EASWARI ENGINEERING COLLEGE

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

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(Regulation 2017)

EC8252 ELECTRONIC DEVICES

2-Marks Questions With Answers

UNIT I SEMICONDUCTOR DIODE

1. What are semiconductors?

The materials whose electrical property lies between those of conductors and insulators are known as Semiconductors. Ex germanium, silicon.

It has two types.

1. Intrinsic semiconductor
2. Extrinsic semiconductor.

2. Differentiate between intrinsic and extrinsic semiconductor.

Pure form of semiconductors are said to be intrinsic semiconductor.
Ex:germanium,silicon.
It has poor conductivity
If certain amount of impurity atom is added to intrinsic semiconductor the resulting semiconductor is Extrinsic or impure Semiconductor.
It has good conductivity.

3. Define drift current?

When an electric field is applied across the semiconductor, the holes move towards the negative terminal of the battery and electron move towards the positive terminal of the battery. This drift movement of charge carriers will result in a current termed as drift current.

4. Give the expression for drift current density.

Drift current density due to electrons

$$J_n = qn\mu_n E$$

Where,

J_n-drift current density due to electron q-
Charge of electron
μ_n-Mobility of electron
E- applied electric field
Drift current density due to holes.

$J_p = qp\mu_p E$

Where,

J_n-drift current density due to holes

q-Charge of holes

μ_p-Mobility of holes

E- applied electric field

5. Define the term diffusion current?

A concentration gradient exists, if the number of either electrons or holes is greater in one region of a semiconductor as compared to the rest of the region. The holes and electron end to move from region of higher concentration to the region of lower concentration. This process is called diffusion and the current produced due this movement is diffusion current.

6. Give the expression for diffusion current density.

Diffusion current density due to electrons

$J_n = qD_n dn/dx$

Where

J_n-diffusion current density due to electron q-

Charge of an electron

D_n–diffusion constant for electron

dn/dx–concentration gradient

Diffusion current density due to holes

$J_p = -qD_p dp/dx$

Where

J_p- diffusion current density due to holes

q- Charge of a hole

D_p– diffusion constant for hole

dn/dx – concentration gradient

7. Differentiate between drift and diffusion currents.

Drift current

1. It is developed due to potential gradient.
2. This phenomenon is found both in metals and semiconductors

Diffusion current

1. It is developed due to charge concentration gradient.
2. This phenomenon is found only in metals

8. What is depletion region in PN junction?

The region around the junction from which the mobile charge carriers(electrons and holes)are depleted is called as depletion region. Since this region has immobile ions, which are electrically charged, the depletion region is also known as space charge region.

9. What is barrier potential?

Because of the oppositely charged ions present on both sides of PN junction an electric potential is established across the junction even without any external voltage source which is termed as barrier potential.

10. What is Reverse saturation current?

The current due to the minority carriers in reverse bias is said to be reverse saturation current. This current is independent of the value of the reverse bias voltage.

11. What is the total current at the junction of pn junction diode?

The total in the junction is due to the hole current entering then material and the electron current entering the p-material. Total current is given by

I=Ipn(0)+ Inp(0)

Where,

I–Total current

Ipn(0)-hole current entering then material

Inp(0)-electron current entering the p-material

12. Give the diode current equation?

The diode current equation relating the voltage V and current I is given by

$$I = I_o\,[e^{(V/\eta V_T)} - 1]$$

where

I–diode current

I_o–diode reverse saturation current at room temperature

V–external voltage applied to the diode

η-aconstant, 1 for Ge and 2 for Si

V_T=kT/q=T/11600, thermal voltage

K–Boltzmann's constant(1.38066x10^-23J/K)

q–charge of electron(1.6x10^-19C)

T–temperature of the diode junction

13. What is recovery time? Give its types.

When a diode has its state changed from one type of bias to other a transient accompanies the diode response, i.e., the diode reaches steady state only after an interval of time"t_r"calledas recovery time. The recovery time can be divided into two types such as

(i)forward recovery time (ii)reverse recovery time

14. Define storage time.

The interval time for the stored minority charge to become zero is called storage time. It is represented as t_s.

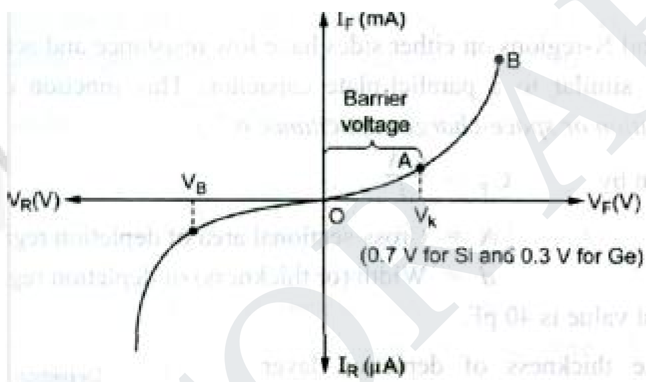
15. Define transition time.

The time when the diode has normally recovered and the diode reverse current reaches reverse saturation current I_o is called as transition time. It is represented as t_t

16. Define PIV.

Peak Inverse Voltage is the maximum reverse voltage that can be applied to the PN junction without damage to the junction.

17. Draw V-I characteristics of PN diode.



18. Write the application of PN diode.

- can be used as rectifier in DC Power Supplies.
- In Demodulation or Detector Circuits.
- In clamping networks used as DC Restorers
- In clipping circuits used for waveform generation.
- As switches in digital logic circuits.
- In demodulation circuits.

UNIT II BIPOLARJUNCTION

PART A

1. Why an ordinary transistor is called bipolar?

The operation of the transistor depends on both majority and minority carriers. So it is called bipolar device.

2. Collector region of transistor is larger than emitter. Why?

Collector is made physically larger than emitter and base because collector is to dissipate much power.

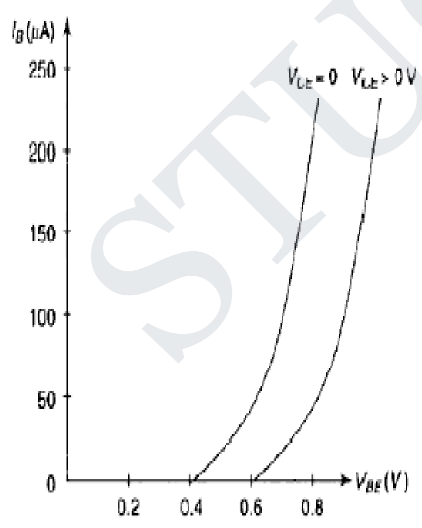
3. Why BJT is called current controlled device?

The output voltage, current, or power is controlled by the input current in a transistor. So it is called the current controlled device.

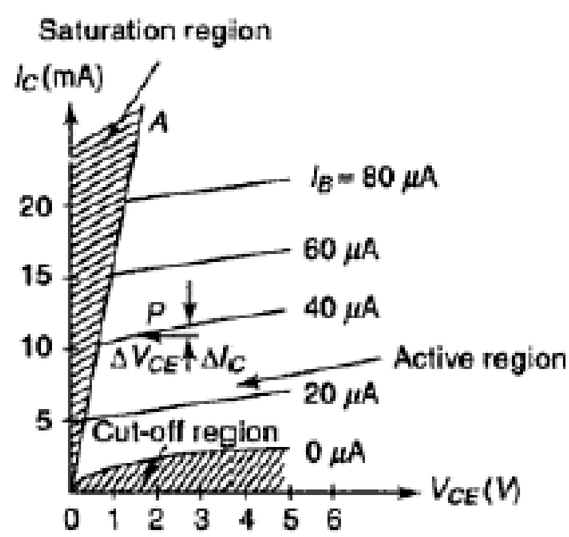
4. Define Early Effect.

A variation of the base-collector voltage results in a variation of the quasi-neutral width in the base. The gradient of the minority-carrier density in the base therefore changes, yielding an increased collector current as the collector-base current is increased. This effect is referred to as the early effect.

5. Draw the characteristics of CE configuration.



CE input characteristics



CE output characteristics

6. Among CE, CB, CC which one is most popular. Why?

CE is most popular among the three because it has high gain compared to baseand collect or configuration. It has the gain about to 500 that finds excellent usage in audio frequency applications.

7. Compare CE, CB, CC.

Property	*CB*	*CE*	*CC*
Input resistance	Low (about 100 Ω)	Moderate (about 750 Ω)	High (about 750 kΩ)
Output resistance	High (about 450 kΩ)	Moderate (about 45 kΩ)	Low (about 25 Ω)
Current gain	1	High	High
Voltage gain	About 150	About 500	Less than 1
Phase shift between input & output voltages	0 or 360°	180°	0 or 360°
Applications	for high frequency circuits	for audio frequency circuits	for impedance matching

8. Why h-parameter model is important for BJT.

It is important because:

1. Its values are used on specification sheets
2. It is one model that may be used to analyze circuit behavior
3. It may be used to form the basis of a more accurate transistor model

9. Define current amplification factor.

In a transistor amplifier with a.c. input signal, the ratio of change in output current to be the change in input current is known as the current amplification factor.

In the CB configuration the current amplification factor, $\alpha = \frac{\Delta I_C}{\Delta I_E}$

In the CE configuration the current amplification factor, $\beta = \frac{\Delta I_C}{\Delta I_B}$

In the CC configuration the current amplification factor, $\gamma = \frac{\Delta I_E}{\Delta I_B}$

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10. What do you meant by multi emitter transistor?

Transistor–transistor logic (**TTL**) is a class of digital circuits built from bipolar junction transistors (BJT) and resistors. It is called *transistor–transistor logic* because both the logic gating function (e.g., AND) and the amplifying function are performed by transistors.

TTL is not able for being a widespread integrated circuit(IC) family used in many applications such as computers, industrial controls, test equipment and instrumentation, consumer electronics, synthesizers, etc,…

11. In a CR connection, the value of I_E is 6.28mA and the collector current Ic is 6.20mA. Determine D.C. current gain.

Given: $I_E = 6.28$ mA and $I_C = 6.20$ mA

We know that common-base d.c. current gain,

$$\alpha = \frac{I_C}{I_E} = \frac{6.20 \times 10^{-3}}{6.28 \times 10^{-3}} = 0.987$$

12. The transistor has I_E =10mA and α=0.98. Find the value of base and collector currents.

Solution:

Given: $I_E = 10$ mA and $\alpha = 0.98$

The common-base d.c. current gain, $\alpha = \frac{I_C}{I_E}$

i.e. $0.98 = \frac{I_C}{10}$

Therefore $I_C = 0.98 \times 10 = 9.8$ mA

The emitter current $I_E = I_B + I_C$

i.e. $10 = I_B + 9.8$

Therefore, $I_B = 0.2$ mA

13. If a transistor has a α of 0.97 find the value of β. If β=200, find the value of α.

Solution:

If $\alpha = 0.97,\ \beta = \frac{\alpha}{1-\alpha} = \frac{0.97}{1-0.97} = 32.33$

If $\beta = 200,\ \alpha = \frac{\beta}{\beta+1} = \frac{200}{200+1} = 0.995$

14. Give some applications of BJT.

The BJT remains a device that excels in some applications, such as discrete circuit design, due to the very wide selection of BJT types available, and because of its high transconductance and output resistance compared to MOSFETs.

The BJT is also the choice for demanding analog circuits, especially for very-high- frequency applications, such as radio-frequency circuits for wireless systems.

Bipolar transistors can be combined with MOSFETs in an integrated circuit by using a Bi-CMOS process of wafer fabrication to create circuits that take advantage of the application strengths of both types of transistor.

UNIT III FIELDEFFECT TRANSISTORS

PART A

1. Why it is called field effect transistor?

The drain current I_D of the transistor is controlled by the electric field that extends into the channel due to reverse biased voltage applied to the gate, hence this device has been given the name Field Effect Transistor.

2. Why FET is called voltage controlled device.

FET the value of the current depends upon the value of the voltage applied at the gate and drain. So it is known as voltage controlled device.

3. Define the term threshold voltage.

The **threshold voltage**, commonly abbreviated as $\mathbf{V_{th}}$, of a field-effect transistor (FET) is the value of the gate–source voltage when the conducting channel just begins to connect the source and drain contacts of the transistor, allowing significant current.

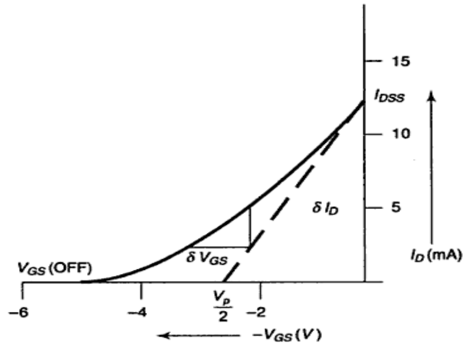
The threshold voltage of a junction field-effect transistor is often called **pinch-off voltage** instead, which is somewhat confusing since "pinch off" for an insulated-gate field-effect transistor is used to refer to the channel pinching that leads to current saturation behaviour under high source–drain bias, even though the current is never off. The term "threshold voltage" is unambiguous and refers to the same concept in any field-effect transistor.

4. What is channel length modulation?

One of several short-channel effects in MOSFET scaling, **channel length modulation** (**CLM**) is a shortening of the length of the inverted channel region with increase in drain bias for large drain biases.

As the drain voltage increases, its control over the current extends further toward the source, so the uninverted region expands toward the source, shortening the length of the channel region, the effect is called channel-length modulation.

5. Draw the transfer characteristics curve for JFET.



6. Compare JFET with BJT.

1. FET operation depends only on the flow of majority carriers-holes for P-channel FETs and electrons for N-channel FETs. Therefore, they are called Unipolar devices. Bipolar transistor (BJT) operation depends on both minority and majority current carriers.
2. As FET has no junctions and the conduction is through an N-type or P-type semiconductor material, FET is less noisy than BJT.
3. As the input circuit of FET is reverse biased, FET exhibits a much higher input impedance (in the order of 100 M Ω) and lower output impedance and there will be a high degree of isolation between input and output. So, FET can act as an excellent buffer amplifier but the BJT has low input impedance because its input circuit is forward biased.
4. FET is a voltage controlled device, i.e. voltage at the input terminal controls the output current, whereas BJT is a current controlled device, i.e. the input current controls the output current.
5. FETs are much easier to fabricate and are particularly suitable for ICs because they occupy less space than BJTs.

7. Differentiate between N and P channel FETs.

1. In an N-channel JFET the current carriers are electrons, whereas the current carriers are holes in a P-channel JFET.
2. Mobility of electrons is large in N-channel JFET; Mobility of holes is poor in P-channel JFET.
3. The input noise is less in N-channel JFET than that of P-channel JFET.
4. The transconductance is larger in N-channel JFET than that of P-channel JFET.

8. Write some applications for JFET.

1. FET is used as a buffer in measuring instruments, receivers since it has high input impedance and low output impedance.
2. FETs are used in RF amplifiers in FM tuners and communication equipment for the low noise level.
3. Since the input capacitance is low, FETs are used in cascade amplifiers in measuring and test equipments.
4. Since the device is voltage controlled, it is used as a voltage variable resistor in operational amplifiers and tone controls.
5. FETs are used in mixer circuits in FM and TV receivers, and communication equipment because inter modulation distortion is low.

9. Compare MOSFET with JFET.

1. In enhancement and depletion types of MOSFET, the transverse electric field induced across an insulating layer deposited on the semiconductor material controls the conductivity of the channel. In the JFET the transverse electric field across the reverse biased PN junction controls the conductivity of the channel.
2. The gate leakage current in a MOSFET is of the order of 10^{-12} A. Hence the input resistance of a MOSFET is very high in the order of 10^{10} to 10^{15} Ω. The gate leakage current of a JFET is of the order of 10^{-9} A and its input resistance is of the order of 10^{8} Ω.
3. The output characteristics of the JFET are flatter than those of the MOSFET and hence, the drain resistance of a JFET (0.1 to 1 MΩ) is much higher than that of a MOSFET (1 to 50 kΩ).
4. JFETs are operated only in the depletion mode. The depletion type MOSFET may be operated in both depletion and enhancement mode.
5. Comparing to JFET, MOSFETs are easier to fabricate.

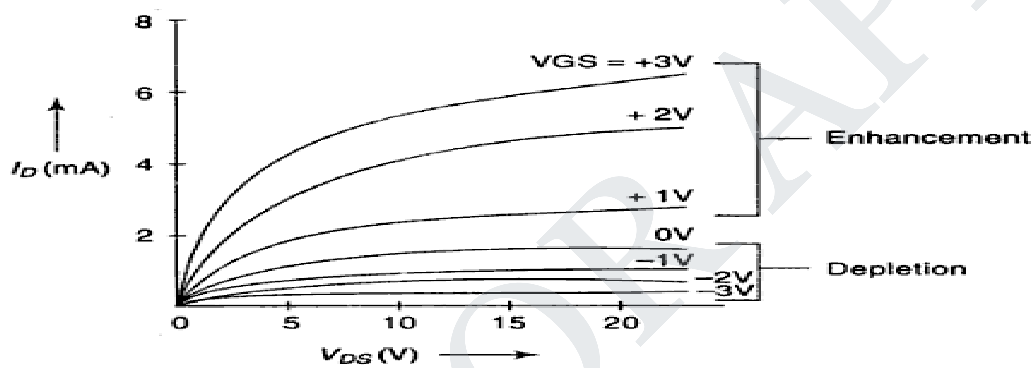
10. Compare N-channel MOSFET with P-channel MOSFET.

1. The P-channel enhancement MOSFET is very popular because it is much easier and cheaper to produce than the N-channel device.
2. The hole mobility is nearly 2.5 times lower than the electron mobility. Thus, a P-channel MOSFET occupies a larger area than an N-channel MOSFET having the same I_D rating.
3. The drain resistance of P-channel MOSFET is three times higher than that for an identical N-channel MOSFET.
4. The N-channel MOSFET has the higher packing density which makes it faster in switching applications due to the smaller junction areas and lower inherent capacitances.
5. The N-channel MOSFET is smaller for the same complexity than P-channel device.

11. Differentiate between current voltage relationships of the N &P channel MOSFET.

N-Channel MOSFET	P-Channel MOSFET
Saturation region ($V_{DS} > V_{DS}$(sat)) $I_D = K_N(V_{GS} - V_{TN})^2$	Saturation region ($V_{SD} > V_{SD}$ (sat)) $I_D = K_P(V_{SG} + V_{TP})^2$
Non saturation region ($V_{DS} < V_{DS}$(sat)) $I_D = K_N[2(V_{GS} - V_{TN})V_{DS} - V_{DS}^2]$	Non saturation region ($V_{SD} < V_{SD}$(sat)) $I_D = K_P[2(V_{SG} + V_{TP})V_{SD} - V_{DS}^2]$
Transition point V_{DS}(sat) $= V_{GS} - V_{TN}$	Transition point V_{SD}(sat) $= V_{SG} + V_{TP}$
Enhancement mode $V_{TN} > 0$	Enhancement mode $V_{TP} < 0$
Depletion mode $V_{TN} < 0$	Depletion mode $V_{TP} > 0$

12. Draw the V-I characteristics curve of MOSFET.



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UNIT IV SPECIAL SEMICONDUCTORDEVICES

PART A

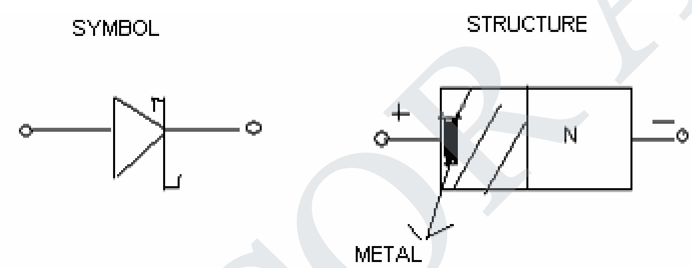
1. What is a metal semi conductor contact?

A metal semiconductor contact is a contact between a metal and a semiconductor which according to the doping level and requirement may act as a rectifying diode or just a simple contact between a semiconductor device and the outside world.

2. Define contact potential in metal semiconductor contact.

The difference of potential between the work function of metal and the work function of semiconductor in a metal semiconductor contact is termed as contact potential.

3. Give the symbol and structure of schottky diode.



4. Give the applications of schottky diode.

1. It can switch of faster than bipolar diodes
2. It is used to rectify very high frequency signals (>10MHZ)
3. As a switching device in digital computers.
4. It is used in clipping and clamping circuits.
5. It is used in communication systems such as frequency mixers, modulators and detectors.

5. Compare between PN and Schottky diodes

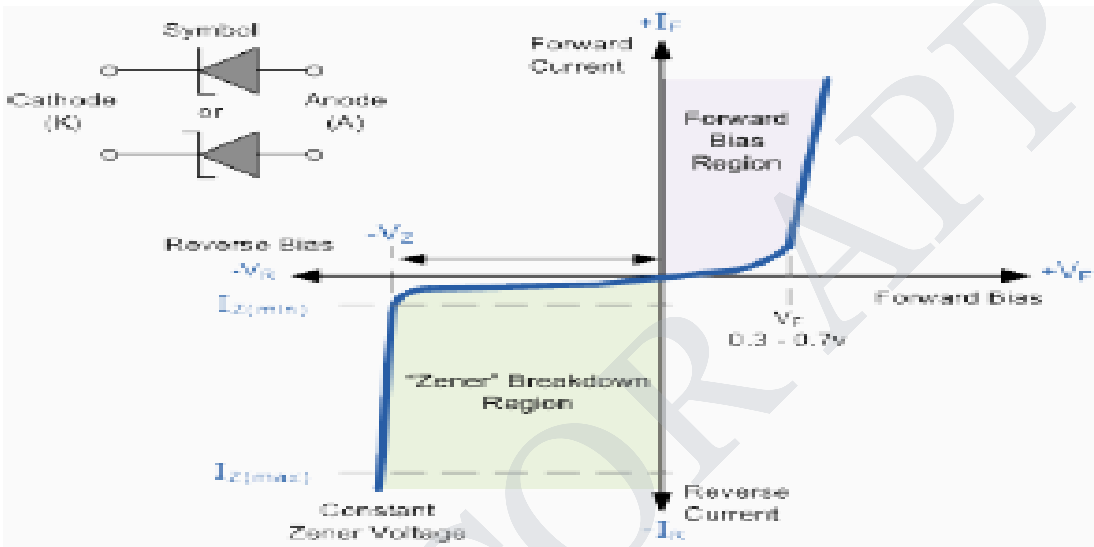
PN junction diode	Schottky diode
1.Here the contact is established between two Semiconductors	1.Here the contact is established between the Semiconductor and metal
2.currentconductionis due to both Majority and minority carriers	2.currentconductionis only due to Majority carriers
3.large reverse recovery time	3.Smallreverse recovery time
4.barrier potential is high about 0.7V	4.Barrier potential is low about 0.25V
5.switching speed is less	5.switching speed is high
6.cannot operate at high frequency	6.can operate at very high frequency (> 300MHz)

6. Why zener diode is often preferred than PN diode.

When the reverse voltage reaches breakdown voltage in normal PN junction diode the current through the junction and the power dissipated at the junction will high. Such an operation is destructive and the diode gets damaged.

Whereas diode can be designed with adequate power dissipation capabilities to operate in Breakdown region. That diode is known as zener diode. It is heavily doped than ordinary diode.

7. Draw the V-I characteristics curve for zener diode.



8. What is zener breakdown?

Zener breakdown takes place when both sides of the junction are very heavily doped and consequently the depletion layer is thin .When a small value of reverse bias voltage is applied, a very strong electric field is set up across the thin depletion layer. This electric field is enough to break the covalent bonds. Now extremely large number of free charge carriers are produced which constitute the zener current. This process is known as zener breakdown.

9.What is avalanche breakdown?

When bias is applied, thermally generated carriers which are already present in the diode acquire sufficient energy from the applied potential to produce new carriers by removing valence electron from their bonds. These newly generated additional carriers acquire more energy from the potential and they strike the lattice and create more number of free electrons and holes. This process goes on as long as bias is increased and the number of free carriers gets multiplied. This process is termed as avalanche multiplication. Thus the breakdown which occurs in the junction resulting in heavy flow of current is termed as avalanche breakdown.

10. What is tunneling phenomenon?

The phenomenon of penetration of the charge carriers directly though the potential barrier instead of climbing over it is called as tunneling.

11. Give the application of tunnel diode.

- As logic memory storage device
- As microwave oscillator
- In relaxation oscillator circuit
- As an amplifier
- As an ultra-high speed switch

12. Give the advantages and disadvantages of tunnel diode.

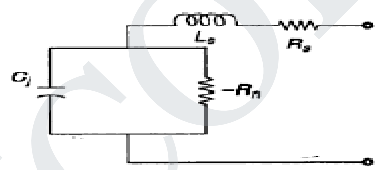
Advantages

- Low noise
- Ease of operation
- Highs peed
- Low power

Disadvantages

- Voltage range over which it can be operated is 1V less.
- Being a two terminal device there is no isolation between the input and output circuit.

13. Draw equivalent circuit of tunnel diode



Equivalent circuit of tunnel diode

- This is the equivalent circuit of tunnel diode when biased in negative resistance region.
- At higher frequencies the series R and L can be ignored.
- Hence equivalent circuit can be reduced to parallel combination of junction capacitance and negative resistance.

14. What is varactor diode?

A varactor diode is best explained as a variable capacitor. Think of the depletion region as a variable dielectric. The diode is placed in reverse bias. The dielectricis "adjusted" by reverse bias voltage changes.

- Junction capacitance is present in all reverse biased diodes because of the depletion region.
- Junction capacitance is optimized in a varactor diode and is used for high frequencies and Switching applications.
- Varactor diodes are often used for electronic tuning applications in FM radios and televisions.

UNIT V POWER DEVICES AND DISPLAY DEVICES

PART A

1. What is intrinsic stand-off ratio of an UJT?

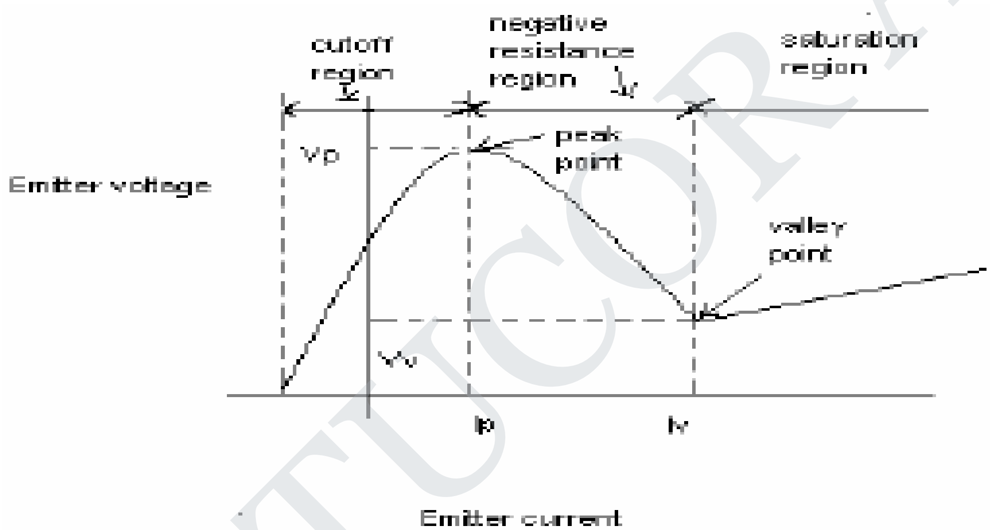
If a voltage V_{BB} is applied between the bases with emitter open the circuit will behave as a potential divider. Thus the voltage V_{BB} will be divided across R_{B1} and R_{B2}

Voltage across resistance R_{B1},

$$V_1 = \frac{R_{B1}}{R_{B1} + R_{B2}} * V_{BB} = \frac{R_{B1} * V_{BB}}{R_{BB}} = \eta * V_{BB}$$

The resistance ratio $\eta = R_{B1}/R_{BB}$ is known as intrinsic stand-off ratio

2. Give the VI characteristics of UJT

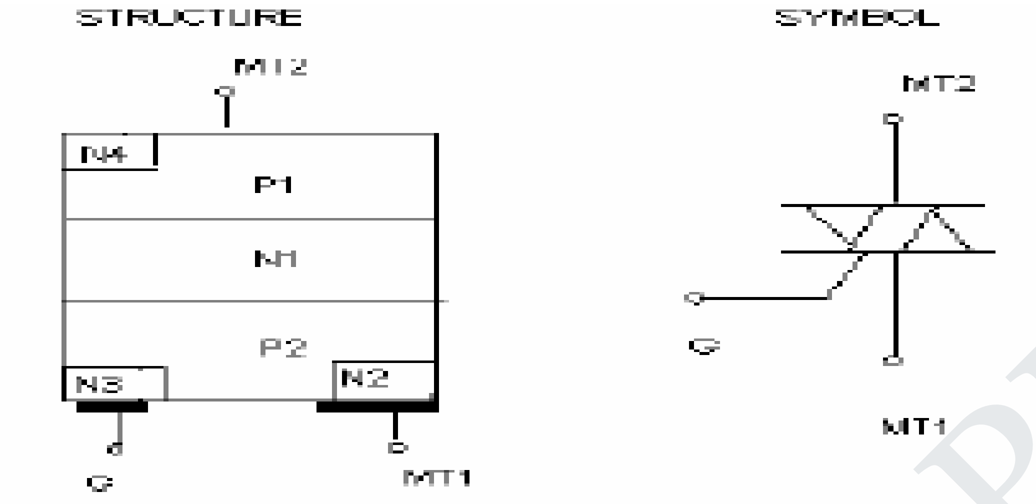


3. Mention the applications of UJT.

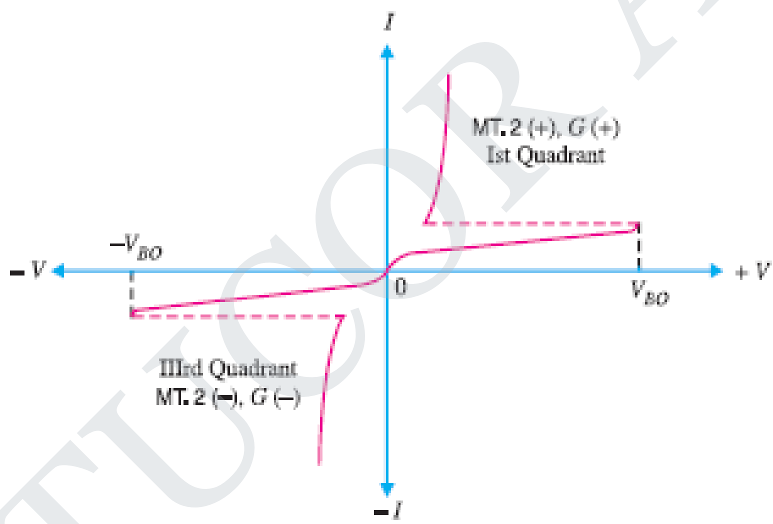
1. It is used in timing circuits
2. It is used in switching circuits
3. It is used in phase control circuits
4. It can be used as trigger device for SCR and triac
5. It is used in sawtooth generator
6. It is used for pulse generation

4. What is a TRIAC? Give the symbol and structure of TRIAC.

TRIAC is a three terminal bidirectional semiconductor switching device. It can conduct In both the directions for any desired period. In operation it is equivalent to two SCR's connected in anti parallel.

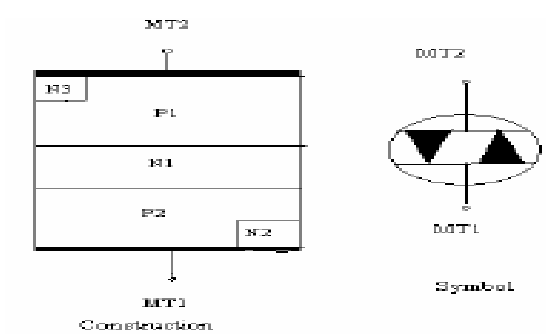


5. Draw the V-I characteristics for TRIAC.



6. What is a DIAC? Give the basic construction and symbol of DIAC.

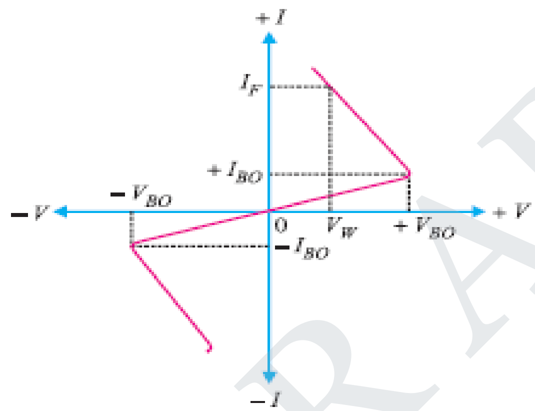
DIAC is a two terminal bidirectional semiconductor switching device. It can conduct in either direction depending upon the polarity of the voltage applied across its main terminals. In operation DIAC is equivalent to two 4 layer diodes connected in anti parallel.



7. Give the application of TRIAC.

1. Heater control
2. Motor speed control
3. Phase control
4. Static switches

8. Draw the V-I curve for DIAC.



9. Give some applications of DIAC.

1. To trigger TRIAC
2. Motor speed control
3. Heat control
4. Light dimmer circuits

10. Why SCR cannot be used as a bidirectional switch?

SCR can do conduction only when anode is positive with respect to cathode with proper gate current. Therefore, SCR operates only in one direction and cannot be used as bidirectional switch.

11. How turning ON of SCR is done?

1. By increasing the voltage across SCR above forward breakover Voltage
2. By applying a small positive voltage at gate
3. By rapidly increasing the anode to cathode voltage
4. By irradiating SCR with light

12. How turning OFF of SCR is done?

1. By reversing the polarity of anode to cathode voltage.
2. By reducing the current through the SCR below holding current.
3. By interrupting anode current by means of momentarily series or parallel switching

13. Define holding current in a SCR.

Holding current is defined as the minimum value of anode current to keep the SCR ON.

14. List the advantages of SCR.

1. SCR can handle and control large currents.
2. Its switching speed is very high
3. It has no moving parts, therefore it gives noiseless operation
4. Its operating efficiency is high.

15. List the application of SCR.

1. It can be used as a speed controller in DC and AC motors.
2. It can be used as an inverter.
3. It can be used as a converter
4. It is used in battery chargers.
5. It is used for phase control and heater control.
6. It is used in light dimming control circuits

16. Compare SCR with TRIAC.

SCR	TRIAC
1. unidirectional current	1. bidirectional current
2. triggered by positive pulse at gate	2. triggered by pulse of positive or negative at gate
3. fast turn off time	3.. Longer turn off time
4. large current ratings	4. lower current ratings

17. Differentiate BJT and UJT.

BJT	UJT
1. It has two PN junctions	1. It has only one PN junctions
2. three terminals present are emitter, base, collector	2. three terminals present are emitter, base1,base2
3. basically a amplifying device	3. basically a switching device

18. State the principle of operation of an LED.

When a free electron from the higher energy level gets recombined with the hole, it gives the light output. Here in case of LEDs, the supply of higher level electrons is provided by the battery connection.

19. Give the advantages of LED.

- They are small in size.
- Light in weight.
- Mechanically rugged.
- Low operating temperature.
- Switch on time is very small.
- Available in different colours.
- They have longer life compared to lamps
- Linearity is better.
- Compatible with ICs.
- Low cost.

20. State some disadvantages of LED.

- Output power gets affected by the temperature radiation.
- Quantum efficiency is low.
- Gets damaged due to over –voltage and over-current.

21. List the applications of LED.

- They are used in various types of displays.
- They are used as source in opto-couplers.
- Used in infrared remote controls.
- Used as indicator lamps.
- Used as indicators in measuring devices.

22. Give some advantages and disadvantages for LCD.

Advantages of LCD

- Low power is required
- Good contrast
- Low cost

Disadvantages of LCD

- Speed of operation is slow
- LCD occupy a large area
- LCD lifespan is quite small, when used on d.c. Therefore, they are used with a.c. suppliers.

23. Give applications of LCD.

- Used as numerical counters for counting production items.
- Analog quantities can also be displayed as a number on a suitable device.(e.g.)Digital multimeter.
- Used for solid state video displays.
- Used for image sensing circuits.
- Used for numerical display in pocket calculators.

24. Compare LEDs and LCDs.

LEDs	LCDs
1. More power is required.	1. Less power is required.
2. Fastest displays	2. Slowest displays.
3. More life.	3. Less life.
4. LED is light source.	4. LCD is not light source. It is a light reflector.
5. More temperature range.	5. Less temperature range
6. Mounting is easy	6. Mounting is difficult.

25. Give some notes on CCD.

A **charge-coupled device** (**CCD**) is a device for the movement of electrical charge, usually from within the device to an area where the charge can be manipulated, for example conversion into a digital value. This is achieved by "shifting" the signals between stages within the device on eat a time. CCDs move charge between capacitive *bins* in the device, with the shift allowing for the transfer of charge between bins. The CCD is a major piece of technology in digital imaging. In a CCD image sensor, pixels are represented by p-doped MOS capacitors.