DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

SUBJECT CODE: EC1201

ELECTRON DEVICES

(FOR THIRD SEMESTER ECE)

TWO MARK QUESTIONS-ANSWERS

PREPARED BY

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Electronics and Communication Engineering

Third Semester

EC1201 – Electron Devices

CHAPTER 1 - Electron Ballistics and Intrinsic semiconductors

PART A

1. **Give the value of Charge, Mass of an electron.**
   Charge of an electron – 1.6×10^{-19} coloumbs
   Mass of an electron - 9.11×10^{-31} Kgs
2. **Define Potential.**
   A potential of V volts at point B with respect to point A, is defined as the work done in taking unit positive charge from A to B , against the electric field.
3. **Give the expression for Equation of motion.**
   $Y = e \times \epsilon \times t^2 / 2m$
4. **What is Transit time? Give the expression for it.**
   It is the time taken by the electron to travel a distance'd' between the plates.
   $\tau = (2 \times m / e \times v)^{1/2} \times d$
5. **What is the Force experienced by an electron in Magnetic field?**
   $F_m = B \times e \times V$ Newton's
6. **Define Current density.**
   It is defined as the current per unit area of the conducting medium.
   $J = I / A$
7. **Define Electron volts.**
   If an electron falls through a potential of one volt then its energy is 1 electron volt.
   $1 \text{ eV} = 1.6 \times 10^{-19}$ joules
8. **What is Electrostatic deflection sensitivity?**
   Electrostatic deflection sensitivity of a pair of deflecting plates of a cathode ray oscilloscope (CRO) is defined as the amount of deflection of electron spot produced when a voltage of 1 Volt DC is applied between the corresponding plates.
9. **Give the expression for Electrostatic deflection sensitivity?**
   $S_E = l \times D \backslash 2 \times S \times V_a$ where l – length of the plates , D – distance between the centre of the plate and screen , S – distance between the plates , V_a - anode potential.
10. **What is Cyclotron?**
    Cyclotron is a device that imparts very high energies to positive ions. These higher energy positive ions are then allowed to bombard some substances, which become radioactive and generally disintegrate.
11. **Give the expression for frequency of Cyclotron?**
    $f = e \times B / 2 \times \pi \times m$ Hz

12. **What is Magnetic deflection sensitivity?**

Magnetic deflection sensitivity of a cathode ray oscilloscope (CRO) is defined as the amount of deflection of electron spot produced when a magnetic flux density of 1 Wb/m^2 is applied.

$S_M = (e\ /\ m)^{1\backslash 2} \times 1\backslash (2V_0)^{1\backslash 2} \times l \times L$

13. **What is atomic number?**

The number of protons or electrons in an atom is atomic number.

14. **What is the relation for the maximum number of electrons in each shell?**

Ans: $2n^2$

15. **What are valence electrons?**

Electron in the outermost shell of an atom is called valence electron.

16. **What is forbidden energy gap?**

The space between the valence and conduction band is said to be forbidden energy gap.

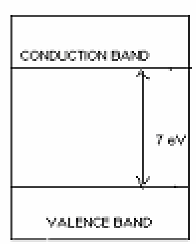
17. **What are conductors? Give examples?**

` Conductors are materials in which the valence and conduction band overlap each other so there is a swift movement of electrons which leads to conduction. Ex. Copper, silver.

18. **What are insulators? Give examples?**

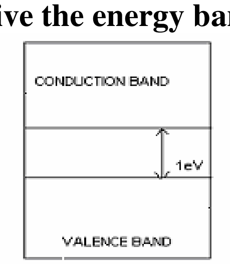
Insulators are materials in which the valence and conduction band are far away from each other. So no movement of free electrons and thus no conduction.
Ex glass, plastic.

19. **Give the energy band structure of Insulator.**



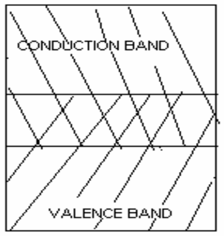
In Insulators there is a wide forbidden energy gap. So movement of valence electron from valence to conduction band is not possible.

20. **Give the energy band structure of Semi conductor.**



In Semiconductors there is a small forbidden energy gap. So movement of valence electron from valence to conduction band is possible if the valence electrons are supplied with some energy.

22. Give the energy band structure of conductor.



In conductors there is no forbidden energy gap, valence band and conduction and over lap each other. so there is a heavy movement of valence electrons.

23. what are Semiconductors? Give examples?

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

24. What are the types of Semiconductor?

1. Intrinsic semiconductor 2. Extrinsic semiconductor.

25. What is Intrinsic Semiconductor?

Pure form of semiconductors are said to be intrinsic semiconductor.
Ex: germanium, silicon.

26. Give the expression for concentration of electrons.

$n = N_c e^{-(E_c - E_F)/KT}$ Where $N_c = 2(2\pi m_n kT \backslash h^2)^{3/2} (1.60 \times 10^{-19})^{3/2}$

27. Give the expression for concentration of Holes.

$p = N_v e^{-(E_F - E_v)/KT}$ Where $N_v = 2(2\pi m_p kT \backslash h^2)^{3/2} (1.60 \times 10^{-19})^{3/2}$

28. Give the expression for intrinsic concentration

Intrinsic concentration $n_i^2 = A_0 T^3 e^{-EG0/kT}$

29 . Give the expression for Fermi Dirac probability function?

$f(E) = 1 \backslash 1 + e^{(E - E_F)/KT}$

30. Define Mass – action law.

Under thermal equilibrium the product of free electron concentration (n) and hole concentration (p) is constant regardless of the individual magnitude.

$$n.p = n_i^2$$

CHAPTER 2 - Extrinsic Semiconductor and PN junction

31. What is Extrinsic Semiconductor?

If certain amount of impurity atom is added to intrinsic semiconductor the resulting semiconductor is Extrinsic or impure Semiconductor.

32. What are the types of Extrinsic Semiconductor?

1. P-type Semiconductor 2. N- Type Semiconductor.

33. What is P-type Semiconductor?

The Semiconductor which are obtained by introducing pentavalent impurity atom (phosphorous, antimony) are known as P-type Semiconductor.

34. What is N-type Semiconductor?

The Semiconductor which is obtained by introducing trivalent impurity atom (gallium, indium) are known as N-type Semiconductor.

35. What is doping?

Process of adding impurity to a intrinsic semiconductor atom is doping. The impurity is called dopant.

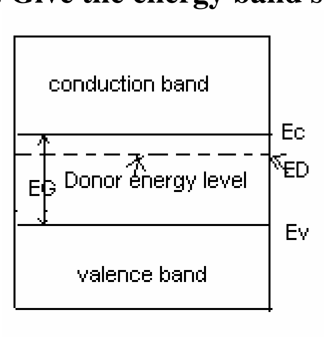
36. Which charge carriers is majority and minority carrier in N-type Semiconductor?

majority carrier: electron and   minority carrier: holes.

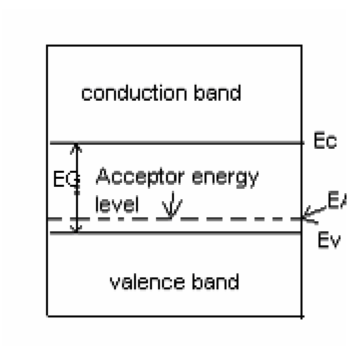
37. .which charge carriers is majority and minority carrier in P-type Semiconductor?

Majority carrier: holes and minority carrier: electron

38. Give the energy band structure of n- type semiconductor.



39. Give the energy band structure of P- type semiconductor.



40. Why n - type or penta valent impurities are called as Donor impurities?

n- type impurities will donate the excess negative charge carriers (Electrons) and therefore they are reffered to as donor impurities.

41. Why P – type or trivalent impurities are called as acceptor impurity?

p- type impurities make available positive carriers because they create holes which can accept electron, so these impurities are said to be as acceptor impurity.

42. Give the law of electrical neutrality?

Law of electrical neutrality states Since the semiconductor is always electrically neutral, The magnitude of positive charge density must equal that of the negative charge density.

$$N_D + p = N_A + n$$

43. Give the relation for concentration of holes in the n- type material?

$$p_n = n_i^2 / N_D$$

Where

p_n - concentration of holes in the n – type semiconductor

N_D - concentration of donor atoms in the n – type semiconductor

44. Give the relation for concentration of electrons in the p - type material?

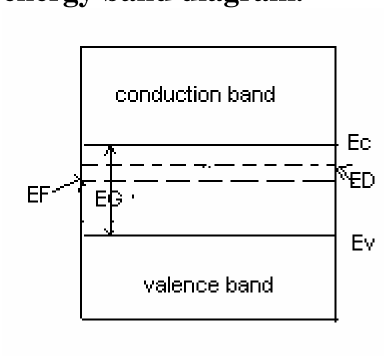
$$n_p = n_i^2 / N_A$$

Where

n_p - concentration of electrons in p- type semiconductor

N_D - concentration of acceptor atoms in the p – type semiconductor

45. Show the position of the Fermi level in the case of n – type semiconductor using energy band diagram.



46. Give the expression for the Fermi level energy in n – type semiconductor.

$E_F = E_C – kT \ln N_C / N_D$

Where,

E_F - Fermi level energy

E_C – Conduction band energy

K – Boltzmann constant

T – Temperature

N_C – dimension of concentration in n - type

N_D - concentration of donor atoms

47. Give the expression for the Fermi level energy in n – type semiconductor.

$E_F = E_V – kT \ln N_V / N_A$

Where,

E_F - Fermi level energy

E_V – valence band energy

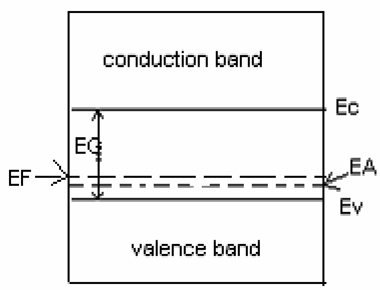
K – Boltzmann constant

T – Temperature

N_V - dimension of concentration in p - type

N_A - concentration of acceptor atoms

48. Show the position of the Fermi level in the case of n – type semiconductor using energy band diagram.



49. What is mobility? What is its unit?

Mobility of the charge carrier is defines as the average drift velocity per unit electricfield. Its unit is meters per volt – seconds.

$$\mu = v / E$$

Where μ – mobility v – Drift velocity E – applied electric field

50. Define Conductivity.

Conductivity is defined as the current density per unit applied electric field.
Its unit is mho per meter

$$\sigma = J / E$$

Where σ – Conductivity J- Current density E - applied electric field

51. Give the relationship between mobility and conductivity .

$$\sigma = q\, n\, \mu$$

Where σ – Conductivity q- charge of electron n- concentration of electron
μ – Mobility

52. 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.

53. Give the expression for drift current density due to electron.

$$J_n = q\, n\, \mu_n E$$

Where,

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

54. Give the expression for drift current density due to holes.

$$J_p = q\, p\, \mu_p E$$

Where, J_n - drift current density due to holes q - Charge of holes
μ_p - Mobility of holes E - applied electric field

55. 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 tend to move from region of higher concentration to the region of lower concentration. This process in called diffusion and the current produced due this movement is diffusion current.

56. Give the expression for diffusion current density due to electron.

$$J_n = q\ D_n\ dn / dx$$

Where

J_n - diffusion current density due to electron

q - Charge of an electron

D_n – diffusion constant for electron

dn / dx – concentration gradient

57. **Give the expression for diffusion current density due to holes.**

$$J_p = - q\ D_p\ dp / dx$$

Where

J_p - diffusion current density due to holes

q - Charge of a hole

D_p – diffusion constant for hole

dn / dx – concentration gradient

58. Define mean life time of a hole or and electron.

The electron hole pair created due to thermal agitation woll disappear as a result of recombination. Thus an average time for which a hole or an electron exist before recombination can be said as the mean life time of a hole or electron.

59. What is the other name of continuity equation? What does it indicate?

The other name of continuity equation is equation of conservation of charge.

This equation indicates that the rate at which holes are generated thermally just equals the rate at which holes are lost because of recombination under equilibrium conditions.

60. Give the expression for continuity equation?

$$dp / dt = - (p-p_0)/\tau_p + D_p\ d^2p / dx^2 - \mu_p\ d(pE) / dx$$

Where

D_p – diffusion constant for hole

μ_p – mobility of holes

61. Define Hall effect?

If a metal or semiconductor carrying current I is placed in a transverse magnetic field B , an electric field E is induced in the direction perpendicular to both I and B , This phenomenon is known as Hall effect.

62. Give the expression for Hall voltage.

$$V_H = BI / \rho\ w$$

Where

V_H – Hall voltage

w – width of the semiconductor

B - transverse magnetic field

I – Current across the specimen

63. Give the expression for Hall coefficient.

$$R_H = 1/ \rho = V_H\ w/ BI$$

Where

R_H - Hall coefficient
V_H – Hall voltage
w – width of the semiconductor
B - transverse magnetic field
I – Current across the specimen

64. Give the expression for mobility in terms of Hall coefficient.

$$\mu = \sigma R_H$$

Where

R_H - Hall coefficient
μ – mobility
σ – conductivity

65. Give some application of Hall Effect.

i. hall effect can be used to measure the strength of a magnetic field in terms of electrical voltage.
ii. it is used to determine whether the semiconductor is p – type or n- type material
iii. it is used to determine the carrier concentration
iv. it is used to determine the mobility.

66. 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.

67. Give the other names of depletion region?

i. space charge region
ii. Transition region

68. 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.

69. What is meant by biasing a PN junction?

Connecting a PN junction to an external voltage source is biasing a PN junction.

70. What are the types of biasing a PN junction?

1. Forward bias 2. Reverse bias.

71. What is forward bias and reverse bias in a PN junction?

When positive terminal of the external supply is connected to P region and negative terminal to N region ,the PN junction is said to be forward biased. under forward biased condition the PN region offers a very low resistance and a large amount of current flows through it.

72. What is reverse bias in a PN junction?

When positive terminal of the external supply is connected to N type and negative terminal to P type then the PN junction is said to be in reverse bias. Under reverse biased condition the PN region offers a very high resistance and a small amount of current flows through it.

73. 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.

74. Why a contact difference of potential exist in PN junction?

when a pn junction is formed by placing a p-type and n-type material in intimate contact, the Fermi level throughout the newly formed specimen is not constant at equilibrium. There will be transfer of electron and energy until Fermi levels in the two side did line up. But the valence and conduction band in pside cannot be at the at the same level as in n side .this shift in energy level results in contact difference of potential .

75. Give the expression of contact difference of potential?

$$E_0 = kT \ln N_D N_A / n_i^2$$

Where

E_0 - contact difference of potential
K – Boltzmann constant
T – Temperature
N_D - concentration of donor atoms
N_A - concentration of acceptor atoms
n_i – intrinsic concentration

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

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

$$I = I_{pn}(0) + I_{np}(0)$$

Where,

I – Total current
$I_{pn}(0)$ - hole current entering the n material
$I_{np}(0)$ - electron current entering the p material.

77. What is the diffusion length for holes (L_p)?

Diffusion length of holes can be said as the mean distance of travel of hole before recombination.

$$L_p = (D_p \tau_p)^{1/2}$$

78. State the law of junction relating the boundary value of injected minority carrier concentration with applied voltage?

The law of junction gives the density of minority carriers injected into a material across the junction. In a pn junction diode, concentration of holes injected in to the n region is given by

$$P_n(0) = p_{no}\, e^{v/v_T}$$

79. Give the diode current equation?

$$I = I_0 . (e^{V / ή.V_T} -1)$$

Where

I –total diode current

I_0. - reverse saturation current

V – Applied voltage

ή – Constant which is 1 for Germanium and 2 for Silicon

V_T - voltage equivalent of temperature (V_T = T/11600)

Chapter 3 - Switching characteristics of PN junction and Special diodes

80. What is the static resistance of a diode?

Static resistance R of a diode can be defined as the ratio of voltage V across the diode to the current flowing through the diode.

$$R = V/ I$$

Where

R - Static resistance of a diode

V - Voltage across the diode

I - current across the diode

81. Define dynamic resistance.

Dynamic resistance of a diode can be defined as the ratio of change in voltage across the diode to the change in current through the diode.

$$r = \Delta V / \Delta I$$

Where

r - Dynamic resistance of a diode

Δ V - change in voltage across the diode

Δ I - change in current through the diode

82. Define dynamic conductance.

Dynamic conductance of a diode can be defined as the ratio of change in the change in current through the diode to the voltage across the diode. This can also be defined as the inverse of Dynamic resistance.

$$g = \Delta I / \Delta V = I + I_0 / ή\, v_T$$

Where

g - Dynamic conductance of a diode

Δ V - change in voltage across the diode

Δ I - change in current through the diode

v_T – threshold voltage

83. Define the term transition capacitance?

When a PN junction is reverse biased, the depletion layer acts like a dielectric material while P and N –type regions on either side which has low resistance act as the plates. In this way a reverse biased PN junction may be regarded as parallel plate capacitor and thus the capacitance across this set up is called as the transition capacitance.

$$C_T = \varepsilon A / W$$

Where

C_T - transition capacitance

ε - Permittivity of material
A - Cross section area of the junction
W – Width of the depletion region

84. Define Alloy junction.

A junction formed experimentally in which there is an abrupt change from acceptor ions on one side to donor ions on the other side is called as an alloy or fusion junction.

85. Define Grown junction.

A junction obtained by drawing a single crystal from a melt of germanium whose type is changed during the drawing process by adding first P-type and then n –type impurity is called as grown junction.

86. Give the Poisson's equation relating the potential and the charge density?

$$d^2V / dx^2 = e N_A / \varepsilon$$

Where

V – Potential
e - Charge of the electron
N_A – acceptor ion concentration
ε - Permittivity of material

87. What is a varactor diode?

A diode which is based on the voltage variable capacitance of the reverse biased p-n junction is said to be varactor diode. It has other names such as varicaps, voltacaps.

88. Define the term diffusion capacitance.

The diffusion capacitance of a forward biased diode is defined as the rate of change of injected charge with voltage.

$$C_D = \tau I / ή V_T$$

Where

τ – time constant
I – current across the diode
v_T – threshold voltage

89. Give the expression for charge control description of a diode.

Charge control description of a diode can be given by

$$I = Q / \tau_p$$

Where

I – current across the diode
Q – stored charge
τ_p - $L^2{}_p / D_p$ – life time for holes

90. 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" called as recovery time. The recovery time can be divided in to two types such as

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

91. What is meant by forward recovery time?

The forward recovery time may be defined as the time interval from the instant of 10% diode voltage to the instant this voltage reaches 90% of the final value. It is represented as t_{fr}.

92. What is meant by reverse recovery time?

The reverse recovery time can be defined as the time required for injected or the excess minority carrier density reduced to zero , when external voltage is suddenly reversed.

93. Define storage time.

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

94. Define transition time.

The time when the diode has normally recovered and the diode reverse current reaches reverse saturaton current I_0 is called as transition time. It is represented as t_t

95. What are break down diodes?

Diodes which are designed with adequate power dissipation capabilities to operate in the break down region are called as break down or zener diodes.

96. What is break down? What are its types?

When the reverse voltage across the pn junction is increased rapidly at a voltage the junction breaks down leading to a current flow across the device. This phenomenon is called as break down and the voltage is break down voltage. The types of break down are

i) zener break down

ii)Avalanche breakdown

97. What is zener breakdown?

Zener break down takes place when both sides of the junction are very heavily doped and Consequently the depletion layer is thin and consequently the depletion layer is tin. 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 break down.

98. What is avalanche break down?

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 get multiplied. This process is termed

as avalanche multiplication. Thus the break down which occur in the junction resulting in heavy flow
of current is termed as avalanche break down.

99. How does the avalanche breakdown voltage vary with temperature?

In lightly doped diode an increase in temperature increases the probability of collision of electrons
and thus increases the depletion width. Thus the electrons and holes needs a high voltage to cross
the junction. Thus the avalanche voltage is increased with increased temperature.

100. How does the zener breakdown voltage vary with temperature?

In heavily doped diodes, an increase in temperature increases the energies of valence electrons, and hence makes it easier for these electrons to escape from covalent bonds. Thus less voltage is sufficient to knock or pull these electrons from their position in the crystal and convert them in to conduction electrons. Thus zener break down voltage decreases with temperature.

101. What is a tunnel diode?

The tunnel diode is a pn junction diode in which the impurity concentration is greatly increased about 1000 times higher than a conventional PN junction diode thus yielding a very thin depletion layer. This diode utilizes a phenomenon called tunneling and hence the diode is referred as tunnel diode.

102. 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.

103. what is backward diode?

The backward diode is a diode in which the doping level is moderate. The forward current in this case is very small, very much similar to that of the reverse current in the conventional diode.

104. what is a photo diode?

The photo diode is a diode in which the current sensitivity to radiation can be made much larger by the use of the reverse biased PN junction. Thus this diode conducts heavily in the reverse bias when there is some radiaton allowed to fall on the PN junction.

105. what is a LED?

A PN junction diode which emits light when forward biased is known as Light emitting diode (LED).

CHAPTER 4 – TRANSISTOR CHARACTERISTICS AND FET DEVICES

106) What is a metal semiconductor 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.

107) What are the two types of metal semiconductor contact?

1. Ohmic type – it is the type of contact designed when lead to be attached to a semiconductor

2. Rectifying type – rectifying type results in a metal semiconductor diode.

108) Define work function.

Work function is defined as the energy difference between the Fermi level and the vacuum level in the energy band of the metal or a semiconductor.

109) Define electron affinity.

Electron affinity can be defined as the energy difference between the conduction band edge and the vacuum level in the semiconductors.

110) 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.

111) What is a schottky diode?

A special type of diode which is manufactured for high frequency (> 10 MHZ) rectifying action and for fast switching is called as schottky diode. It is formed by connecting a metal and a semiconductor along with the ohmic contacts.

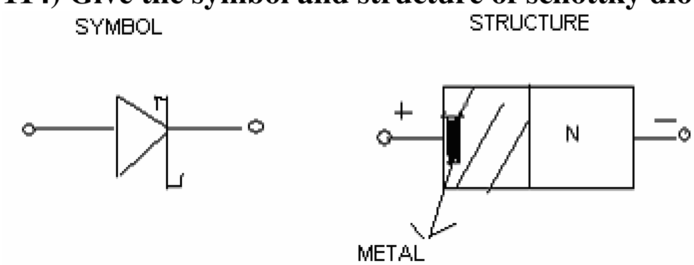
112) What are the other names of schottky diode?

1. Rectifying metal semiconductor diode
2. Surface barrier diodes.
3. Hot carrier diodes

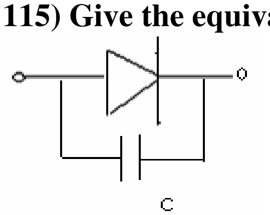
113) What are hot carriers?

The injected carrier from the semiconductor to the metal is termed as hot carriers. They are so called because they possess high kinetic energy.

114) Give the symbol and structure of schottky diode.



115) Give the equivalent circuit of schottky diode.



116) Give the applications of schottky diode.

1. It can switch off faster than bipolar diodes
2. It is used to rectify very high frequency signals (>10 MHZ)
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.

117) Compare between schottky diode and conventional diode.

PN junction diode	Schottky diode
1. Here the contact is established between	1. Here the contact is established between

two semiconductors	the semiconductor and metal
2. current conduction is due to both majority and minority carriers	2. current conduction is only due to majority carriers
3. large reverse recovery time	3. Small reverse recovery time
4. barrier potential is high about 0.7 V	4. Barrier potential is low about 0.25 V
5. switching speed is less	5. switching speed is high
6. cannot operate at high frequency	6. can operate at very high frequency (> 300MHz)

118) What is a Ohmic contact?

An ohmic contact is a low resistance junction providing conduction in both direction between metal and the semiconductor.Ohmic contact acts as contact between any semiconductor device and outside world.

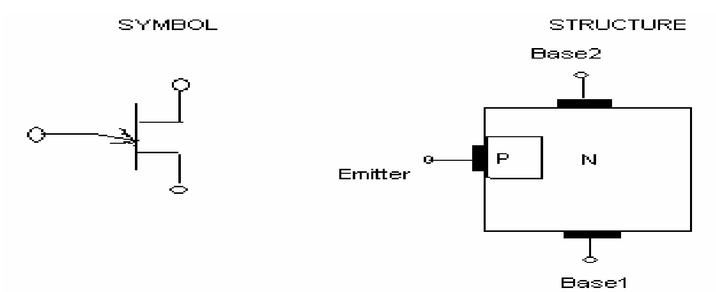
119) Give the types of ohmic contact.

1. Non rectifying barrier
2. Tunneling barrier

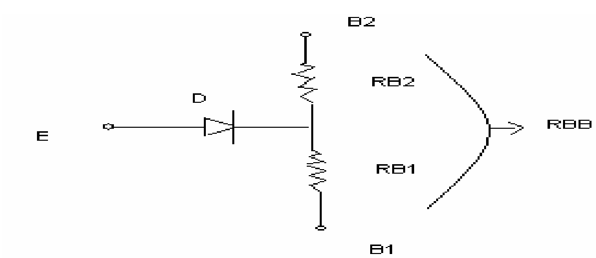
120)What does UJT stands for? Justify the name UJT.

UJT stands for unijunction transistor. The UJT is a three terminal semiconductor device having two doped regions. It has one emitter terminal (E) and two base terminals ($B_1$and B_2). It has only one junction, moreover from the out look, it resembles to a transistor hence the name unijunction transistor.

121) Give the symbol and structure of UJT.



122) Give the equivalent circuit of UJT.



123) 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},

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

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

124) What is interbase resistance of UJT?
The resistance between the two bases (B_1 and B_2) of UJT is called as interbase resistance.
Interbase resistance = $R_{B1} + R_{B2}$
R_{B1}- resistance of silicon bar between B_1 and emitter junction.
R_{B2} - resistance of silicon bar between B_2 and emitter junction

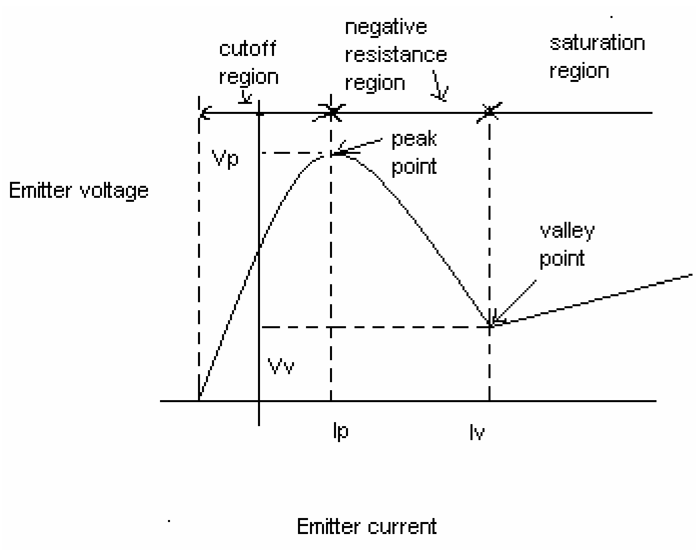
125) Give the expression for peak point voltage for UJT?

$V_P = \acute{\eta} \cdot V_{BB} + V_D$

Where

V_P - peak point voltage
$\acute{\eta}$ - intrinsic stand -off ratio
V_{BB} - voltage applied between the bases
V_D – barrier potential of UJT

126) Give the VI characteristics of UJT.



127) What are the regions in the VI characteristics of UJT?
1. Cut-off region
2. Negative resistance region.
3. Saturation region

128) What is meant by negative resistance region of UJT?
In a UJT when the emitter voltage reaches the peak point voltage, emitter current starts flowing. After the peak point any effort to increase in emitter voltage further leads to sudden increase in the emitter current with corresponding decrease in emitter voltage, exhibiting negative resistance. This takes place until the valley point is reached. This region between the peak point and valley point is called negative resistance region.

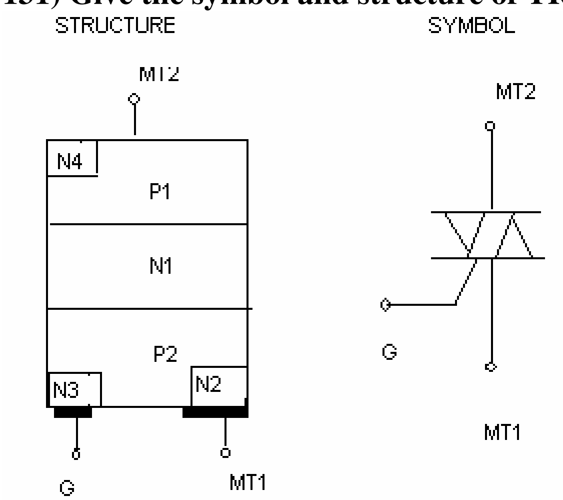
129) Mention the applications of UJT.

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 saw tooth generator.
6. It is used for pulse generation.

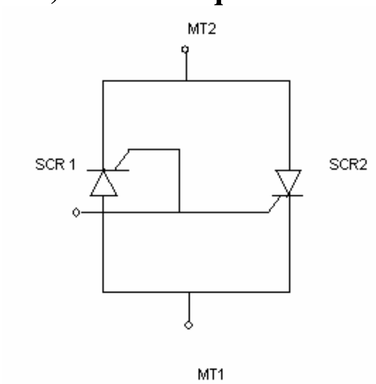
CHAPTER 5 – METAL SEMICONDUCTOR CONTACTS AND POWER CONTROL DEVICES

130) What is a 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 antiparallel.

131) Give the symbol and structure of TRIAC.



132) Give the equivalent circuit of TRIAC.



133) Give the application of TRIAC.
1. Heater control
2. Motor speed control

3. Phase control
4. Static switches

134) What are the different operating modes of TRIAC?

1. Keeping MT2 and G positive
2. Keeping MT2 and G negative.
3. Keeping MT2 positive and G negative.
4. Keeping MT2 negative and G positive.

135) Give the VI characteristics of TRIAC.

136) What is a DIAC?

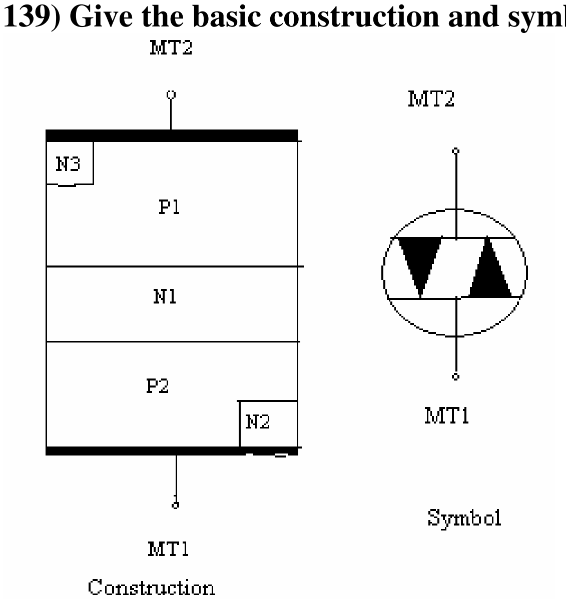
DIAC is a two terminal bidirectional semiconductor switching device. . It can conduct in either direction depending upon the polarity of the voltage applied across its main terminals. In operation DIAC is equivalent to two 4 layer diodes connected in antiparallel.

137) Give some applications of DIAC.

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

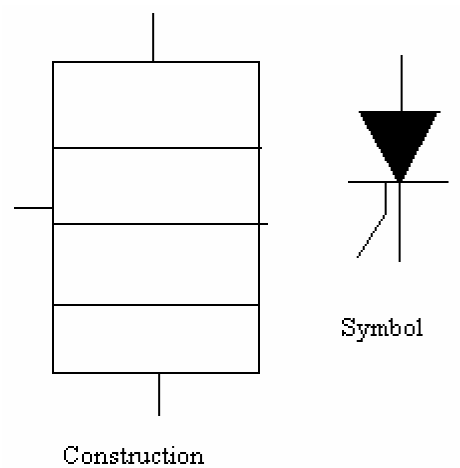
138) Give the VI characteristics of DIAC.

139) Give the basic construction and symbol of DIAC.



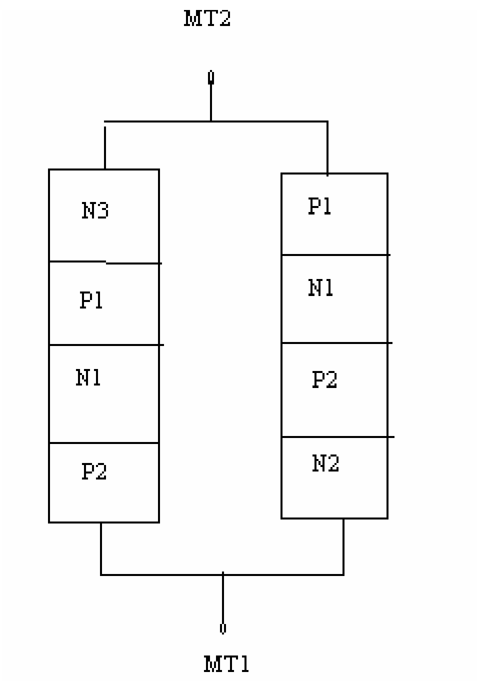
140) What is a SCR?
A silicon controller rectifier (SCR) is a three terminal, three junction semiconductor device that acts as a true electronic switch. It is a unidirectional device. It converts alternating current into direct current and controls the amount of power fed to the load.
141) Define break over voltage of SCR.
Break over voltage is defined as the minimum forward voltage with gate open at which the SCR starts conducting heavily.
142)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.

143) Give the construction and symbol of SCR.



144) How turning on of SCR is done?
1. By increasing the voltage across SCR above forward break over 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.
145) 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

146) Give the equivalent circuit of DIAC.



Equivalent circuit

147) Define holding current in a SCR.
Holding current is defined as the minimum value of anode current to keep the SCR ON.
148) 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.

149) 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.
150) What is meant by latching.
The ability of SCR to remain conducting even when the gate signal is removed is called as latching.

151) Define forward current rating of a SCR.
Forward current rating of a SCR is the maximum anode current that it can handle without destruction.
152) List the important ratings of SCR.
1. Forward break over voltage

2. Holding current
3. Gate trigger current
4. Average forward current
5. Reverse break down voltage.

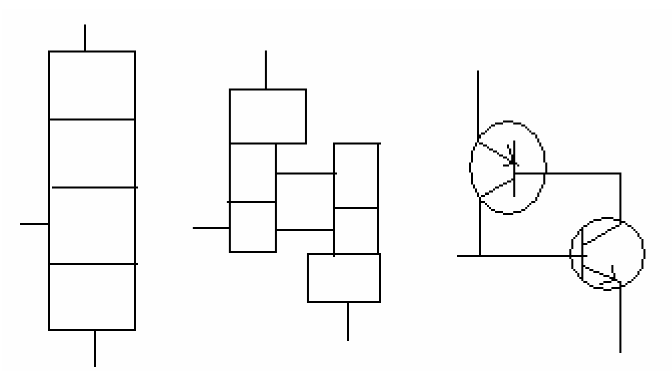
153) Compare SCR with TRIAC.

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

154) 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

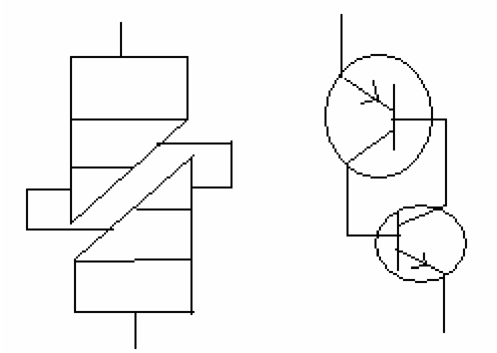
155) Give the two transistor model of SCR.



156) What is Shockley diode (PNPN diode)?

Shockley diode is a four layered PNPN silicon diode. It is a low- current SCR without a gate. This device is switched ON when the anode to cathode voltage is increased to forward switching voltageV_S which is equivalent to SCR forward break over voltage.

157) Give the two transistor model of PNPN diode.



158) What is a thyristor?
Thyristor is a semiconductor device having three or more junctions .Such a device acts as a switch without any bias and can be fabricated to have voltage ratings of severalhundred volts and current ratings from a few amperes to almost thousand amperes.

159) What are the types of thyristors?
1. Unidirectional thyristors
2. Bidirectional thyristors
3. Low-power thyristors

160) Give the various triggering devices for thyristors.
1. SCR
2. UJT
3. DIAC
4. TRIAC

<u>16 mark Questions</u>

<u>PART B</u>

1. Explain the Force on a particle and motion of a particle in electric field.
Maximum mark for this question: 10 marks

a. Force on a particle in electric field – (4marks)
   Initial explanations (2 marks)
   Final expression: F = e x E (2 marks)

b. Motion of a particle in electric field - (6marks)
   Initial explanations with diagram (2 marks)
   Expression for acceleration, velocity, displacement (4marks)

2. Explain the Force on a particle and motion of a particle in magnetic field.
Maximum mark for this question: 12 marks

a. Force on a particle in magnetic field– (4marks)

Initial explanations with diagram (2 marks)
i.e. F_m = B I L Newton
Final expression: F_m = B e V (2 marks)

b. Motion of a particle in magnetic field - (8marks)
Initial explanations with diagram (2 marks)
Each case of the electron movement with the field to be explained (6marks)
Case (i) : electron at rest
Case (ii) : electron moving parallel to the field
Case (iii): electron moving perpendicular to the field
Case (ii): electron making an angle with the field.
`

3. Explain Cyclotron and derive the expression for its frequency.
Maximum mark for this question: 8 marks
Definition (2 marks)
Explanations with diagram (2 marks)
Derivation of frequency of Cyclotron (4 marks)
f = 1/T = e x B / 2 x π x m Hz

4. Obtain the relation for Electrostatic deflection sensitivity.
Maximum mark for this question: 10 marks
Definition (2 marks)
Diagram (2 marks)
Explanation of all the notations used in the diagram (1mark)
Explanation of the concept involved is also necessary
Derivation of Deflection Sensitivity (5 marks)
S_E = l x D \ 2 x S x V_a

5. Obtain the relation for Magnetic deflection sensitivity
Maximum mark for this question: 10 marks
Definition (2 marks)
Diagram (2 marks)
Explanation of all the notations used in the diagram (1mark)
Explanation of the concept involved is also necessary
Derivation of Deflection Sensitivity (5 marks)
$S_M = (e / m)^{1\backslash 2}$ x 1\ $(2V_0)^{1\backslash 2}$ x l x L

6. Derive for the carrier concentrations in an intrinsic semiconductor.
Maximum mark for this question: 16 marks
a. concentration of electrons (n) - (6 marks)
b. concentration of Holes (p) - (6 marks)
c. intrinsic concentration (n_i) – (4 marks)

7. Explain N-type and P-type semiconductor with their energy band diagram?
Maximum mark for this question: 8 marks
Definition of extrinsic semiconductor and its types (2 marks)

N-type semiconductor (3marks)
Definition
Diagram of crystalline structure and energy band (2 marks)
P-type semiconductor (3marks)
Definition
Diagram of crystalline structure and energy band (2 marks)

8. Explain the position of Fermi level in extrinsic semiconductor using the energy band diagram and obtain relation for the same.

Maximum mark for this question: 8 marks

Initial explanation (2 marks)
Derivation for position of Fermi level in n-type (3marks)
Diagram, concept explanation , derivation required
Derivation for position of Fermi level in p-type (3marks)
Diagram, concept explanation , derivation required

9. Explain the following

a. Mobility b. Drift current c. Conductivity d. Diffusion current

Maximum mark for this question: 12 marks

a. mobility - definition and relation required (2 marks)
b. Drift current – definition, diagrams and derivation of relation required (4marks)
c. Conductivity - definition and relation required (2 marks)
d. Diffusion current - definition, diagrams and derivation of relation required (4marks)

10. What is Hall effect? Derive the relation for hall coefficient?

Maximum mark for this question: 8 marks

Definition (2 marks)
Diagram and explanation (2marks)
Derivation of hall coefficient (4marks)

11. Derive the continuity equation and explain how it varies with concentration.

Maximum mark for this question: 16 marks
Initial explanation (2 marks)
Diagram (2 marks)
Derivation of continuity equation (6marks)
Concentration independent of distance and with zero electric field(2 marks)
Concentration independent of time and with zero electric field(2 marks)
Concentration varying sinusoidally with time and with zero electric field(2 marks)

12. Define the term transition capacitance and derive the relation for the same.

Maximum mark for this question:12 marks

Definition (2 marks)
transition capacitance in Alloy junction (6marks)
Explanation of alloy junction formation
Diagram of charge density and potential variation
Derivation of transition capacitance
transition capacitance in grown junction (4 marks)
Explanation of grown junction formation

Diagram of charge density
Derivation of transition capacitance

13. Define dynamic conductance and derive the relation for the same.
Maximum mark for this question: 8 marks
Definition (2 marks)
Explanation of concept involved (2marks)
Derivation of transition capacitance (4marks)

14. Explain the charge control description of a diode.
Maximum mark for this question: 6 marks
Explanation of concept involved (2marks)
Derivation of relation involved (4 marks)

15. Explain the switching characteristics of a diode.
Maximum mark for this question: 12 marks
Definition of recovery time (2 marks)
Forward recovery time (2 marks)
Reverse recovery time (2 marks)
Diagram of minority carrier density is necessary to explain the both recovery times
Storage and transition time (6marks)
Explanation of the concept with the wavefoms in a diode is necessary
Definition of both Storage and transition time is also necessary.

16. What is break down in diode? What are its types?
Maximum mark for this question: 6 marks
Definition of break down and explanation (2 marks)
Zener break down (2 marks)
Avalanche break down (2 marks).

17. Explain the energy band structure of the metal semiconductor contact and also explain about the rectifying metal semiconductor diode.
Maximum mark for this question: 16 marks
Energy band structure of the metal semiconductor contact (8marks)
Initial introduction (2marks)
Diagram of energy band (4marks)
Explanation (2marks)
Rectifying metal semiconductor diode (8marks)
Construction (2marks)
Operation (2marks)
Volt-ampere characteristics (2marks)
Application (2marks)

18. Explain about the Ohmic contact type of metal semiconductor contact.
Maximum mark for this question: 8 marks

Construction (2marks)
Diagram of energy band (4marks)
Explanation (2marks)

19. Explain the construction, operation, volt ampere characteristics, and application of SCR, also explain its two transistor model.
Maximum mark for this question: 16 marks
Construction (2marks)
Equivalent circuit and two transistor model (2marks)
Operation (4marks)
Volt ampere characteristics (4marks)
Application (2marks)

20. Explain the construction, operation, equivalent circuit, volt ampere characteristics, and application of UJT.
Maximum mark for this question: 16 marks
Construction (4marks)
Equivalent circuit (2marks)
Operation (4marks)
Volt ampere characteristics (4marks)
Application (2marks)

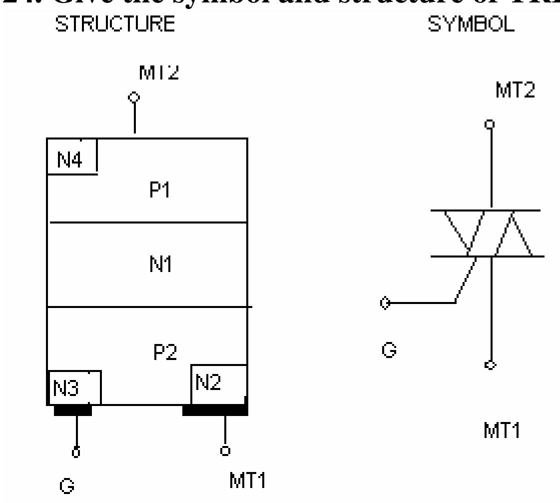
21. Explain the construction, operation, equivalent circuit, volt ampere characteristics, and application of DIAC.
Maximum mark for this question: 16 marks
Construction (4marks)
Equivalent circuit (2marks)
Operation (4marks)
Volt ampere characteristics (4marks)
Application (2marks)

22. Explain the construction, operation, equivalent circuit, volt ampere characteristics, and application of TRIAC
Maximum mark for this question: 16 marks
Construction (4marks)
Equivalent circuit (2marks)
Operation (4marks)
Volt ampere characteristics (4marks)
Application (2marks)

23. Explain the construction, operation, equivalent circuit, volt ampere characteristics, and application of Shockly diode (PNPN diode).
Maximum mark for this question: 16 marks
Construction (4marks)

Equivalent circuit (2marks)
Operation (4marks)
Volt ampere characteristics (4marks)
Application (2marks)

24. Give the symbol and structure of TRIAC.



25. Give the two transistor model of SCR.