II/IV B.Tech Regular Degree Examination, NOVEMBER 2019

Scheme of Evaluation

Subject code:- 18EC303

Subject Name:- ELECTRONIC DEVICES

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1. Answer all Questions **10X1=10M**

a) The dynamic resistance is the resistance offered by the p-n junction diode when AC voltage is applied. When forward biased voltage is applied to a diode that is connected to AC circuit, an AC or alternating current flows though the diode.

b**) Varactor Diode symbol:-**

c) Under thermal equilibrium the product of the free electron concentration and the free hole concentration is equal to a constant equal to the square of intrinsic carrier concentration. The intrinsic carrier concentration is a function of temperature. The equation for the mass action law for semiconductors is: $np=ni^2$

d) Transformer Utilization Factor (TUF) is defined as the ratio of DC power output of a rectifier to the effective Transformer VA rating used in the same rectifier

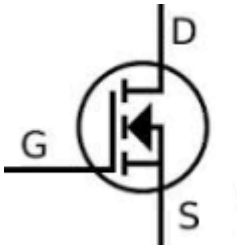
e) Ripple Factor is the ratio of rms value of ac component present in the rectified output to the average value of rectified output.

f) The Early effect is the variation in the width of the base in a BJT due to a variation in the applied base-to-collector voltage.

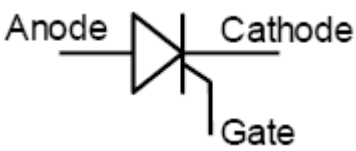
g) The operating point of a device, also known as a bias point, quiescent point or Q-point, is the steady-state DC voltage or current at a specified terminal of an active device such as a transistor with no input signal applied.

h) Pinch off voltage is the drain to source voltage after which the drain to source current becomes almost constant and JFET enters into saturation region and is defined only when gate to source voltage is zero.

i)

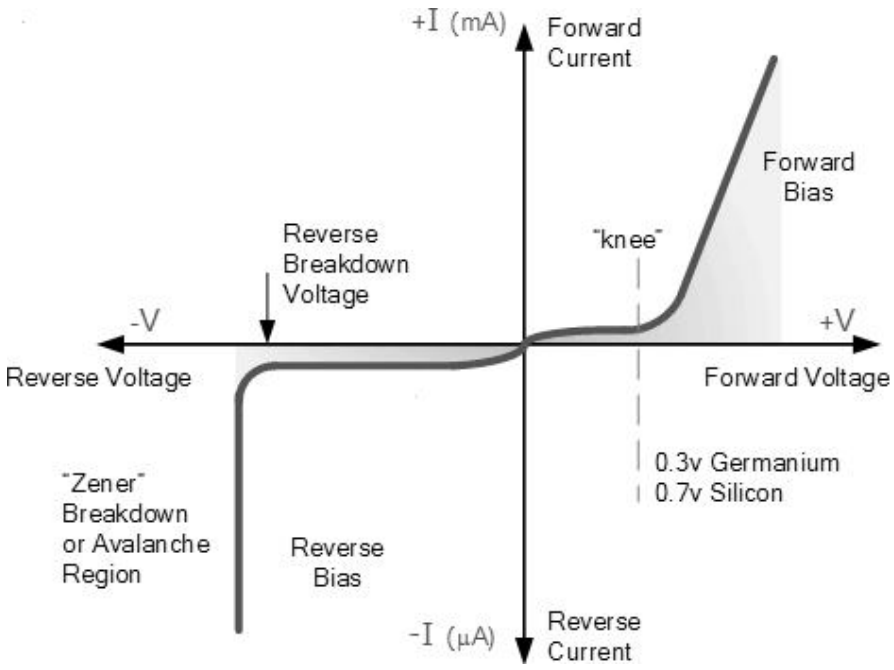


j) SCR symbol:-

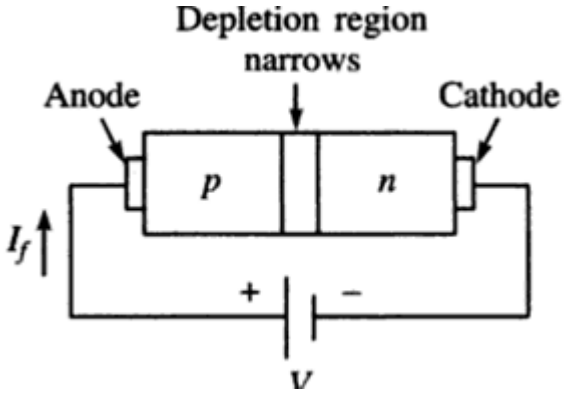


UNIT I

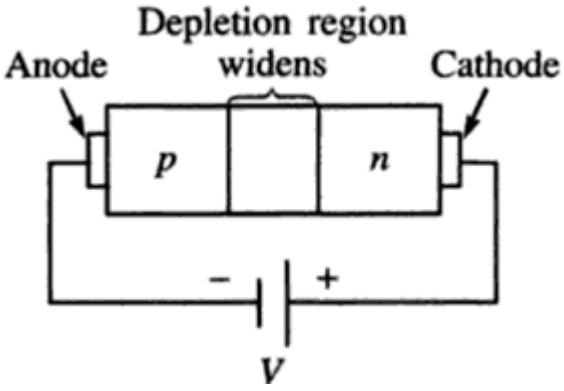
2)a) V-I Characteristics of PN Junction Diode:- **Explanation FB 3M+ RB 3M = 6M**



Forward Bias:- When a diode is connected in a Forward Bias condition, a negative voltage is applied to the N-type material and a positive voltage is applied to the P-type material. If this external voltage becomes greater than the value of the potential barrier, approx. 0.7 volts for silicon and 0.3 volts for germanium, the potential barriers opposition will be overcome and current will start to flow.



Reverse Bias:- When a diode is connected in a Reverse Bias condition, a positive voltage is applied to the N-type material and a negative voltage is applied to the P-type material. The positive voltage applied to the N-type material attracts electrons towards the positive electrode and away from the junction, while the holes in the P-type end are also attracted away from the junction towards the negative electrode. The net result is that the depletion layer grows wider due to a lack of electrons and holes and presents a high impedance path, almost an insulator. The result is that a high potential barrier is created thus preventing current from flowing through the semiconductor material.



2)b) Calculating voltage from diode current equation - 4M

$$I = I_0\left(e^{\frac{qV}{\eta KT}} - 1\right)$$

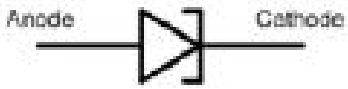
(OR)

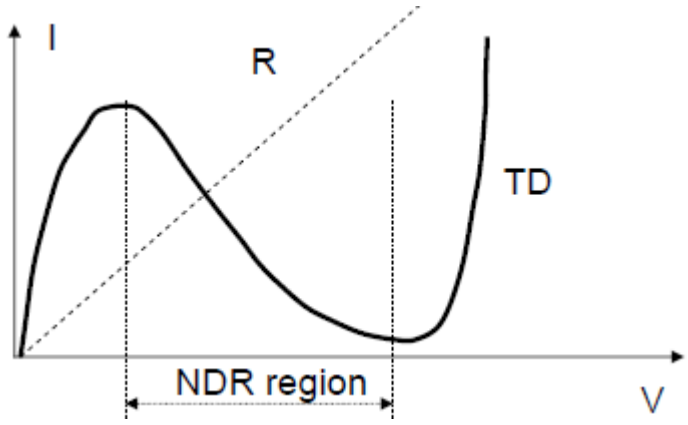
3)a) <u>Tunnel Diode:-</u>

SYMBOL -1M

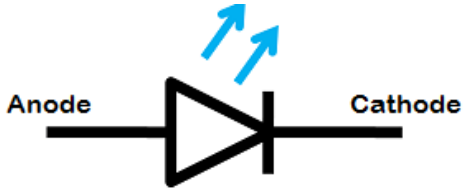
EXPLANATION WITH ENERGY BAND DIAGRAMS-4M

EXPLANATION OF CHARACTERISTICS -1M





<u>3)B) Light Emitting Diode:-</u> **Symbol 2M+ Working 2M =4M**



Working Principle:-

The working principle of the Light emitting diode is based on the quantum theory. The quantum theory says that when the electron comes down from the higher energy level to the lower energy level then, the energy emits from the photon. The photon energy is equal to the energy gap between these two energy levels. If the PN-junction diode is in the forward biased, then the current flows through the diode.

The flow of current in the semiconductors is caused by the both flow of holes in the opposite direction of current and flow of electrons in the direction of the current. Hence there will be recombination due to the flow of these charge carriers. The recombination indicates that the electrons in the conduction band jump down to the valence band. When the electrons jump from one band to another band the electrons will emit the electromagnetic energy in the form of photons and the photon energy is equal to the forbidden energy gap.

Advantages of LEDs:

1. Very low voltage and current are enough to drive the LED.Voltage range – 1 to 2 volts. Current – 5 to 20 milliamperes.
2. Total power output will be less than 150 milliwatts.
3. The response time is very less – only about 10 nanoseconds.

Disadvantages:

1. A slight excess of voltage or current can damage the device.
2. The device is known to have a much wider bandwidth compared to the laser.
3. The temperature depends on the radiant output power and wavelength.

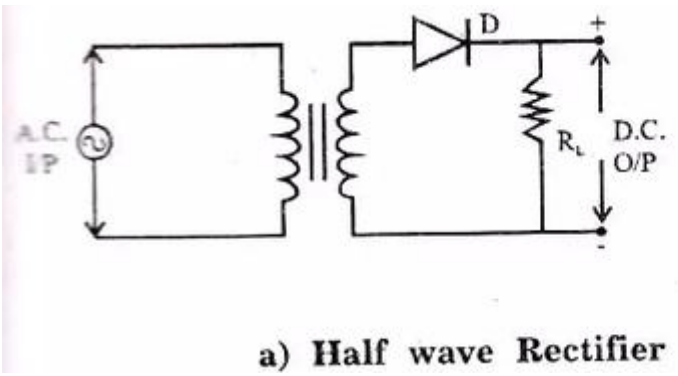
UNIT-II

4)a) HALF WAVE RECTIFIER :-

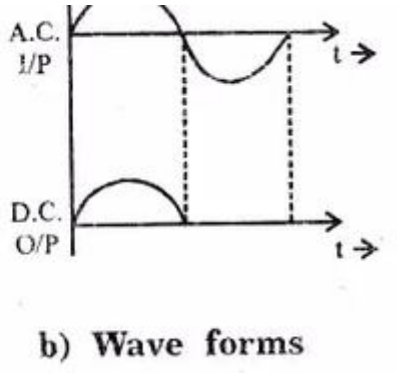
DIAGRAM -2M

EXPLANATION & DERIVATION FOR EFFICIENCY,RIPPLEFACTOR-4M

A half wave rectifier is defined as a type of rectifier that only allows one half-cycle of an AC voltage waveform to pass, blocking the other half-cycle. Half-wave rectifiers are used to convert AC voltage to DC voltage, and only require a single diode to construct.



a) Half wave Rectifier



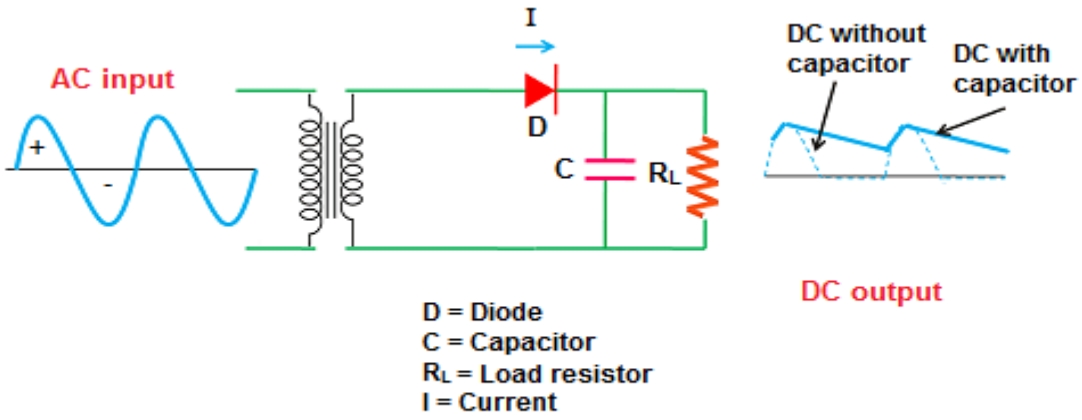
b) Wave forms

(OR)

4)b) <u>CAPACITIVE FILTER</u>:-

DIAGRAM -2M

WORKING-2M



Half wave rectifier with capacitor filter

During the conduction period, the capacitor charges to the maximum value of the supply voltage. When the voltage between the plates of the capacitor is equal to the supply voltage, the capacitor is said to be fully charged. When the capacitor is fully charged, it holds the charge until the input AC supply to the rectifier reaches the negative half cycle. When the negative half cycle is reached, the diode D gets reverse biased and stops allowing electric current through it. During this non-conduction period, the input voltage is less than that of the capacitor voltage. So the capacitor discharges all the stored charges through the load resistor R_L. This prevents the output load voltage from falling to zero.

The capacitor discharges until the input supply voltage is less than the capacitor voltage. When the input supply voltage is greater than the capacitor voltage, the capacitor again starts charging. When the positive half cycle is reached again, the diode D is forward biased and allows electric current. This makes capacitor to charge again. The capacitor filter with a large discharge time constant will produce a very smooth DC voltage. Thus, a smooth and steady DC voltage is obtained by using the filter.

(OR)

<u>5)A) Bridge rectifier:-</u>

Explanation of Merits and De-Merits -4M

The bridge rectifier is widely used to provide full wave rectification and it is possibly the most widely used circuit for this. Using four diodes the bridge rectifier the circuit has a distinctive format with the circuit diagram based on a square with one diode on each leg.

The bridge rectifier full wave rectifier has the advantage over the full wave rectifier using a centre tapped transformer that there is no centre tapped transformer requirement and that the both halves of the cycle are used in the winding.

5)B) **CALCULATION OF EACH PARAMETER CARRIES 2M**

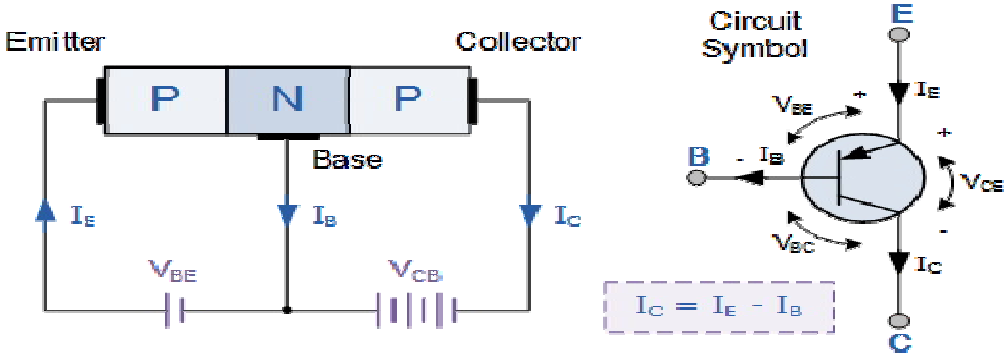
<u>UNIT-III</u>

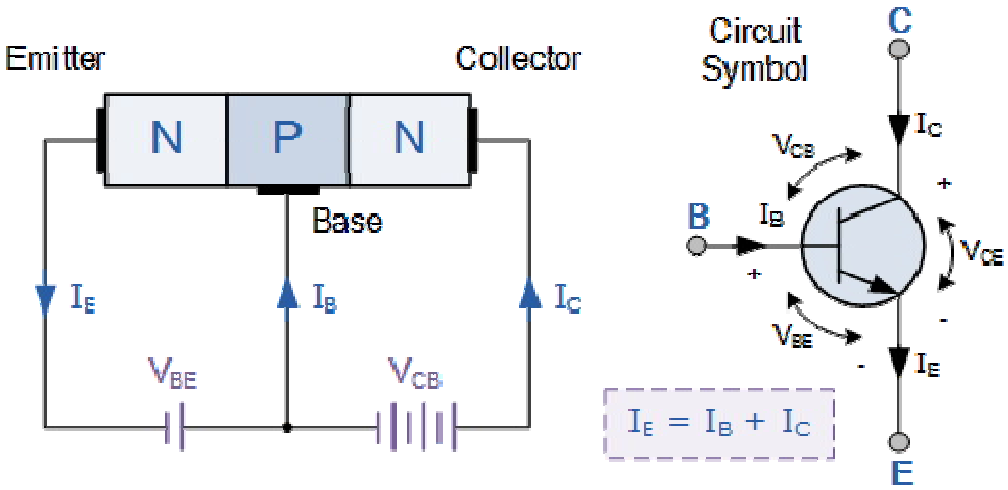
6)A) **<u>TRANSISTOR ACTION FOR PNP AND NPN:</u>**

DIAGRAM AND EXPLANATION FOR PNP -2M

DIAGRAM AND EXPLANATION FOR NPN -2M

The **transistor** is a semiconductor device which transfers a weak signal from low resistance circuit to high resistance circuit. It has three terminals namely emitter, base and collector. There are two types of **transistor**, namely NPN **transistor** and PNP **transistor**.





6)B) BIAS COMPENSATION

STABILIZATION TECHNIQUE:

This refers to the use of resistive biasing circuits which allow I_B to vary so as to keep I_C Relatively constant with variations in I_{CO} , β and V_{BE}

COMPENSATION TECHNIQUE:

This refers to the use of temperature sensitive devices such as diodes, transistors, thermistors, etc, which provide compensating voltages and current to maintain the operating point stable.

STABILITY FACTORS:

- → The stability factor is a measure of stability provided by the biasing circuit.
- → Stability factor indicates the degree of change in operating point due to variation in temperature.
- → Since there are 3 temperature dependent variables, there are 3 stability factors.

$$S = \frac{\partial I_C}{\partial I_{CO}} |V_{BE,\beta\ constant} \quad \text{(or)} \quad S = \frac{\Delta I_C}{\Delta I_{CO}} |V_{BE,\beta\ constant}$$

(OR)

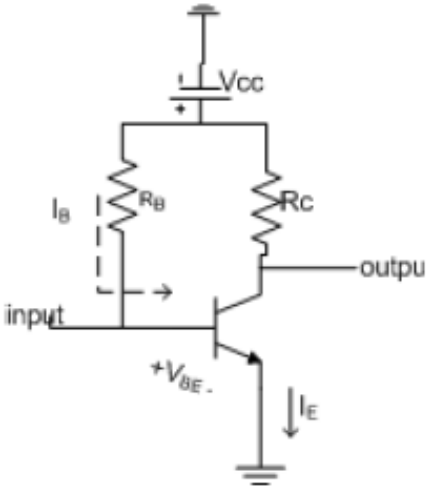
7)A) FIXED BIASED CIRCUIT FIND THE STABILITY FACTOR S:-

DEFINITION-1M

CIRCUIT DIAGRAM-2M

CALCULATING STABILITY S-3M

The stability factor is the rate of change of collector current with respect to the reverse saturation current when the collector-emitter current gain (β) and base current is constant.



Stability in fixed bias:

Take general equation for stability factor. It is given in the post 'Stability factors & Biasing circuits'. It is here for our convenience

$$S = \frac{1+\beta}{1-\beta\frac{dI_B}{dI_c}}$$ ----- (5)

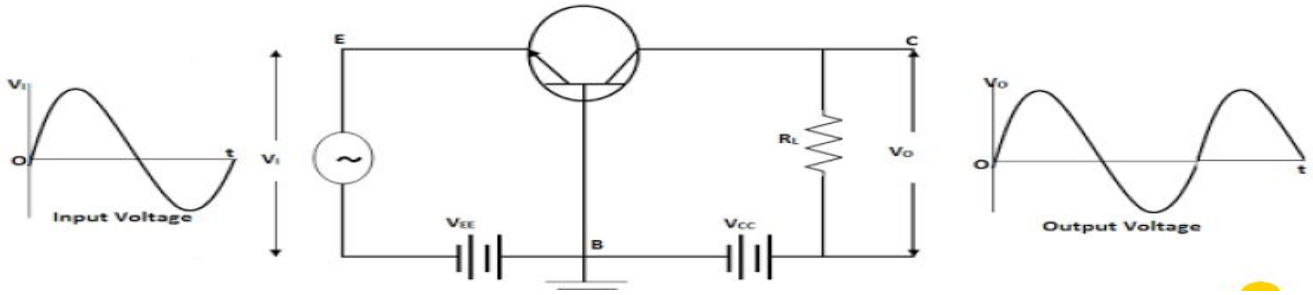
This equation contains two terms -β and dI_B/dIc. Among them β is constant and check dI_B/dIc. From equation(2), we know that, I_B is constant and is independent of variations in Ic. So dI_B/dIc is almost zero. Now the equation become

$$S = 1+\beta$$ ----- (6)

This equation gives a very high value to stability factor(because β is very high), an undesirable condition. So it has least stability.

7)B) TRANSISTOR ACTS AS AN AMPLIFIER:-

DIAGRAM 2M+ EXPLANATION 2M==4M



A transistor acts as an amplifier by raising the strength of a weak signal. The DC bias voltage applied to the emitter base junction, makes it remain in forward biased condition. This forward bias is maintained regardless of the polarity of the signal.

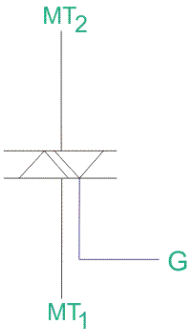
The low resistance in input circuit, lets any small change in input signal to result in an appreciable change in the output. The emitter current caused by the input signal contributes the collector current, which when flows through the load resistor RL, results in a large voltage drop across it. Thus a small input voltage results in a large output voltage, which shows that the transistor works as an amplifier.

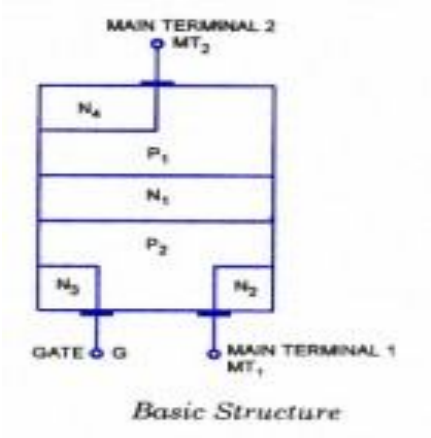
UNIT IV

8)A) TRIAC:-

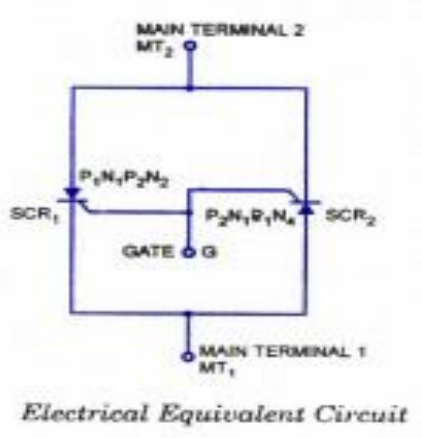
SYMBOL & CONSTRUCTION -2M

EXPLANATION& CHARACTERISTICS-2M





Basic Structure



Electrical Equivalent Circuit

There are four different modes of operations, they are-

When MT2 and Gate being Positive with Respect to MT1

When this happens, current flows through the path P1-N1-P2-N2. Here, P1-N1 and P2-N2 are forward biased but N1-P2 is reverse biased. The triac is said to be operated in positively biased region. Positive gate with respect to MT1 forward biases P2-N2 and breakdown occurs.

When MT2 is Positive but Gate is Negative with Respect to MT1

The current flows through the path P1-N1-P2-N2. But P2-N3 is forward biased and current carriers injected into P2 on the triac.

When MT2 and Gate are Negative with Respect to MT1

Current flows through the path P2-N1-P1-N4. Two junctions P2-N1 and P1-N4 are forward biased but the junction N1-P1 is reverse biased. The triac is said to be in the negatively biased region.

When MT2 is Negative but Gate is Positive with Respect to MT1

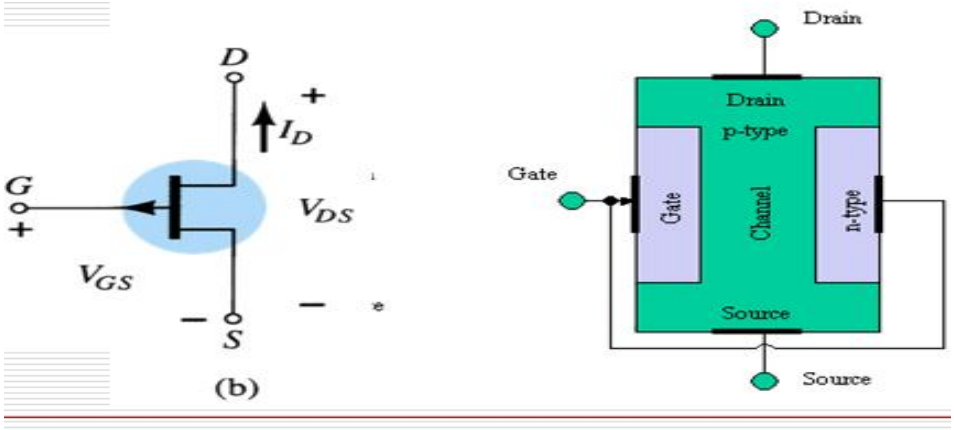
P2-N2 is forward biased at that condition. Current carriers are injected so the triac turns on. This mode of operation has a disadvantage that it should not be used for high (di/dt) circuits. Sensitivity of triggering in mode 2 and 3 is high and if marginal triggering capability is required, negative gate pulses should be used. Triggering in mode 1 is more sensitive than mode 2 and mode 3.

8)B) P-channel JFET:-

SYMBOL&CONSTRUCTION -2M

EXPLANATION -2M

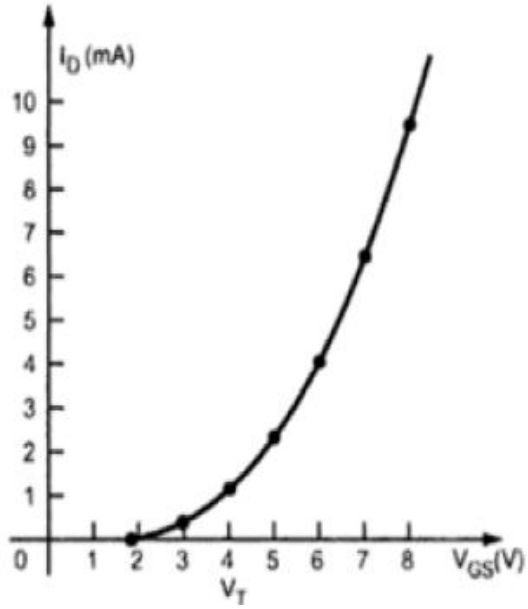
CHARACTERISTICS -2M

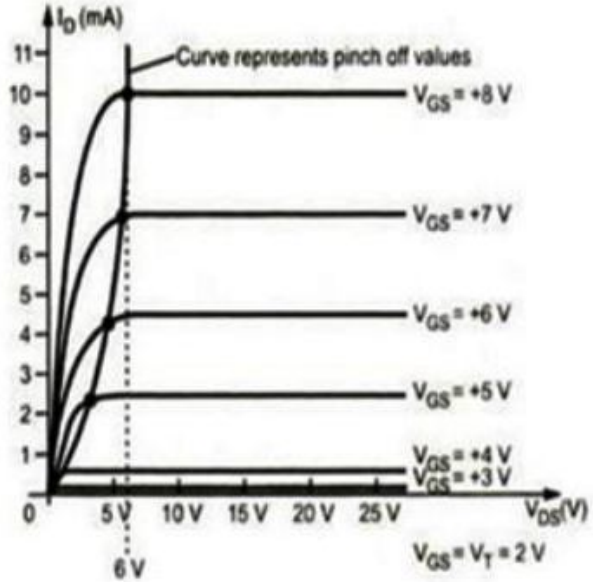


It is made with an p-type silicon channel that contains 2 n-type silicon terminals placed on either side. The gate lead is connected to the N-type terminals, while the drain and source leads are connected to either ends of the P-type channel.

When no voltage is applied to the gate of a P-Channel JFET, current (holes) flows freely through the central P-channel. This is why JFETs are referred to as "normally on" devices. Even without any voltage, they conduct current across from source to drain.

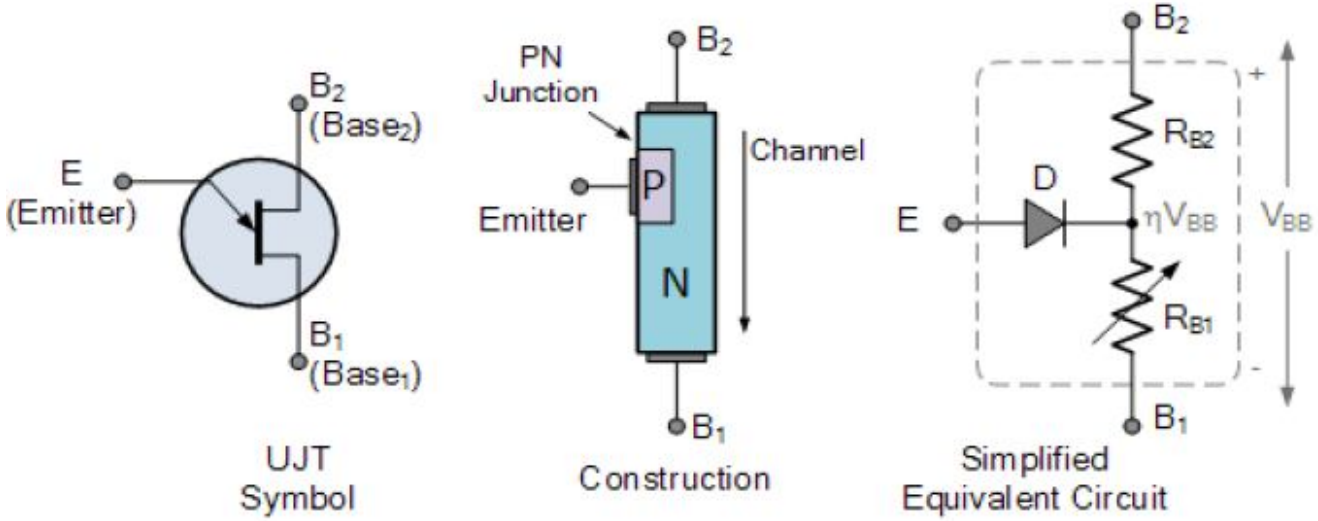
Transfer and Drain Characteristics:





(OR)

9)A) Uni Junction Transistor(UJT):- **Diagrams 3M+ Explanation 2M=5M**



The Unijunction Transistor or UJT for short, is another solid state three terminal device that can be used in gate pulse, timing circuits and trigger generator applications to switch and control either thyristors and triac's for AC power control type applications.

The UJT consists of a single solid piece of N-type semiconductor material forming the main current carrying channel with its two outer connections marked as Base 2 (B2) and Base 1 (B1).
The third connection, confusingly marked as the Emitter (E) is located along the channel. The emitter terminal is represented by an arrow pointing from the P-type emitter to the N-type base.

The Emitter rectifying p-n junction of the unijunction transistor is formed by fusing the P-type material into the N-type silicon channel. However, P-channel UJT's with an N-type Emitter terminal are also available but these are little used.

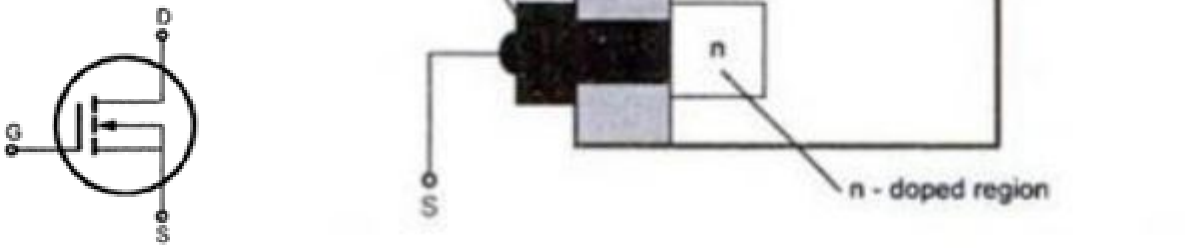
The Emitter junction is positioned along the channel so that it is closer to terminal B2 than B1. An arrow is used in the UJT symbol which points towards the base indicating that the Emitter terminal is positive and the silicon bar is negative material. Below shows the symbol, construction, and equivalent circuit of the UJT.

9)B) N-MOSFET IN ENHANCEMENT MODE:-

Block diagram of enhancement mode MOSFET -2M

Operation of enhancement MOSFET- 2M

Characteristics of enhancement MOSFET -1M



A body or substrate of P type silicon is used, then two heavily doped N type regions are diffused into the upper surface, to form a pair of closely spaced strips. A very thin (about 10−4 mm) layer of silicon dioxide is then evaporated onto the top surface forming an insulating layer. Parts of this layer are then etched away above the N type regions using a photographic mask to leave these regions uncovered. On top of the insulating layer, between the two N type regions, a

layer of aluminum is deposited. This acts as the GATE electrode. Metal contacts are also deposited on the N type regions, which act as the SOURCE and DRAIN connectors.

The gate has a voltage applied to it that makes it positive with respect to the source. This causes holes in the P type layer close to the silicon dioxide layer beneath the gate to be repelled down into the P type substrate, and at the same time this positive potential on the gate attracts free electrons from the surrounding substrate material. These free electrons form a thin layer of charge carriers beneath the gate

electrode (they can't reach the gate because of the insulating silicon dioxide layer) bridging the gap between the heavily doped source and drain areas.

Any further increase in the gate voltage attracts more charge carriers into the inversion layer, so reducing its resistance, and increasing current flow between source and drain. Reducing the gate source voltage reduces current flow. When the power is switched off, the area beneath the gate reverts to P type once more. As well as the type described above, devices having N type substrates and P type (inversion layer) channels are also available. Operation is identical, but of course the polarity of the gate voltage is reversed.

This method of operation is called "ENHANCEMENT MODE" as the application of gate source voltage makes a conducting channel "grow", therefore it enhances the channel. Other devices are available in which the application of a bias voltage reduces or "depletes" the conducting channel.

Transfer and Drain Characteristics: