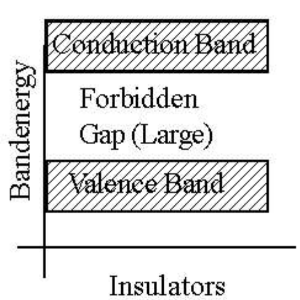
SEMI CONDUCTOR DEVICES

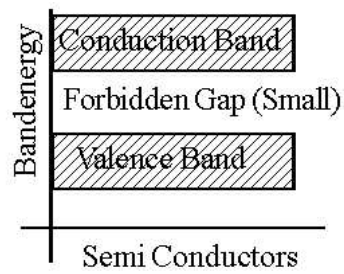
SYNOPSIS :

I. Energy Bands

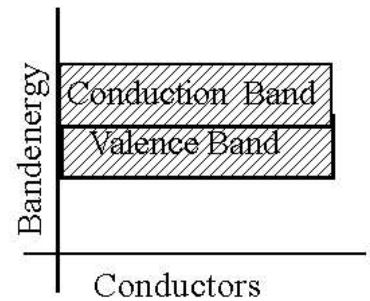
- Formation of bands in solids is due to the electric field infuence of the nieghbouring atoms.
- Bands can be mainly observed in solids. To certain extent in liquids and in high dense gases.
- Formation of band takes place only if the distance between the atoms is less than a particular value called typical interatomic distance.
- **Valence band :** The energy band indicating the different energy states of a valence electron is called valence band.
- **Conduction band :** The energy band indicating different energy levels possessed by a free electron which can be used for conduction is called conduction band.
- Energy of an electron in conduction band is greater than that in valence band.
- Energy gap between valence band and conduction band is called forbidden energy gap.
- A solid consists of atoms, ions or molecules packed together closely and their proximity (nearness) is responsible for characteristic properties of this state of matter.
  Solid state physics is that branch of physics which deals with the nature and properties of matter present in solid state.
- Solids can be classified into two categories
  a) Crystalline solids b) Amorphous solids
- In crystalline solids atoms are packed very closely and they have periodicity.
- Crystalline solids have particlular geometric shape.
- In amorphous solids atoms are packed irregularly i.e., they have no periodicity.
- Crystalline solids are anisotropic.
- Amorphous solids are isotropic.
- Basing on the forbidden energy gap present in solids, they can be classified into three types. They are
  a) Insulators



b) Semiconductors



c) Conductors



- Materials in which forbidden energy gap is zero are called conductors. Eg: Metals
- Materials in which forbidden energy gap is large i.e., about 5eV are called insulators.
- Materials in which forbidden energy gap is very small i.e., about 1eV are called semiconductors. Ex: Silicon, Germanium
- Conductivity of conductors decreases and that of semi conductors increase with increase in temperature.
- Semi conductors behave as insulators at absolute zero temperature.
- **Intrinsic Semi-Conductor:**
  a) Semi conductors in their purest form are called intrinsic semi conductors.
  b) In this, the number of electrons in conduction band and that of holes in valence band are the same.
  c) "The average energy of electrons in conduction band and that of holes in valence band is called Fermi Energy Level. It is mid way between valance band and conduction band.
  d) Holes (+ve charge) also take part in electrical conduction like free electrons.
  e) The ratio of free electrons to holes is 1 : 1 and even with increase of temperature the ratio remains same i.e., 1 : 1.
- **Extrinsic semi-condcutors:**
  a) "The process of adding impurities to pure Ge

or Si in controlled manner i.e., very small quantites (1 for 10^7) is called doping."

b) When a small quantity of impurity is added to an intrinsic semi conductor we get an extrinsic semi conductor.

c) Extrinsic semi conductors are of two types: (i) n-type and (ii) p-type.

- **n-type Semi conductor.**

a) Since excess of negatively charged electrons are present, it is called n(negative) type.

b) n-type is obtained by introducing (adding) a pentavalent impurity. i.e., a V group element like Phosphorous, Arsenic, Antimony in very small quantities to pure Ge or Si.

c) In this the majority charge carries are electrons.

d) In this the minority charge carries are holes.

e) In n-type the fermi energy levels lies nearer to the conduction band.

f) Since pentavalent impurity atom donates an electron, it is called donor impurity.

- **p-type semi conductor:**

a) Since excess of positively charged holes are present it is called p (positive) type.

b) p-type is obtained by introducing (adding) a trivalent impurity. i.e., a III group element like Aluminium, Indium or Gallium in very small quantities to pure Ge or Si.

c) In this the majority charge carries are holes.

d) In this the minority charge carriers are electrons.

e) In p-type, the fermi energy level lies nearer to the valence band.

f) Since trivalent impurity atom accepts an electron, it is called acceptor impurity.

g) Both p-type and n-type semiconductors are electrically neutral.

- **p-n Junction diode:**

a) In a single Ge or Si crystal by doping one part with trivalent impurity and the other part with pentavalent impurity, a P - N junction is formed.

b) The small region around the junction where holes and electrons neutralise to form a neutral region is called depletion region or depletion layer.

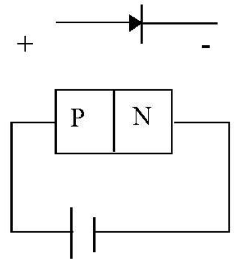
c) The potential difference developed across the depletion layer is called potential barrier. The formation of potential barrier prevents the further diffusion of charge carriers across the junction.

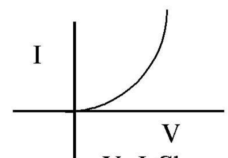
d) The thickness of the depletion layer is in the order of micron (10^{-6}m).

e) Potential barrier is 0.2 to 0.3V in Ge and 0.6 to 0.7V in Si.

f) The value of potential barrier depends on the nature of the crystal, its temperature and the amount of doping.

- **p-n Junction in Forward Bias Position:**





V- I Characteristics

a) "That external source of e.m.f which is responsible for the migration of charge carriers across the junction into opposite regions is called Forward Bias".

b) Connecting the p-type of a p-n junction to the positive and n-type to the negative terminal of a battery is called Forward Bias. In general, when the potential of the p-type is greater than the potential of the n-type by atleast barrier potential, then the diode is in forward bias.

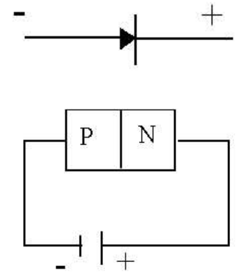
c) The p-n junction conducts in forward bias position in forward direction.

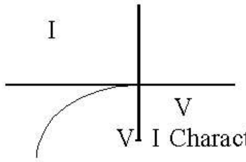
d) The width and the resistance of junction decreases in forward bias or the junction offers low resistance in forward bias position.

e) For an ideal diode resistance in forward bias is zero.

f) If applied voltage exceeds barrier potential, the major current carriers diffuse through the junction and constitue an electric current called diffusion current.

- **p-n Junction in Reverse Bias Position:**





V I Characteristics

a) Connecting the p-type of a p-n junction to the -ve terminal and the n-type to the positive terminal of a battery is called reverse bias arrangement.

In general, when the potential of the p-type is smaller than potential of n-type, then the diode is in reverse bias.

b) The p-n junction does not conduct appreciable current in reverse bias position.

A current of the order of μ A in case of Ge and of the order of nA in case of Si due to minority charge carriers. This current is called reverse saturation current.

c) The width and resistance of the junction increases in this process. It offers high resistance.

d) For an ideal diode, resistance in reverse bias is infinity.

e) If the applied voltage in the reverse bias exceeds knee voltage, the covelant bonds in the diode breaks and thus drifting of charge carriers takes place through the junction, the current thus constituted is called drift current

- **Uses of a Semi conductor diode:**

A semi conductor diode is used as a

(1) Rectifier (2)Detector and also as

(3) An electronic switch

Rectification & Rectifier:

a) The process of conversion of Alternating Current (ac) to Direct Current (dc) is called rectification.

b) For fullwave rectification we need atleast two semicondcutor diodes.

c) The output dc from a full wave rectifier is not smooth and steady, due to a small fraction of ac component (ripple) present in it.

d) The out put dc from a full wave rectifier is made smooth and steady by using a filter circuit.

e) The function of a filter circuit is to eliminate the ripple present in dc output.

f) In half wave rectifier the efficienty is

$\eta = 0.406 \dfrac{R_L}{r_f + R_L}$ It's maximum value is 40.6%.

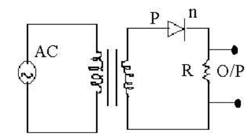
g) In full wave rectifier the effeciency is

$\eta = 0.812 \dfrac{R_L}{r_f + R_L}$. It's maximum value is 81.2%

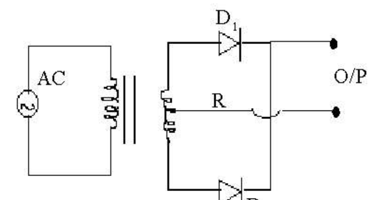
(where $r_f \rightarrow$ forward resistance of diode and $R_L \rightarrow$ load resistance.)

h) In half wave rectifier the ripple frequency is same as that of the input frequency.

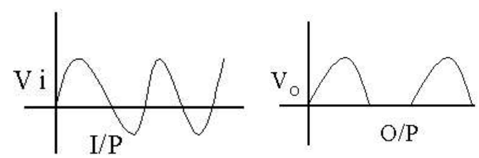
i) In full wave rectifier the ripple frequency is double that of the input frequency.



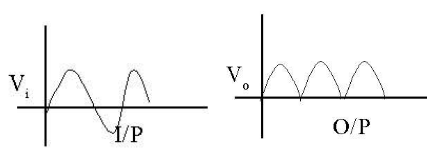
Half Wave Rectifier



Full Wave Rectifier



Half wave rectifier



Full wave rectifier

- a) **Avalanche Break Down and Zener Break Down:**

At high reverse bias voltage, a p-n junction gives an unexpected rise of current, as a result of which the device becomes heated and finally damaged. This is due to

1. Avalanche Break Down: At high reverse bias voltages, the minority charge carriers acquire high velocity and diffuse across the depletion layer, breaking down the covalent linkages between different atoms. The free electrons liberated further are responsible for breakage of other covalent bonds. Thus there is an unexpected rise (multiplication) of electrons and hence current. This high current produces heat and the device is damaged. It takes place in a lightly doped diode.

2. Zener Break Down: At high reverse bias voltages, there is the direct breakage of covalent bonds due to very strong electric field which gives rise to unexpected increase in electron number, current value and hence heat energy. It take place in a heavily doped diode.

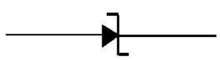
- b). **Zener Diode**: A zener diode is a reverse biased heavily doped silicon (or gemanium) p-n junction diode, which is operated in the break down region. The symbol of a zener diode is shown in figure.

  i) Zener diodes are used for voltage regulation.

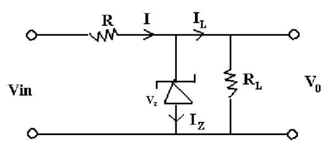
  ii) Zener diode is used as a voltage regulator.

It's circuit diagram is

1) $I = I_Z + I_L$
2) $Vin = IR + V_Z$
3) $V_0 = V_Z = I_L \times R_L$



Zenor Diode



- **TRANSISTORS:**

a) Transistors are current operated solid-state devices.

b) Silicon is the element from which most of the transistors and other semiconductor components are made today.

c) Transistor was invented by John Bardeen, William Shockley and Brattain.

d) Transistor is a three layer semicondcutor device and it is equivalent to a triode valve.

e) Transistor has two p-n junction diodes.

f) In a transistor either a p-type or an n-type semiconductor is sandwiched between a pair of opposite type of semi condcutor layers and two p-n junctions are formed.

g) Transistor has three regions known as the emitter (E), base (B) and collector (C).

h) Emitter is heavily doped.

i) Base of a transistor is lightly doped.

j) Collector of a transistor is moderately doped.

k) Among the three portions of a transistor maximum thickness is for collector and minimum for base.

l) Transistor has two junctions

  i) emitter-base junction

  ii) Collector-base junction.

m) In a transistor the emitter base junction is forward biased and the collector base junction is reverse biased.

n) The main function of transistor is amplification of a small ac signal.

o) Transistor can be used in different configurations

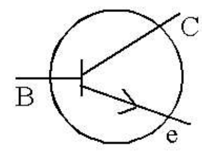
1) CB configuration 2) CE configuration.

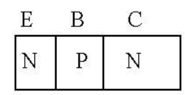
3) CC configuration.

p) Most commonly used transistor configuration is CE.

q) Transistor are also used as oscillators, switchs and amplifiers.

- **In an n-p-n Transistor:**





npn

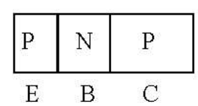
a) The current is due to electrons and they are the majority charge carriers

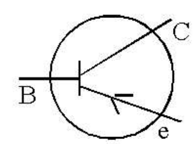
b) The conventional current flows from base to emitter.

c) The emitter curret (I_E) is the sum of base curret (I_B) and collector current (I_C), $I_E = I_B + I_C$

d) I_C is 97 to 98% of I_E and I_B is 2 to 3% of I_E.

- **In a p-n-p Transistor:**





pnp

a) The current is due to holes and they are the majority charge carriers.

b) The conventional current is from emitter to base.

c) The emitter junction is forward biased and the collector junction is reverse biased.

d) Here also $I_E = I_C + I_B$

e) The collector current is less than the emitter current ($I_C < I_E$)

- a) The emitter is the source of the charge carriers in a transistor. The collector receives (collects) most of the charge carriers. The base controls the collector current.

b) The current flow inside a transistor is carried out by the majority-charge carriers, which are free electrons in n-p-n transistor and holes in p-n-p transistor.

c) There are also minority carriers. The small minority-carrier current in the collector-base junction with the emitter open is called leakage current of I_{CB}.

d) Because of a high input impedance (resistance) and a high current gain, the common emitter amplifier is mostly used.

e) Current amplification factor of common base configuration $\alpha = \left(\frac{\Delta I_C}{\Delta I_E}\right)_{V_{CB}\ constant}$

f) Current amplification factor of common emitter configuration $\beta = \left(\frac{\Delta I_C}{\Delta I_E}\right)_{V_{CE}\ constant}$.

g) Values of α range from 0.95 to 0.99.

h) Values of β range from 20 to 500.

i) α and β of a transistor is related as

$$\frac{1}{\alpha} = \frac{1}{\beta} + 1$$

$$\beta = \frac{\alpha}{1-\alpha}\ ;\ \alpha = \frac{\beta}{1+\beta}$$

j) Input resistance of transistor in CE configuration is $R_{in} = \left(\frac{\Delta V_{BE}}{\Delta I_B}\right)_{V_{CE}}$

k) Output resistance of transistor in CE configuration is $R_{out} = \left(\frac{\Delta V_{CE}}{\Delta I_C}\right)_{I_B}$

l) Voltage gain = current gain x resistance gain.

m) Power gain = $\left(\frac{\Delta I_C}{\Delta I_B}\right)^2 \times \frac{R_{out}}{R_{in}} = \beta^2 \times$ resistance gain.

Input characterestics

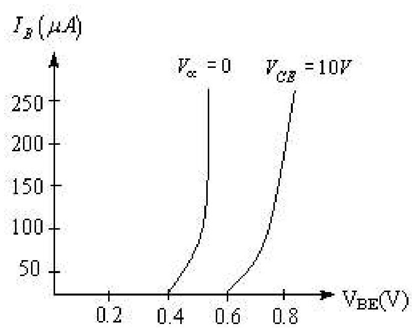
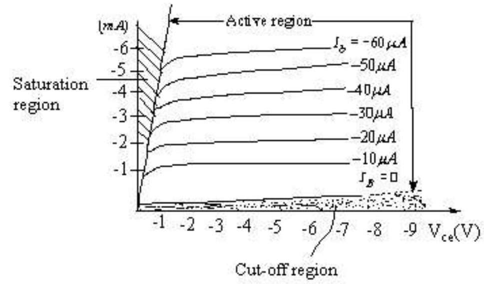


Fig.11.19 p-n-p Transistor (C.E) input characteristics

The output voltage V_{ce} is fixed (say at zero volts). The input voltage V_{be} is changed in steps (say 0.1V) upto 1 volt and the corresponding base current I_b is noted down. This process is repeated for different values (say 10V, 20V etc.) of V_{ce}.

Output characterestics

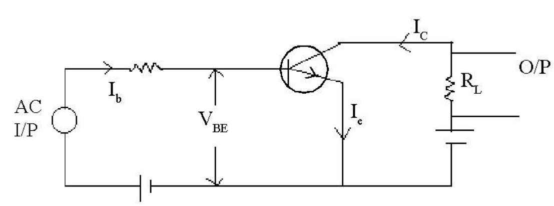


1) Saturation :- In this region the collector current becomes almost independent of the base current. This happens when both junctionis are forward biased.

2) Cut off region:- In this region the collector curent is almot zero. Thin happens when both the junctionis are reverse biased.

3) Active region:- In this region collector current (I_c) is many times greater than base current (I_b). A small change in input current (ΔI_b) produces a large change in the output current (ΔI_c). This happens when emitter junction is forward b.iased and collector junction is reverse biased. The transistor works as an amplifier when operated in the active region.

- **Hybrid or 'h' parameters of transistor:**



1) Input impedance, **(h_{ie})** :

$$h_{re} = \left(\frac{\Delta\ V_{be}}{\Delta\ V_{ce}}\right)_{I_b} \text{ constant.}$$

Unit for h_{ie} is Ohm (same as resistance)

2) Reverse voltage ratio, **(h_{re})**

$$h_{re} = \left(\frac{\Delta V_{be}}{\Delta I_{ce}}\right)_{I_b} \text{ constant.}$$

It is a dimensionless constant.

3) Forward current ratio, (h_{fe})

$$h_{fe} = \left(\frac{\Delta I_c}{\Delta I_b}\right)_{V_{ce}} \quad \text{constant}$$

It is a dimensionless constant.

4) Output admittance, (h_{oe})

$$h_{oe} = \left[\frac{\Delta I_C}{\Delta V_{CE}}\right]_{I_b}$$

Unit for (h_{oe}) is siemen.

- 1) In put characterstics are drawn between V_{BE} verses I_B at constant V_{CE}
  2) Out put characterstics are drawn between V_{CE} verses I_C at constant I_B
- Advantages of a semi conductor device over vaccum tube device:
  a) Filaments are not required in a transistor, where as it is a must in a vaccum tube triode.
  b) Very low operating voltages (0-8V) are required for a transistor, where as very high operating voltages are required for vaccum tube triode (0-300V)
  c) Creation of vaccum is not necessary in a transistor where as it a must in a vaccum tube triode.
  d) A transistor is more compact, economical and has a long life when compared to a vaccum tube triode.

CONCEPTUAL QUESTIONS

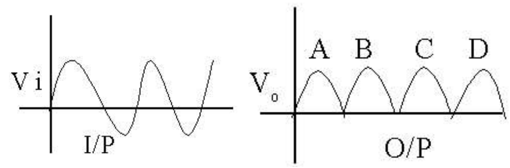
1. An electrically neutral semi conductor has
1) equal amounts of negative and positive charges
2) no minority charge carriers
3) no majority charge carriers
4) no free charges

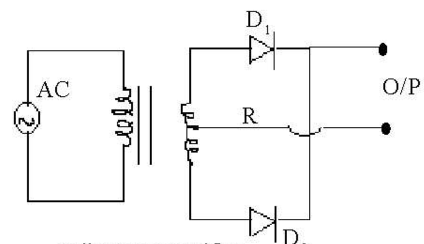
2. The potential barrier at PN junction is due to
1) fixed acceptor and donor ions on either side of the junction
2) minority carriers on either side of the junction
3) majority carriers on either side of the junction
4) both majority and minority carriers on either side of junction

3. The reverse saturation current in a PN junction diode is due to only the
1) minority carriers 2) majority carriers
3) acceptor ions 4) donor ions

4. A PN junction diode cannot be used
1) as rectifier
2) for converting light energy to electric energy
3) for getting light radiation
4) for increasing the amplitude of an ac signal.

5. A full wave rectifier along with the output is shown in fig. the contributions from the diode (1)are





Full Wave Rectifier

1) C 2) A, D 3) B, D
4) A, B, C, D

6. There is no hole current in conductors, because they
1) are full of electron gas (or) fermi gas2) have large forbidden gap
3) have no valence band
4) have overlapping valence and conduction bands.

7. In the insulators
1) the valence band is partially filled with electrons
2) the conduction band is partially filled with electrons
3) the conduction band is partially filled with electrons and valence band in empty
4) the conduction band is empty and the valence band is filled with electrons.

8. In semiconductors the forbidden energy gap between V.B. and C.B. is of the order of
1) 1eV 2) 5eV 3) 1 keV 4) 1MeV

9. The level formed due to impurity atom, in the forbidden energy gap, very near to the valence band in a p-type semicoductor is called
1) acceptor level 2) donar level
3) condcution level 4) forbidden level

10. The bond in semiconductors is
1) covalent 2) ionic
3) metallic 4) hydrogen

11. On increasing temperature, the conductivity of pure semiconductors
1) decreases 2) increases
3) remains unchanged 4) becomes zero

12. The mobility of free electrons is greater than that of free holes because
1) they carry negative charge
2) they are light
3) their mutal collisions are less
4) they require low energy to continue their motion

13. A semiconductor at 0K behaves as
1) conductor 2) insulator
3) super condcutor
4) extrensive semiconductor

14. The valency of impurity element for making n-type semiconductor is
1) 3 2) 5 3) 4 4) 7

15. The valency of impurity element for making p-type semiconductor is
1) 5 2) 4 3) 3 4) 7

16. In n-type semiconductors the electron concentration is equal to
1) density of donor atoms
2) density of acceptor atoms
3) density of both type of atoms
4) neither density of acceptor atoms nor density of donor atoms

17. In n-type, semiconductor, the Fermi, energy level is present
1) just below the valence band
2) just below the conduction band
3) just above the valence band
4) in the middle of valence and conduction bands

18. The hole in a p-type semi conductor is
1) an electron deficiency 2) an electron excess
3) an atom deficiency 4) positive ion

19. p-type semi conductor is
1) negatively charged 2) positively charged
3) neutral
4) may be positive or negative

20. n-type semi conductor is
1) negatively charged 2) positively charged
3) neutral
4) may be positive or negative

21. The ripple frequency in the input of full wave rectifier working at 50Hz ac source will
1) 50 Hz 2) 100 Hz 3) 200 Hz 4) 25 Hz

22. The thickness of deplection layer is approximately
1) 1 μ m 2) 1mm 3) 1cm 4) 1m

23. The correct relation between current gains α and β is
1) $\beta = \frac{\alpha}{1-\alpha}$ 2) $\beta = \frac{\alpha}{1+\alpha}$
3) $\beta = \alpha(1-\alpha)$ 4) $\beta = \frac{1-\alpha}{\alpha}$

24. Transistors are made of
1) insulators 2) conductors
3) alloys 4) doped semi-condcutors

25. The depletion region is
1) region of opposite charges
2) neutral region
3) Region of infinite energy
4) Region of free current carriers

26. p-n junction diode acts as
1) ohmic resistance
2) non-ohmic resistance
3) Both 1 and 2 4) None

27. The process of converting alternating current into direct current is known as
1) modulation 2) amplification
3) detection 4) rectification

28. In n-p-n transistor the arrow head on emitter represents that the conventional current flows from
1) base to emitter 2) emitter to base
3) emitter to collector 4) base to collector

29. On increasing reverse voltage in a p-n junction diode the value of reverse current will
1) gradually increase
2) first remains constant and then suddenly increase
3) remain constant 4) gradually decrease

30. In forward bias the depletion layer behaves like
1) an insulator 2) a conductor
3) a semiconductor 4) capacitor

31. In a junction transistor the emitter, base and collector are made of
1) extrinsic semi conductors
2) intrinsic semi conductors
3) both 1 and 2 4) metal

32. p-n junction in reverse bias behave like
1) an inductor 2) a condenser
3) a rectifier 4) an off switch

33. The main cause of avalenche breakdown is
1) collision by ionisation 2) high doping
3) recmobination of electrons and holes
4) low doping

34. The main cause of Zener breakdown is
1) the base semiconductor being germanium
2) production of electron - hole pairs due to thermal exitation
3) low doping 4) high doping

35. In a transistor
1) both emitter and the collector are equally doped
2) Base is more heavily doped that then collector
3) Collector is more heavily doped than the emitter
4) the base is made very thin and is lightly doped

36. In a transistor
1) length of emitter is greater than that of collector
2) length of collector is greater than that of emitter
3) both emitter and collector have same length
4) any one of emitter and collector can have greater length

37. In-transistor the emitter current is
1) slightly more than the collector current
2) slightly less than the collector current
3) equal to the collector current
4) equal to the base current

38. In the use of transistor as an amplifier
1) the emitter - base junction is reverse biased and the collector base junction is also reverse biased
2) the emitter - base junction is forward biased and the collector - base junction is reverse biased
3) both the junctions are forward biased
4) any of the two junctions may be forward biased.

39. One way in which the operation of an npn transistor differ from that of a pnp transistor is that
1) the emitter junction is reverse biased in npn
2) the emitter junction injects minority carriers into the base region of the pnp.
3) the emitter injects holes into the base of the pnp and electrons into the base region of npn
4) the emitter injects holes into the base of npn

40. npn transistors are preferred to pnp transistors because they have
1) low cost
2) low dissipation energy
3) capable of handling large power
4) electrons have high mobility than holes and hence high mobility of energy

41. A transistor amplifies a weak current signal because collector current is
1) β times I_b 2) β times I_C
3) α times I_b 4) α times I_C

42. In common collector circuit, out put resistance is
1) very high 2) moderate
3) low 4) very low

43. When p-n junction is foward biased, the current across the junction is mainly due to
1) diffusion of charges 2) drifting of charges
3) both diffusion and drifting of charges
4) holes only

44. When the condcutivity of a semi conductor is only due to breaking of covalent bonds, the semi condcutor is called
1) n-type 2) p-type
3) intrensic 4) extrinsic

45. An electric fields is applied across a semi conductor. Let n be the number of charge carriers. As temperature increases, n will
1) increase 2) decrease
3) does not change 4) may increase or decrease

46. The diffusion current in a p-n junction is greater than the drift current when the junction is
1) forward biased 2) reverse biased
3) un biased
4) both forward and reverse biased

47. Germanium diode
1) may be used as rectifier because it offers a relatively low resistance for forward bias and very high resistance for reverse bias.
2) may be used as a rectifier because it offers a relatively high resistance for forward bias and very low resistance for reverse bias.
3) cannot be used as a rectifier
4) may be used as an amplifier

48. Terminal potentials of two diodes P and Q are shown in figure. Then which of the following is correct

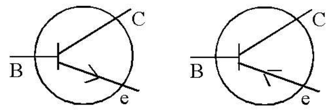
1) Both are reverse biased
2) P is forward biased and Q is reverse biased
3) P is reverse biased and Q is forward biased
4) Both are forward biased.

49. The current flow in a Zener diode is mainly due to
1) thermally generated charge carriers
2) minority charge carriers
3) collision generated charge carriers
4) ions

50. A zener diode
1) is a lightly doped junction diode
2) heavily doped junction diode
3) is either p-type or n-type
4) has no P-N junction

51. In case of common emitter p-n-p transistor input characteristic is a graph drawn
1) With I_C on y-axis and V_{CE} on x-axis keeping I_B constant
2) With I_B on y-axis V_{BE} on x-axis keeping V_{CE} constant
3) With I_C on y-axis I_B on x-axis keeping V_{CE} constant
4) With V_{be} on y-axis and V_{CE} x-axis keeping I_B constant

52. The symbols in (1) and (2) represent standard symbols for transistors. Then



(1) (2)

1) both represents p-n-p transistors
2) both represents n-p-n transistors
3) (1)represents n-p-n and (2) represents p-n-p
4) (1)represents p-n-p and (2) represents n-p-n

53. Avalanche breakdown is initiated by
1) majority carriers 2) minority carriers
3) both 4) neither

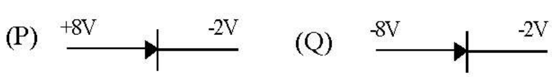
54. When a positive voltage signal is applied to the base of a common emitter npn amplifier
1) The emitter current decreases
2) The collector voltage becomes more positive
3) The collector voltage becomes less positive
4) The collector current decreases

55. A diode characteristic curve is a plot between
1) Current and time 2) Voltage and time
3) Voltage and current 4) Voltage& resistance

56. The electric field in the depletion layer of an unbiased p-n junction is
1) Zero
2) from p-side to n-side
3) from n-side to p-side 4) Not defined

57. When a junction diode is reverse biased, the current called drift current is due to
1) majority charge carriers of both n&p sides
2) minority charge carriers of both n&p sides
3) holes of both n &p sides
4) conduction band electrons of n-side only

58. In the following figures, the diodes are either forward biased or reverse biased, choose the correct statement



1) both (P) and (Q) forward biased
2) both (P) and (Q) reverse biased
3) (P) is forward biased and (Q) is reverse biased
4) (Q) is forward biased and (P) is reverse biased

59. The avalanche breakdown in P-N junction is due to
1) shift of fermi level
2) cumulative effect of conduction band electron collisions
3) widening of forbidden gap
4) high impurity concentration

60. In a transistor the base is made very thin and is lightly doped with an impurity, because
1) to enable the collector to collect about 95% of the holes or electrons coming from the emitter side
2) to enable the emitter to emit small number of holes or electrons
3) to save the transistors from high current effects
4) to enable the base to collect about 95% of holes or electrons coming from the emitter side

KEY

1) 1	2) 1	3) 1	4) 45) 3
6) 1	7) 4	8) 1	9) 110) 1
11) 2	12) 4	13) 2	14) 2
15) 3	16) 1	17) 2	18) 1
19) 3	20) 3		
21) 2	22) 1	23) 1	24) 4
25) 4	26) 2	27) 4	28) 1
29) 2	30) 2	31) 1	32) 4
33) 1	34) 2	35) 4	36) 2
37) 1	38) 2	39) 3	40) 4
41) 1	42) 1	43) 1	44) 4
45) 1	46) 1	47) 2	48) 4
49) 3	50) 2	51) 2	52) 3
53) 2	54) 3	55) 3	56) 3
57) 2	58) 3	59) 2	60) 1

LEVEL - 1

DIODES

1. If the input frequency of half-wave rectifier is n Hz ac, then its output is
1) a constant dc 2) n/2 Hzpulsating dc
3) n Hz pulsating dc 4) 2n Hz pulsating dc

2. If the input frequency of a full wave rectifier is 50 Hz ac. Its output frequency is
1) 50 Hz dc 2) 100 Hz dc
3) 200 Hzdc 4) 500 Hz dc

3. In a half wave rectifier output is taken across a 90 ohm load resistor. If the resistance of diode in forward biased condition is 10ohm, the efficiency of rectification of ac power into dc power is
1) 40.6% 2) 81.2%
3) 73.08 % 4) 36.54%

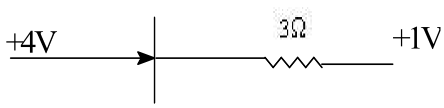
4. In a full wave rectifier output is taken across a load resistor of 800 ohm. If the resistance of diode in forward biased condition is 200 ohm, the efficiency of rectificaton of ac power into dc power is

1) 64.96% 2) 40.6%
3) 81.2% 4) 80%

5. In a p-n junction the depletion region is 400nm wide and electric field of $5\times10^{5}Vm^{-1}$ exists in it. The minimum energy of a conduction electron, which can diffuse from n-side to the p-side is
1) 4eV 2) 5eV
3) 0.4eV 4) 0.2eV

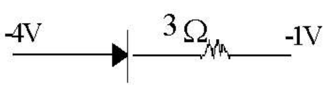
6. The reverse bias in a junction diode is changed from 5V to 15V then the value of current changes from 38 μ A to 88 μ A. The resistance of junction diode will be
1) 4 x $10^5\,\Omega$ 2) 3 x$10^5\,\Omega$
3) 2 x $10^5\,\Omega$ 4) $10^6\,\Omega$

7. The value of current in the adjacent diagram is (diode assumed to be ideal one)



1) 0 2) 1 amp
3) 1.66 amp 4) 15 amp

8. The value of current is the following diagrams is (diode assumed to be ideal one)



1) 0.1 amp 2) 0.01amp
3) 1 amp 4) zero

9. A potential barrier of 0.5V exists across a p-n junction. If the width of depletion layer is 10^{-6}m, then intensity of electric field in this region will be
1) 1 x 10^6 V/m 2) 5 x 10^5 V/m
3) 4 x 10^4 V/m 4) 2 x 10^6 V/m

10. In half wave rectifier a p-n diode with internal resistance 20 Ω is used. If the load resistance of 2KΩ is used in the circuit, then the efficiency of this half wave rectifier is
1) 80.4% 2) 40.2%
3) 20% 4) 50%

11. A full wave p-n diode rectifier uses a load resistance of 1300Ω. No filter is used. If the internal resistance of each diode is 9Ω, then the efficiency of this full wave rectifier is
1) 80.64% 2) 40.6%
3) 13.9% 4) 100%

12. In a silicon diode, the forward current changes by 2.5mA when the voltage changes from 0.08 to 0.09 V, then the forward dynamic ac resistance of the diode is
1) 4Ω 2) 0.25Ω 3) 2.5Ω 4) 8.5Ω

13. An intrinsic semi conductor has $10^{18}/m^3$ free electron and is doped with pentavalent impurity of $10^{24}/m^3$. Then the free electrons density order increase by
1) 4 2) 3 3) 5 4) 6

14. The potential barrier of a silicon junction diode is 0.7V. If the thickness of the depletion layer in it is 10^{-4} cm. Then the intensity of electric field across the junction is
1) $7\times10^{3}V/m$ 2) $7\times10^{5}V/m$
3) $7\times10^{-5}V/m$ 4) $7\times10^{-4}V/m$

15. A diode made of silicon has a barrier potential of 0.7V and a currrent of 20mA passes through the diode when a battery of emf 3V is connected to it. The wattage of the resistor and diode are
1) 0.046W, 0.014W 2) 4.6W, 0.14W
3) 0.46W, 0.14W 4) 46W, 14W

16. A p-n junction ideal diode is in forward bias and a current of 20mA flows through the circuit. When it is in reverse bias, the magnitude of the current is
1) 20mA 2) Infinity
3) Zero 4) 30 mA

TRANSISTORS

17. In an npn transistor the base and collector currents are 100 μ A and 9mA respectively. Then the emitter current will be
1) 9.1mA 2) 18.2mA
3) 3.91 μ A 4) 18.2 μ A

18. For a common emitter connection the values of constant collector current and base current are 5mA and 50 μ A respectively. The current gain will be
1) 10 2) 20 3) 40 4) 100

19. A transistor has a base current of 1mA and emitter current 100mA. The current transfer ratio will be
1) 0.9 2) 0.99 3) 1.1 4) 10.1

20. In the above problem, the current amplification factor (β) will be
1) 89 2) 95 3) 99 4) 101

21. A transistor has α = 0.95. If the emitter current is 10mA, then the collector current will be
1) 9.5 mA 2) 10mA 3) 0.95mA 4) 95mA

22. A transistor has α = 0.95. If the emitter current is 10mA the base current will be
1) 0.1mA 2) 0.2mA
3) 0.3mA 4) 0.5mA