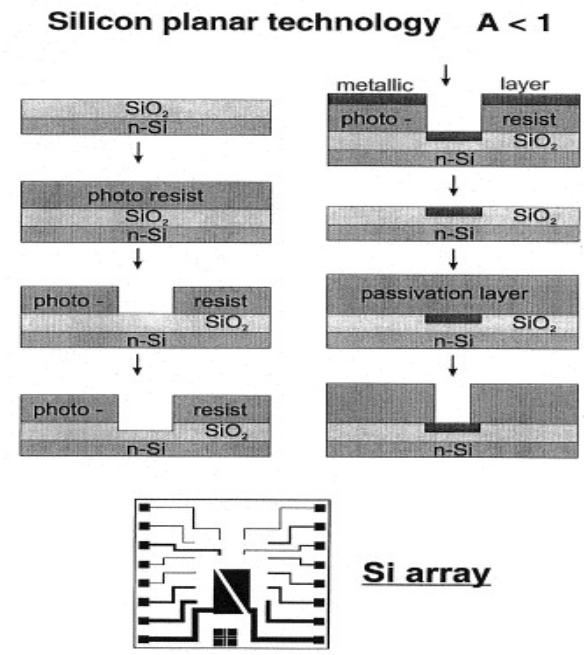


Photo resists are of two types: negative & positive. Materials which are rendered less soluble in a developer solution by illumination yield a negative pattern of the mask and are called negative photo resists.
Photo resist became more soluble when subjected to light and therefore yield a positive image of the mask. The selection if the photo resist depends upon specific requirements of resolution and type of surface to be encountered differences in solid contents and viscosity determine the flow characteristic & thus the thickness of coating.

Example of negative photo resist is Kodak microney 747 suited to projection printing and provide high throughput and resolution.

Example of positive photo resist is MP-2400 and HPR-206.

QUIZ/ANSWERS:

Q-1 What is photo resist?
Ans Resist which changes it behavior when exposed to light is called photo resist.
Q-2 Name the types of photo resist?
Ans 1. Positive photo resist.
2. Negative photo resist.
Q-3 What is positive photo resist?
Ans the resist whose property get changes i.e. become more soluble when exposed to light called Positive photo resist.
Q-4 What is Negative photo resist?
Ans the resist whose property get changes i.e. become less soluble when exposed to light called Negative photo resist.
Q-5 Example of negative photo resists?
Ans Kodak Microney 747.
Q-6 Example of positive photo resist?
Ans MP-2400 and HPR-206.
Q-7 Give one application of photo resist?
Ans Sensor
Q-8 What is the principle constituent of photo resist?
Ans Polymer
Q-9 What is sensitizer?
Ans Sensitizer is choromophoric organic molecules.
Q-10 On what technology photo resist fabrication is based?
Ans Planner Technology

EXPERIMENT NO. 12

AIM: To study Zener diode characteristics.

APPARATUS REQUIRED: Regulated DC power supply, Voltmeter, Connecting Wires, kit

Specifications:

Breakdown Voltage = 5.1V
Power dissipation = 0.75W
Max. Forward Current = 1A

THEORY: An ideal P-N Junction diode does not conduct in reverse biased condition. A **zener diode** conducts excellently even in reverse biased condition. These diodes operate at a precise value of voltage called break down voltage. A **zener diode** when forward biased behaves like an ordinary P-N junction diode. A **zener diode** when reverse biased can either undergo ***avalanche break down*** or ***zener break down***.

Avalanche break down:-If both p-side and n-side of the diode are lightly doped, depletion region at the junction widens. Application of a very large electric field at the junction may rupture covalent bonding between electrons. Such rupture leads to the generation of a large number of charge carriers resulting in **avalanche multiplication**.

Zener break down:-If both p-side and n-side of the diode are heavily doped, depletion region at the junction reduces. Application of even a small voltage at the junction ruptures covalent bonding and generates large number of charge carriers. Such sudden increase in the number of charge carriers results in **zener mechanism**.

CIRCUIT DIAGRAM:

Fig (1) – Forward Bias Condition:

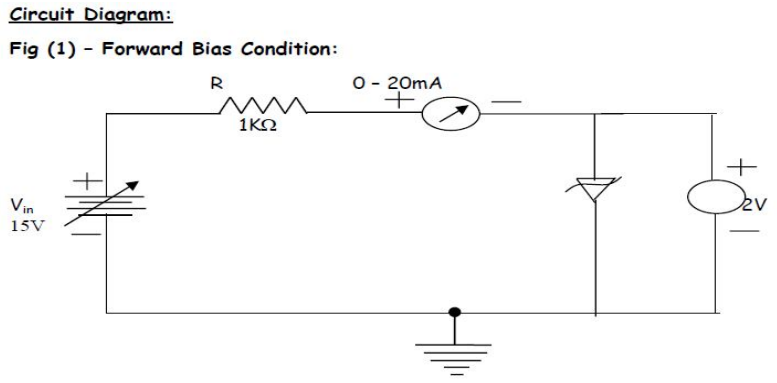
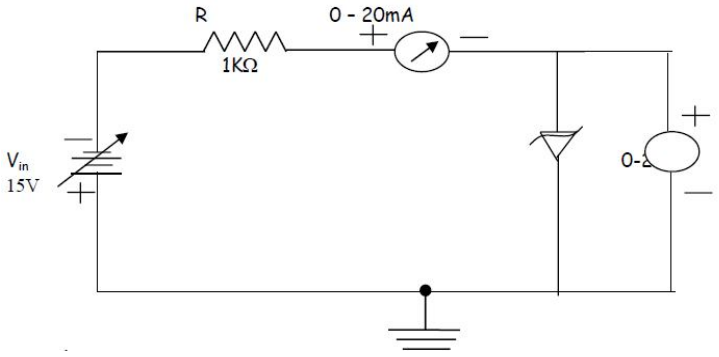


Fig (2) – Reverse Bias Condition:



PROCEDURE:

Forward biased condition:

1. Connect the circuit as shown in fig (1).
2. Vary Vzf gradually and note down the corresponding readings of Izf.
3.. Step Size is not fixed because of non linear curve and vary the X-axis variable (i.e. if output variation is more, decrease input step size and vice versa).
4. Tabulate different forward currents obtained for different forward voltages.

Reverse biased condition:

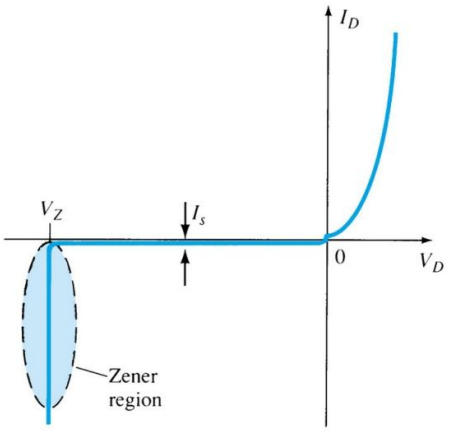
1. Connect the circuit as shown in fig (2).
2. Vary Vzr gradually and note down the corresponding readings of Izr.
7. Step Size is not fixed because of non linear curve and vary the X-axis variable (i.e. if
output variation is more, decrease input step size and vice versa).
8. Tabulate different reverse currents obtained for different reverse voltages.

OBSERVATIONS:

Zener diode in Forward Zener diode & reverse biased condition should be observed.

Forward Voltage across the diode Vz_f (volts)	Forward current through the diode Iz_f (mA)

Reverse Voltage Across diode Vzr (volts)	Reverse current through the diode Izr (mA)



CALCULATIONS FROM GRAPH:

Static forward Resistance Rdc = Vf/If
Dynamic forward Resistance rac = ΔVf/ΔIf
Static Reverse Resistance Rdc = Vr/Ir
Dynamic Reverse Resistance rac = ΔVr/ΔIr

PRECAUTIONS:

1. While doing the experiment do not exceed the ratings of the diode. This may lead to damage the diode.
2. Connect voltmeter and Ammeter in correct polarities as shown in the circuit diagram.
3. Do not switch **ON** the power supply unless you have checked the circuit connections as Per the circuit diagram.

RESULT:

1. The zener diode characteristics have been studied.
2. The zener resistance at the breakdown voltage was found to be = ……

QUIZ:

Q1 Give applications of Zener diode?
A 1: Applications of Zener diode are (a) Voltage regulation (b) Meter protection (c) Zener diode as a peak clipper (d) Zener diode as a reference element
Q2 what is voltage regulation of Zener diode?
A 2: Voltage regulation is a measure of circuit's ability to maintain a constant output voltage even when either input voltage or load current varies.
Q3 what is Zener current?
A 3: The Zener current in the breakdown region of Zener diode is called Zener current.
Q4 Give the equation from which series resistance of Zener diode regulator determined?
A 4: The equation from which series resistance of Zener diode regulator determined is RS = VS-VOUT / IZMAX Where VS is source voltage, VOUT is output voltage & IZMAX is maximum current through Zener diode.

Q5 Give advantages of Zener diode regulator over other regulators?
A 5: Advantages of Zener diode regulator over other regulators are that they are smaller in size, lighter in weight and have longer life.
Q6. What is Zener diode?
A 6: Zener diode, also sometimes called the breakdown diode is a P-N junction diode specially designed for operation in the breakdown region in reverse bias condition.
Q7 Give several methods used to manufacture of Zener diodes?
A 7: several methods used to manufacture of Zener diodes are diffused structure, diffused and passivated structure and alloy diffused structure.
Q8 In passivated structure of a Zener diode by which layer edges of the junction are covered?
A 8: In passivated structure of a Zener diode; Silicon Dioxide layer edges of the junction are covered.
Q9 Give the voltage range availability of Zener diodes?
A 9: The voltage range availability of Zener diodes is 2.4v to 200v.
Q10. What is Zener voltage?
A 10: The voltage at which the Zener diode breaks down is called the Zener voltage.

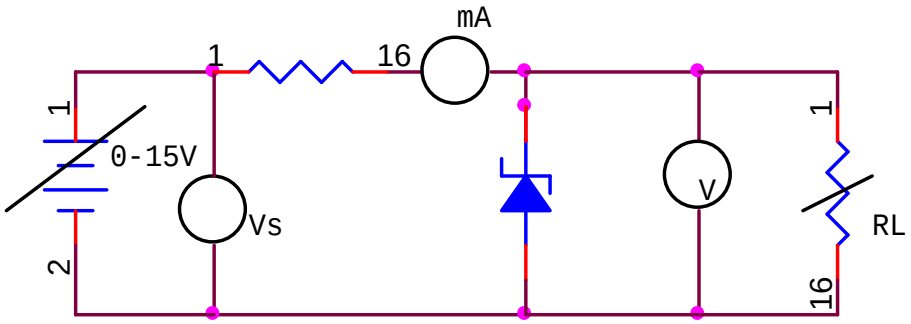
EXPERIMENT NO. 13

AIM: To study zener diode as voltage regulator.

APPRATUS REQUIRED: Power Supply, Zener Diode, Two Voltmeter and connected leads Ammeter.

BRIEF THEORY:- The Zener diode is operated in the breakdown or zener region, the voltage across it is substantially constant for a large current of current through it. This characteristic permits it to be used as a voltage regulator. As the lode Current increases, the Zener current decrease so that current through resistance Rs is constant. As out put voltage = Vin – Irs, and I is constant, Therefore, output Voltage remains unchanged. The input voltage Vin increase, more current will flow through the zener, the voltage drop across Rs will increase but lode voltage would remain constant.

CIRCUIT DIAGRAM:



PROCEDURE:

(a)Connect the circuit as per the circuit diagram
(b)Keep load resistance constant (take maximum value of load resistance)
(c)Vary input voltage and note down output voltage
(d)Now keep input voltage constant and vary load resistance and note down corresponding voltmeter reading
(e)Plot the respective graph

OBSERVATION TABLE:

S. No	Vs(VOLT)	V(VOLT)	RL(E)	V (VOLT)
1				
2				
3				
4				
5				
6				
7				

8 9				

PRECAUTIONS:

(a)Connections should be tight
(b)Handle the equipments with care

RESULT: Studied how Zener diode is used as a voltage regulator**.**

QUIZ:

QNo	QUESTION	ANSWERS
1	Give applications of Zener diode?	Applications of Zener diode are (a) Voltage regulation (b) Meter protection (c) Zener diode as a peak clipper (d) Zener diode as a reference element
2	What is voltage regulation of Zener diode?	Voltage regulation is a measure of circuit's ability to maintain a constant output voltage even when either input voltage or load current varies.
3	What is Zener current?	The Zener current in the breakdown region of Zener diode is called Zener current.
4	Give the equation from which series resistance of Zener diode regulator determined?	The equation from which series resistance of Zener diode regulator determined is $R_S = V_S - V_{OUT} / I_{ZMAX}$ Where V_S is source voltage, V_{OUT} is output voltage & I_{ZMAX} is maximum current through Zener diode.
5	Give advantages of Zener diode regulator over other regulators?	Advantages of Zener diode regulator over other regulators are that they are smaller in size, lighter in weight and have longer life.
6	What is Zener diode?	Zener diode, also sometimes called the breakdown diode ia a P-N junction diode specially designed for operation in the breakdown region in reverse bias condition.
7	Give several methods used to manufacture of Zener diodes?	several methods used to manufacture of Zener diodes are diffused structure, diffused and passivated structure and alloy diffused structure.
8	In passivated structure of a Zener diode by which layer edges of the junction are covered?	In passivated structure of a Zener diode; Silicon Dioxide layer edges of the junction are covered.
9	Give the voltage range availability of Zener diodes?	The voltage range availability of Zener diodes is 2.4v to 200v.
10	What is Zener voltage?	The voltage at which the Zener diode

		breaks down is called the Zener voltage.

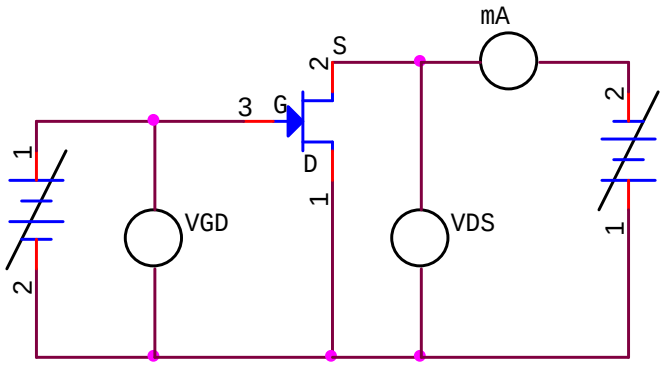
EXPERIMENT NO.14

AIM: To study and draw the characteristics of FET in common drain configuration.

APPRATUS REQUIRED: Power supply, FET charact. Kit,connecting leads, two Multimeters.

BRIEF THEORY: A FET is a three terminal semiconductor device in which current conduction is by one type of carries & is controlled by the effect of electric field. There are two types of FET namely JFET & MOSFET. Again, a JFET can either have N-channel or P-channel. A N-channel JFET has a N-type semiconductor bar, the two ends of which make the Drain & source terminal. On the two sides of this bar, P-N junction is made. This P region makes gate. Usually, these two gates are connected Together to form a single gate .The gate is given a –ve bias w.r.t source. The Drain is given +ve potential w.r.t source. Drain is Common in input and output.

CIRCUIT DIAGRAM:



PROCEDURE:

(a)Connect the circuit as per the circuit diagram

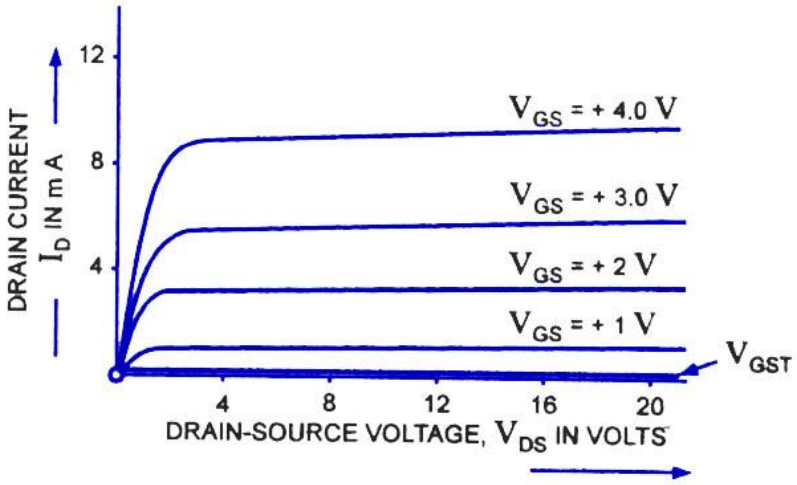
Input characteristics

(b)Keep drain-source voltage constant
(c)Vary gate-drain voltage in steps and note down drain current
(d) Readings are tabulated and graph is drawn

Output characteristics

(a)Keep gate-drain voltage constant
(b)Vary drain-source voltage in steps and note down drain current.
(c) Readings are tabulated and graph is drawn

GRAPH:



Drain Characteristics

OBSERVATION TABLE:

	I/P at const. VDS		O/P at const. VGD	
S. No	**VGD (V)**	**ID (mA)**	**VDS (V)**	**ID (mA)**
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

PRECAUTIONS:

(a)Connections should be tight
(b)Handle the equipments with care

RESULT: Input and output characteristics is obtained.

QUIZ:

Q. No	QUESTION	ANSWERS

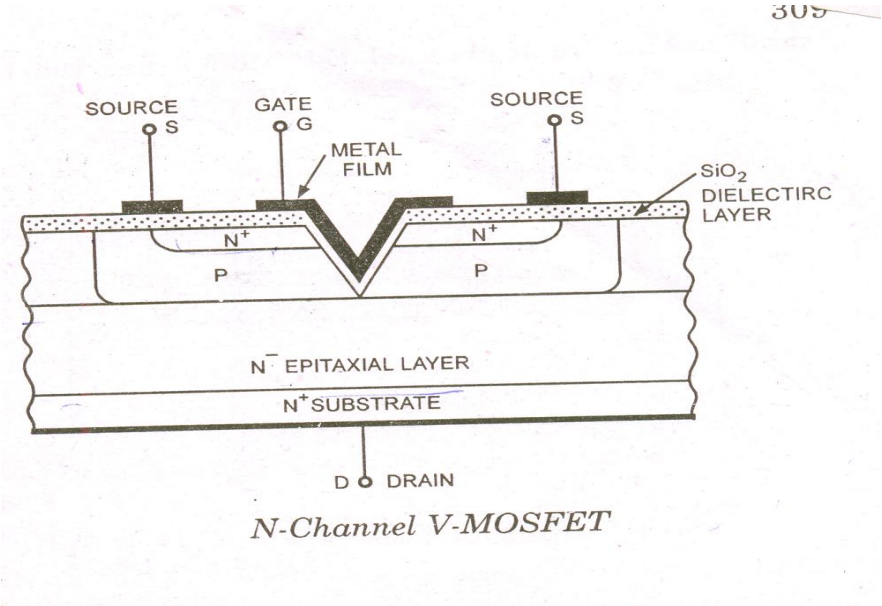
1	Which is the common log in common drain FET amplifier Between input and output.	Drain leg is common between input and output.
2	Define Pinch off voltage.	The value of drain–source voltage at which channel is pinched off (i.e. all the free charges from the channel are removed)is called pinch–off voltage
3	Write advantages of FET over conventional Transistor.	Advantages are (a) Thermal stability. (b) Immunity to radiation. (c) High input impedance.
4	How much is the gain of common drain FET amplifier?	Gain of common drain amplifier is less than unity.
5	Define Drain resistance.	Drain resistance can be defined as ratio of drain to source voltage to drain current.
6	Define Transconductance.	Transconductance can be defined as ratio of drain current to gate to source voltage
7.	A common-gate amplifier is similar in configuration to which BJT amplifier?	Common base
8.	A common-drain amplifier is similar in configuration to which BJT amplifier?	Common Collector
9.	What is (are) the function(s) of the coupling capacitors C_1 and C_2 in an FET circuit?	• to create an open circuit for dc analysis • to isolate the dc biasing arrangement from the applied signal and load • to create a short-circuit equivalent for ac analysis
10.	What is the input resistance ($R_{in(source)}$) of a common-gate amplifier?	$1 / g_m$

EXPERIMENT NO. 15

AIM: To study VMOS Technology.

THEORY: Power MOSFET are usually constructed in V-configuration that is why the device is called V-MOSFET. V-shaped cut penetrates from the device surface almost to the N+ substrate through N+, P and N- layers. The N+ layers are heavily doped, low resistive material, while the N- layer is a lightly doped high resistance region. The SiO2 dielectric layer covers both the horizontal surface and V-cut surface. V-MOSFET is an E-Mode FET and no channel exists between drain & source until the gate is made positive w.r.t the source. On making gate positive w.r.t the source, an N-type channel is formed close to the gate, as in case of E-MOSFET.

DIAGRAM:-



N-Channel V-MOSFET

In this case, N- type channel provides a vertical path for the charge carriers to flow between the N+ substrate (i.e drain) and the N+ source termination. When Vgs is zero or negative, no channel exists and the drain current is zero.With the increase in gate voltage, the channel resistance is reduced and therefore the drain current Id increases. Thus the drain current Id can be controlled bu gate voltage control. So that for a given level of Vgs, Id remains constant over wide range of Vds levels.In V-MOSFET the channel length is determined by the diffusion process, while in other MOSFETs the

channel length depends upon the dimensions of the photographic masks employed in the diffusion process. By controlling the doping density and the diffusion time much shorter channels can be produced than are possible with mask control of channel length. These shorter channels allow much more current densities which again contribute to layer power dissipations. The shorter channel length allows a layer Tran conductance gm to be attained in V-FET & improves frequency response.

QUIZ :

1. What is the power consumption of VMOS.
Ans: VMOS shows a very low power consumption as compared to other MOS.
2. What are the main advantages of VMOS.
Ans: Greater speed and greater packing density.
3. Which method is used in the fabrication of VMOS.
Ans: photolithography
4. VMOS can handle large …….. current as compared to other MOS.
Ans: large
5. What is value of ON resistance in VMOS.
Ans About 3 ohm.
6. What is the application of VMOS.
Ans: Wideband amplifier.
7. Why VMOS is used for wideband amplifier.
Ans: It provides constant gain up to 10 MHz
8. Which layer decides the gate length in n-channel VMOS.
Ans: Thickness of p region
9. For n-channel VMOS which type of substrate is used.
Ans: heavily doped n^+ silicon wafer
10. Which layer is the outermost layer in VMOS.
Ans: silicon dioxide layer.