SEMICONDUCTOR DEVICES

1.What is the order of energy gap in a conductor, semi conductor, and insulator?.

Conductor   - no energy gap
Semi Conductor   - It is of the order of 1 ev.
Insulator   - 6 ev (or) more than 6 ev.

2. Zener effect and avalanche effect are the two possible break down mechanisms that helps the external current . Why

Zener effect : The electric field in the depletion layer reach a point that it can break the covalent bonds and generate electron–hole pairs.

Avalanche breakdown : The minority carriers that across the depletion layer under the influence of the electric field gain sufficient kinetic energy to be able to break covalent bond in atoms which they collide.

3. Light emission in semiconductor is the process of creation of a photon by means of the annihilation of an electron-hole pair. How can we create them. Give the necessary condition for the light emission?

$h\omega = E_{eh}$ greater than or equal to E_g.

Condition for light emission is excess carriers.

4.Why does the conductivity of a semi conductor change with the rise in temperature ?

When a semi conductor is heated more & more electrons get enough energy to jump across the forbidden energy gap from valence band to the conduction band, where they are free to conduct electricity. Thereby increasing the conductivity of a semi conductor.

5. On the basis of energy level diagram, identify the P-type semi conductor & N-type semi conductor

C.B

- - - - - - - - - → Donor energy level

V.B

.

C.B

- - - - - - - - - - → Acceptor energy level

V.B
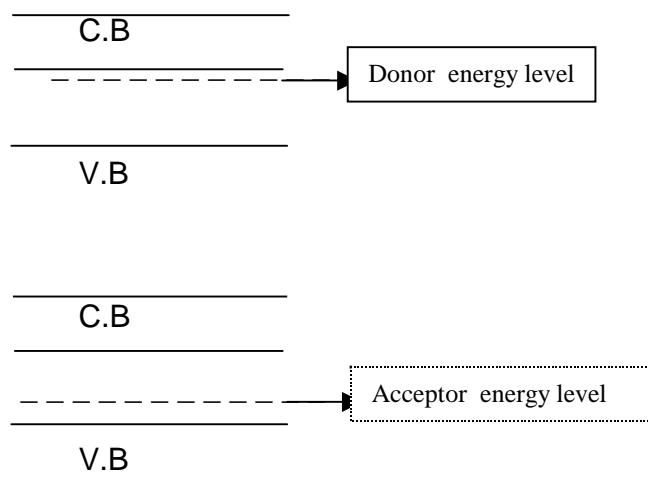
6. A student has to study the characteristics of a P-N Junction diode. What kind of a circuit arrangement should she use for this purpose?
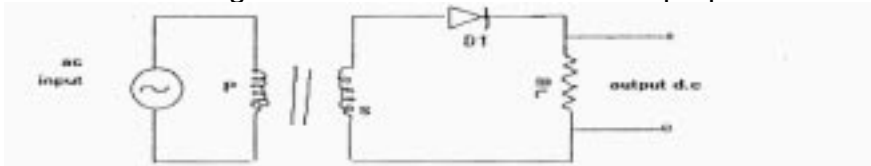
7. Draw the typical shape of input characteristics likely to be obtainedby a student . What do we understand by the forward bias and reverse bias of the diode? In which of these states does the diode being used as a rectifier.?
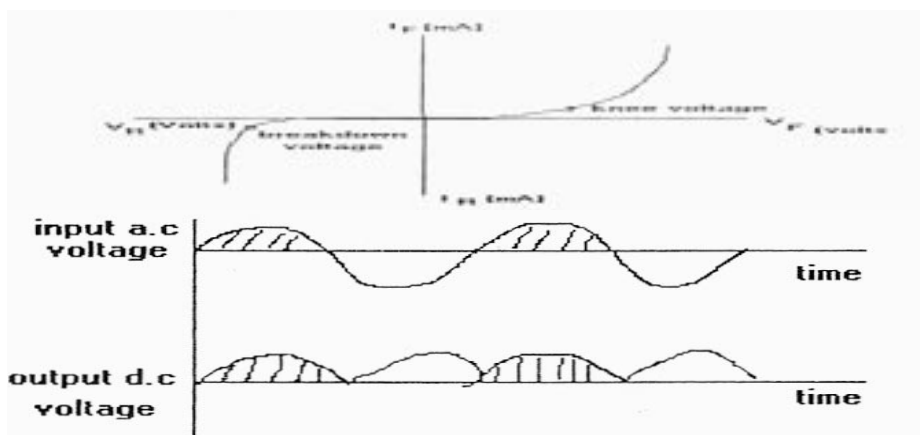
8. To achieve light amplification, We should provide positive feed back in LASER .Why?
Laser is not an amplifier but an oscillator! However, any oscillator is an amplifier with a positive feedback. To obtain lasing , it is necessary to achieve light amplification and provide positive optical feedback.

9. Self supporting stimulated emission is the principle of a Laser .why?
Probability of stimulated emission is proportional to the density of excess electrons and holes , and to the density of photons. Under the normal circumstances it is negligible. Therefore if we provide a positive feedback , the stimulated emission can become self supporting.

11. If the active layer in a P-N photo diode is the thick depletion layer then P-N Photodiode act very effective . Why?
In p-I-n photodiode ,due to thick i – layer the sensitivity improves dramatically.. Large reverse biases (< 100V for Si) may be required.

12. Modern technology use poly silicon instead of metal to form the gate. Why?
Poly silicon has high conductivity compare to metal.

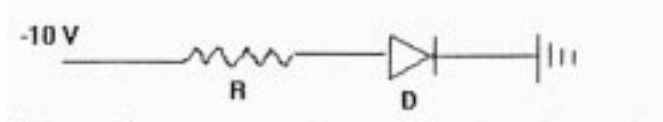15. Digiatal signal is preferred for communication Why not analog signal?Give its waveform.

A continuous time varying wave form of a current (or) voltage is called analogue signal.
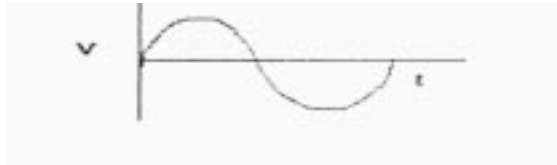
A digital signal in a two level voltage signal (ie) "0" and "1" . Digital signals are in the form of pulse of equal level.
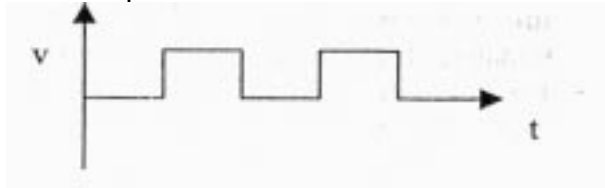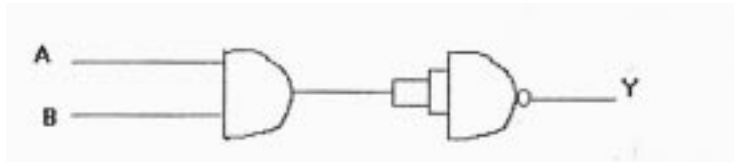

16. In a given diagram ,is the diode reverse (or) forward biased?.

Reverse biased.

17.Identify the logic gate, Give its truth table and output wave form?.

NAND GATE.

18.The ratio of number of free electrons to holes n_e/n_h for two different materials A and B are 1 and <1 respectively. Name the type of semi conductor to which A and B belongs.

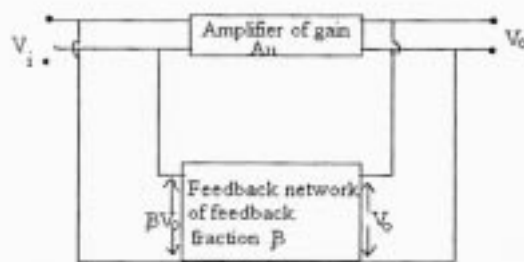If $n_e/n_h =1$. Hence A is intrinsic semi conductor.

If $n_e/n_h <1$, $n_e<n_h$ hence B is P-type.

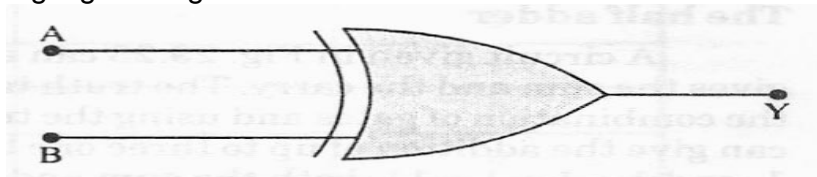19.Can you identify waveform. How will you convert A.C To D.C?
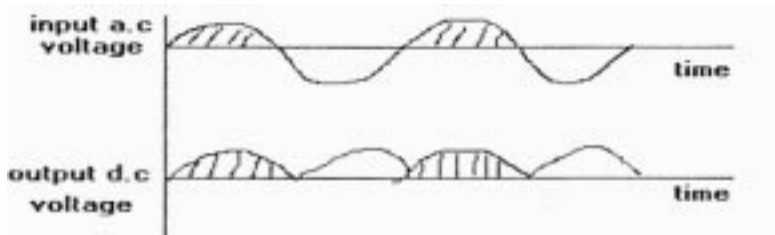
20. Under what conditions an amplifier can be converted in to an oscillator.Draw a suitable diagram .
 1. When feed back is positive.   2. When feed factor k is equal to l/AV

21.Using basic logic gates (NOT, OR, AND) construct the circuit for the given logic gate & give its truth table and wave form.?

22. Convert a Fraction *from* Decimal $(0.625)_{10}$ *to* Binary?

Hint:$(0.625)_{10}$ = $(0.101)_2$

23. Convert an octal number (4536) into decimal number?

$(4536)_8 = 4 \times 8^3 + 5 \times 8^2 + 3 \times 8^1 + 6 \times 8^0 = (1362)_{10}$

24. Convert Hexa decimal (3A9F) and (2D3.5) into decimal number?

$(3A9F)_{16} = 3 \times 16^3 + 10 \times 16^2 + 9 \times 16^1 + 15 \times 16^0 = 14999_{10}$

$(2D3.5)_{16} = 2 \times 16^2 + 13 \times 16^1 + 3 \times 16^0 + 5 \times 16^{-1} = 723.3125_{10}$

25. In the circuit diagram given , a volt meter is connected across a lamp , what changes would occur at lamp"L" and voltmeter "V:" , if the resistor R is reduce in value? Give reason for your answer?
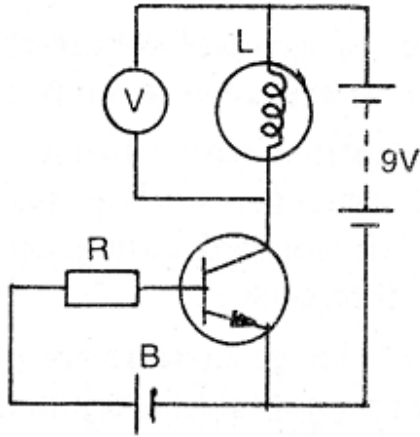
In the given circuit emitter –base junction of N-P-N transistor is forward biased , with battery "B". When "r" decreases I_E increases . Because
$I_C = I_E - I_B$.
Therefore IC will also increase. Hence bulb will glow with more brightness and voltmeter reading will increase.

26.Determine the current through resistance "R" in each circuit. Diodes D1 and D2   are identical and ideal.

(i)   (ii)
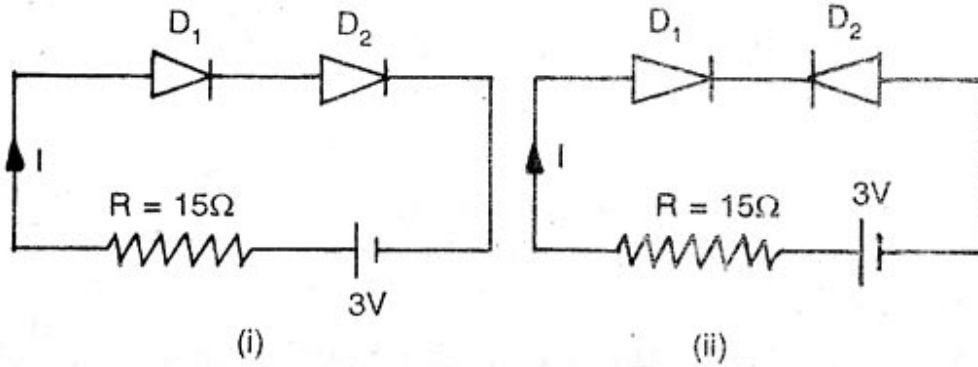
        In circuit (i) Both D1 and D2 are forward baiased hence both will conduct current and resistance of each diode is "0". .Therefore I = 3/15 = 0.2 A
(ii) Diode D1 is forward bias and D2 is reverse bias, therefore resistance D1 is "0" and resistance D2 is infinite. Hence D1 will conduct and D2 do not conduct . No current flows in the circuit.

27.Write the output wave form of the OR gate for the inputs given?

Time Interval	1	2	3	4	5	6	7	8
Input A	0	1	1	0	0	1	1	0

Input B	0	0	1	1	0	0	0	1
Output, Y=A+B	0	1	1	1	0	1	1	1

28.In the figure given below is (i) emitter and (ii) collector forward or ereverse biased. With the help of a circuit diagram explain the action of a N-P-N transistor?
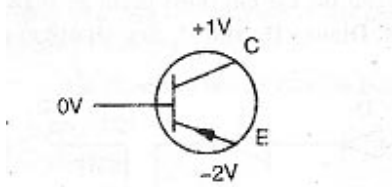
Emitter –base is reverse biased and (ii) collector – base is forward biased . This will not acts as transistor.

29. In only one of the circuits given below the lamp"L" light   glow . Identify which circuit is it? Give reason for your answer?


(i)   (ii)   (iii)
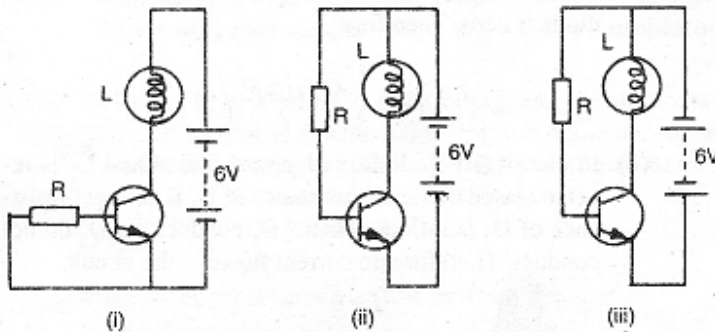
In fir (i) emitter –base junction has no source of emf . Therefore Ic =0, bulb will not glow. In figure (ii) emitter – base junction is forward biased, therefore lamp "L" will glow.

30. the emitter and base of n-p-n transistor have same doping concentrations, explain how will the collector and base currents be affected?

All charge carriers entering the base will be neutralise in the base due to electron –hole combination. Therefore collector current in this situation is almost zero.($I_E = I_B$) .

31 From the given graph identify the KNEE voltage and breakdown voltage. Explain?
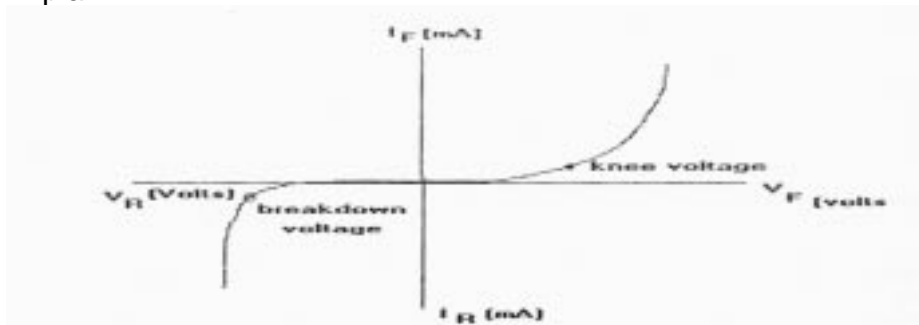
32.Differentiate the electrical conductivity of both types of extrinsic semiconductors in terms of the energy band picture.

33. semiconductors obey OHM'S law for only low fields .Give reason?
The drift velocity of a charge carrier is proportional to electric E.

Therefore $V = eET/m$ ie. $V \propto E$

But V cannot be increased indefinitely by increasing E . At high speed relaxation time (T) begins to decrease due to increase in collision frequency. S: so drift velocity saturates at thermal velocity ($10ms^{-1}$). An electric field of 10^6 V/m causes saturation of drift velocity. Hence semi- conduction obey ohm's law for low electrical field and above this field ($E < 10^6$ V/m) current becomes independent of potential.

34. Relate input frequency and the output frequencies of a half wave rectifier and a full wave rectifier?
 In half-wave rectification, we get pulsating output for half cycle only. Therefore output ripple frequency is same as the input frequency. But in full wave rectification we get output for both half cycle. Hence the output at ripple frequency is full-wave rectification is double the input frequency.
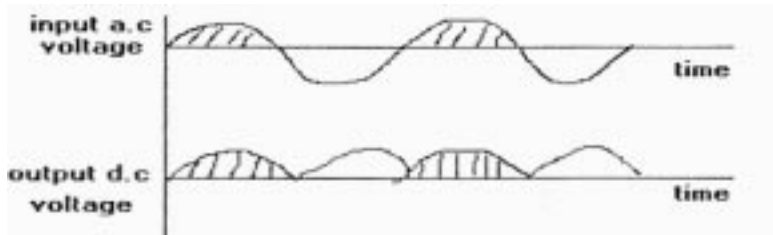
35. Emitter is heavily doped while collector is moderately doped . Why?
There are two main differences between emitter and collector of a transistor construction wise. First emitter is heavily doped while collector is moderately doped. Second the area of the collector is larger than the emitter.So output will be maximum.

36. Key point for its proper functioning of base region in a transistor depends upon the thickness of the base Why ?
Base region in a transistor controls the current. The majority charge carriers supplied by the emitter do not combine in the same region due to its thin size and light doping and most of them pass on to the collector. This is the key point for its proper functioning.

37. For faster action which transistor is used and why?
For faster action NPN Transistor is used .In an NPN transistor, current conduction is mainly by free electron ,whereas in PNP type transistor .it is mainly holes Since electron are more mobile than holes we prefer NPN for faster action as well as high conduction current.

38.A student has to study the input and output characteristics of a n-p-n silicon transistor in the common emitter configuration. What kind of a circuit arrangement should she use for this purpose?
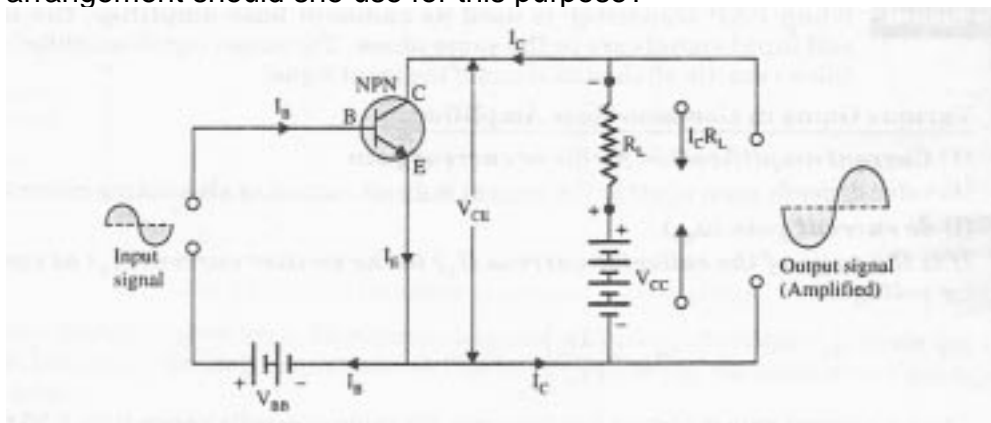
39. Draw the typical shape of input characteristics likely to be obtained by a student. What do we understand by the cut off, active and saturation of the

transistor? In which of these states does the transistor not remain when being used as a switch?
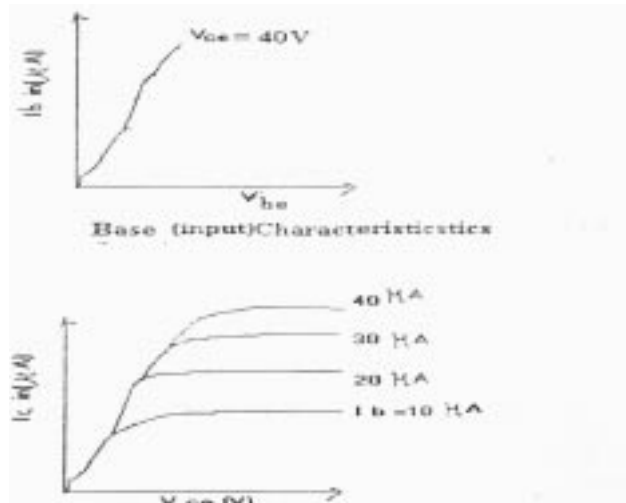

Base (input)Characteristics

V ce (V)

When both emitter and collector are reverse biased, no current flows through the transistor. This condition is known as cut-off state.

When both Emitter and collector are reverse biased, no current flows through the transistor. This condition is known as saturation state.

40. A germanium diode is preferred to a silicon one for rectifying small voltages. Explain why?

 Because the energy gap for Ge (Eg = 0.7 ev) is smaller than the energy gap for Si (Eg = 1.1ev) . Moreover, the germanium diode is much more open to the danger of   high temperature affect than silicon at high voltage.

41. Draw the logic circuit and the output wave form for given output Y=0,0,1,1.
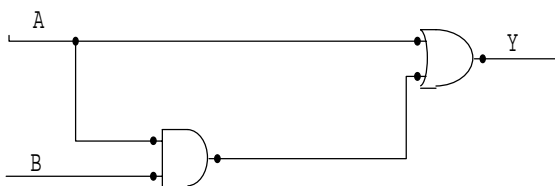
The output of the AND gate is Y = A.B consequently the input of the OR gate are A and A.B . Then the final Y = A + A.B

Input for AND gate		Output of AND gate	Input of OR gate		output of OR gate
A	B	Y= A.B	A	Y	Y = A + Y
0	0	0	0	0	0
0	1	0	0	0	0
1	0	0	1	0	1
1	1	1	1	1	1

42. Construct the truch table for the Boolean equation Y=(A+B).C and represent by logic circuit .
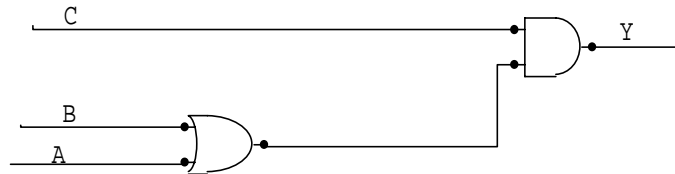
The output of OR gate is A+B. Consequently, the inputs of AND gate are A+B & C Hence the Boolean equation for the given circuit is Y=(A+B).C

A	B	C	Y'=A+B	Y=(A+B).C=Y'.C
0	0	0	0	0
0	0	1	0	0
0	1	0	1	0
0	1	1	1	1
1	0	0	1	0
1	0	1	1	1
1	1	0	1	0
1	1	1	1	1

43.Write the output wave form of the OR gate for the inputs given?

Time Interval	1	2	3	4	5	6	7	8
Input A	0	1	1	0	0	1	1	0
Input B	0	0	1	1	0	0	0	1
Output, Y=A+B	0	1	1	1	0	1	1	1

44. Is it Logic gate used to prove Commutativity and Associativity ? Draw the truth table ?
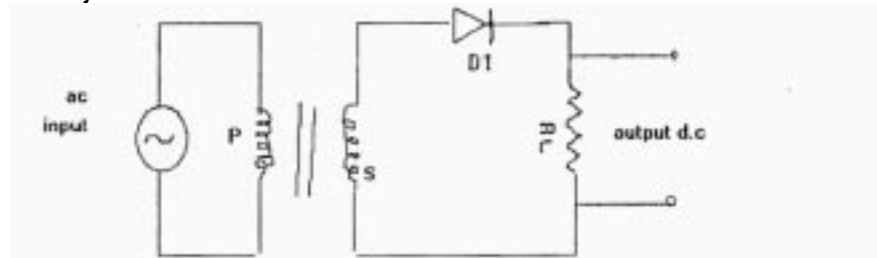The Commutative Property:
a + b = b + a
a · b = b · a
The Associative Property:
a + (b + c) = (a + b) + c
a · (b · c) = (a · b) · c

45. Diode acts as rectifier Why? Differentiate between Half wave and full wave rectification?

Rectification — It is the process in which alternating current is converted to direct current.P-N junction Diode as Half wave rectifier


As shown in the figure above the a.c input is applied across the primary of transformer. The secondary is connected to junction diode and load resistance (Rc) in series.
WORKING PRINCIPLE:- when positive half cycle or a.c takes place the diode is forward biased and output is obtained across the load resistance Rc. But when it negative half cycle diode is reverse biased and no current flows, hence there is no output across load resistance Rc. So only half is obtained as output.
Full wave rectification:
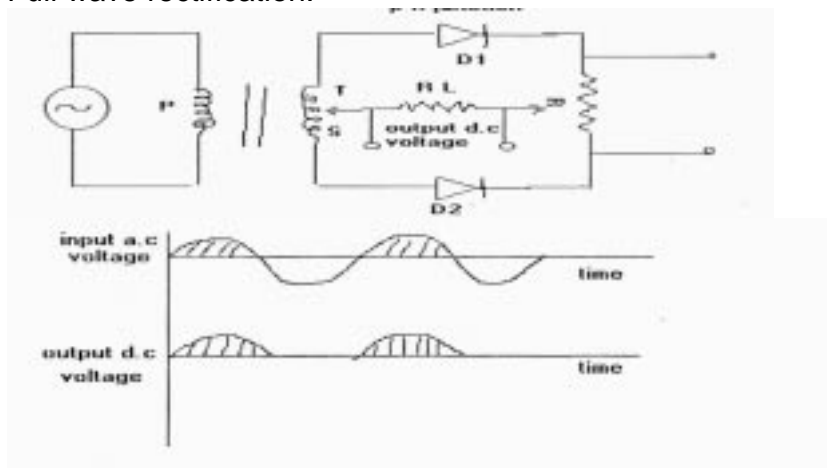
46.Construct AND gate using NAND GATE and give its truth table?.
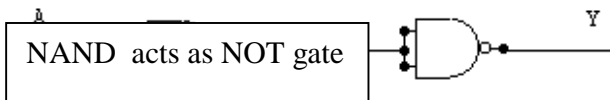 AND Gate using NAND GATE:-
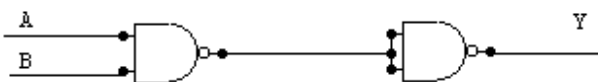
A	B	Y= A.B
0	0	0
0	1	0
1	0	0
1	1	1

4.Construct NOT gate using NAND gate and give its truth table.

NOT gate using NAND gate:-
Truth Table:-

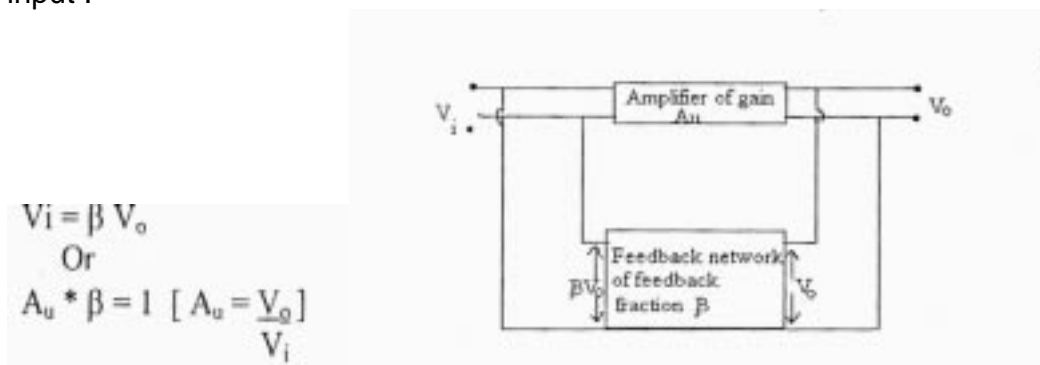| A	Y=$\overline{A}$
0	1
1	0

47.. Using suitable block diagram for explain the function of feed back amplifier.?Explain..
Transistor as an oscillator- It consists of three main parts
2. Feedback circuit
3. Transistor acts as an amplifier.
Feed back circuit : It is used to give the part of the output of the transistor as an input .

$$Vi = \beta\, V_o$$
Or
$$A_u * \beta = 1 \quad [\, A_u = \frac{V_o}{V_i}\,]$$

Transistor acts as an amplifier : in this circuit the NPN transistor acts as an amplifier. It amplifies the input signal. This amplified output goes to the R_l .

48.Compliment(1's) the following binary numbers
(a) 110010   (b) 111101   (c) 101010   (d)111111
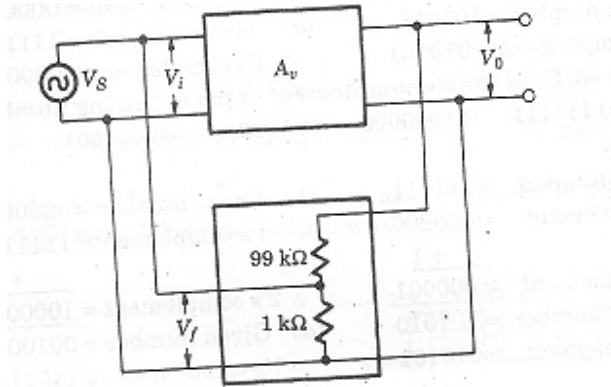 (a) 1's compliment=001101
        (b) 1's compliment=000010
        (c) 1's compliment=010101
        (d) 1's compliment=000000

49. In the circuit, V_s=0.2V, V_0 = -10 V. Find V_i & gain $A_v = V_0 / V_i$ & $A_v' = V_0 / V_s$?
Sol: V_s=0.2 V, V_0 = -10 V

$V_f = 1/99+1\ V_0 =(/100) \times (-10) = -0.1V$
$V_i = V_s - V_f = 0.2-(-0.1)= 0.3V$
$V_i = V_s + V_f = 0.2+(-0.1)=0.1V$
Therefore, gain
$A_v = V_0 / V_i = -10/0.1 = -100$
$A_v = V_0 / V_s = -10/0.2= -50$

50 . Why should we use Zener diode in the output stage of the electronic circuit?
Zener effect : The electric field in the depletion layer reach a point that it can break the covalent bonds and generate electron–hole pairs.
If the output voltage of a DC power supply does not change with load it is called regulated power supply Explain the working of a Zener diode as a voltage regulator. Zener diode as a voltage regulator.
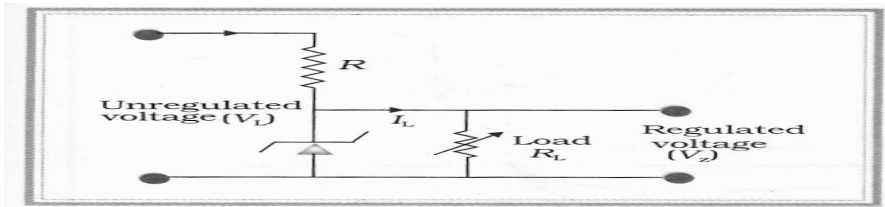
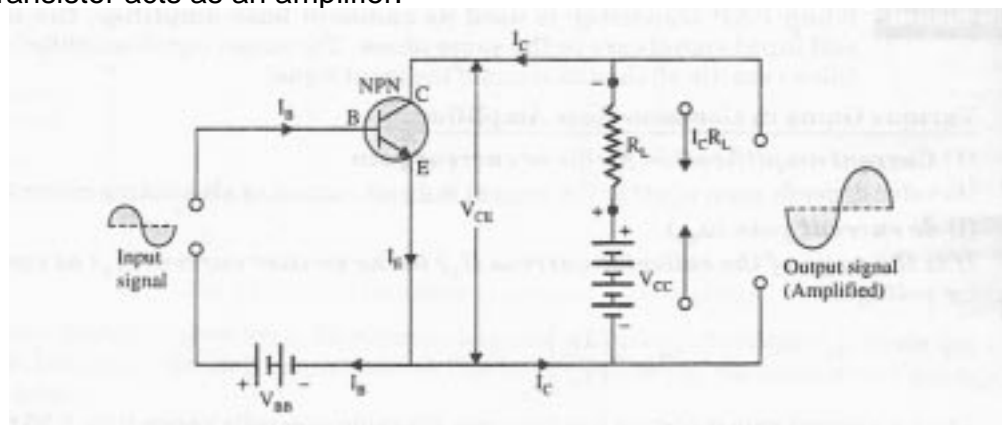Using basic building block construct AND,OR,NOT and give its truth table and output waveform.
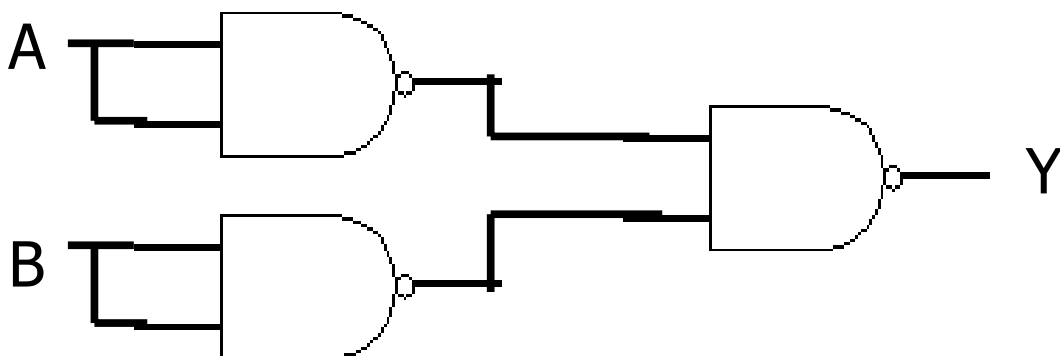
51.For the given Boolean expression F = x(y+z') and its output
Y=0,0,0,0,1,0,1,1 . Draw the logic circuit for the Boolean expression and input
/ output wave form.
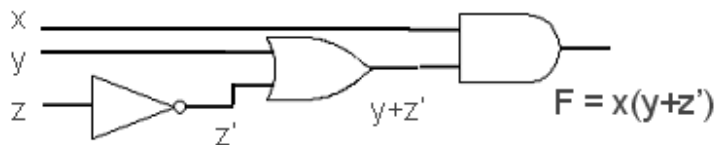
F = x(y+z')

53. The output of the transistor amplifier is 180⁰ out of phase Why ?
 CE Transistor acts as an amplifier:-
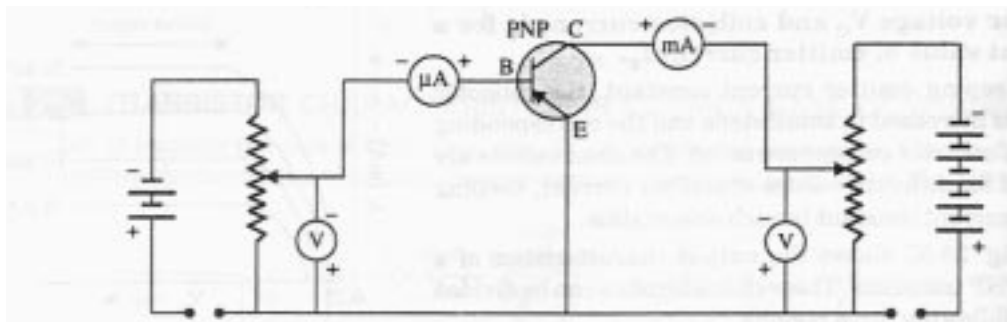

Using Kirchhoffs first law, $I_E = I_B + I_C$
This voltage drop $I_C R_L$ is clearly in opposition to the applied voltage Vcc.
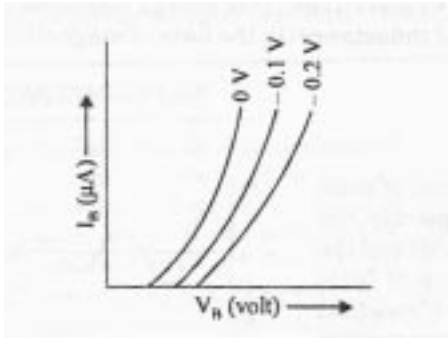Net collector voltage, $V_{CE} = V_{cc} - I_C R_L$ .. (1)

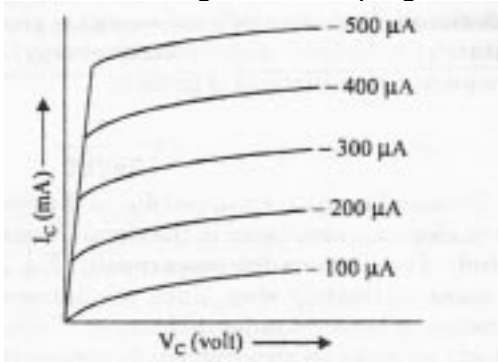54.Draw a circuit diagram for PNP common emitter transistor characteristics.
Explain the input and output characteristics.
Common Emitter Transistor characteristics.

Output Characteristics of PNP represent the variation of collector current 1 with collector voltage V_{ce} , keeping base constant current I_b.


55.Identify which basic gate OR, AND and NOT is represented by the circuits in the dotted lines boxes 1,2 and 3. Give the truth table for the entire circuit for all possible values of A and B?
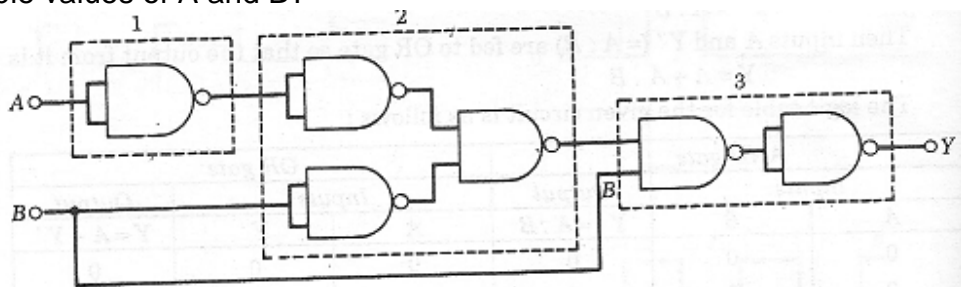
The dotted line box 1 represents a NOT gate. The dotted line box 2 represents an OR gate.Here we use de Morgan's theorem. The dotted line 3 represents AND gate.

56.Two input waveforms A and B shown in figure (a) and (b) are applied to an AND gate . Write the output

Time interval	1	2	3	4	5	6
Input A	0	1	1	0	0	1
Input B	0	0	1	1	0	0
Output Y = A.B	0	0	1	0	0	0
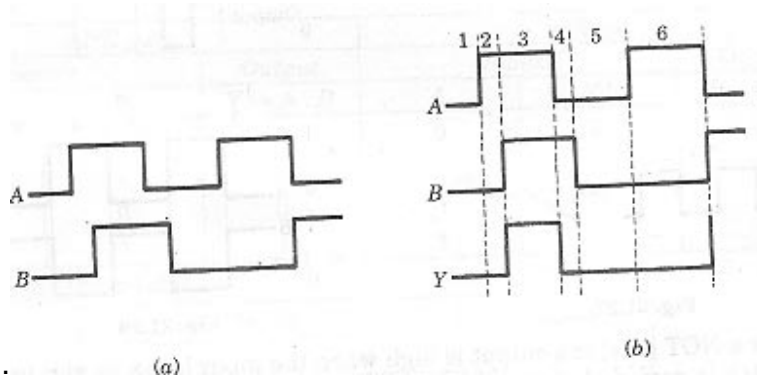
waveform.   (a)   (b)

57. In NPN transistor circuit, the collector current is 5mA. If 95% of the electrons emitted reach the collector region, what is the base current?
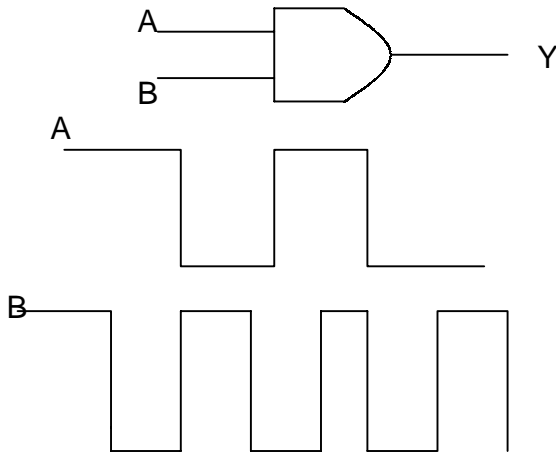Here

$\quad I_c$=95% of Ie $\ = \ $ (95 / 100) I_e
$\quad\quad I_e = $ (100 / 95) × 5 mA $ = $ 5.26mA
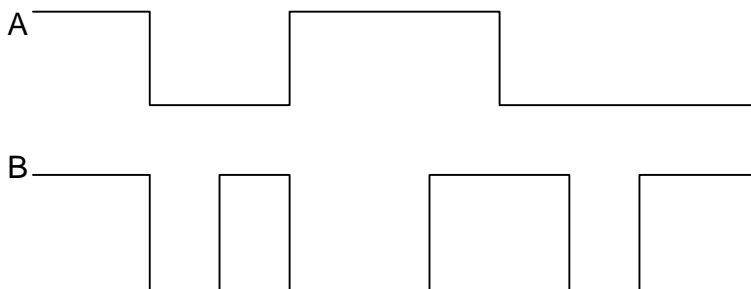$\quad\quad I_e = I_c + I_b$
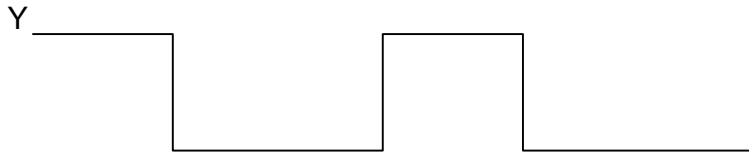$\quad\quad I_b = $ 0.25 mA

58. A circuit symbol of a logic gate and two input wave forms A and B are shown.

a) Name the logic gate
b) Give the output wave form

This is AND logic gate Output wave form

Y

59. For a transistor working as a common base amplifier, current gain is 0.96. If the emitter current is 7.2mA, then calculate the base current.

Here

$$\alpha = 0.96 \ , \ I_e = 7.2mA$$
$$\alpha = I_c / I_e$$
$$\therefore I_c = \alpha \ I_e \ = \ 6.91 \ mA$$
$$I_b = I_e - I_c$$
$$I_b = 0.29 \ mA.$$

60. The base current of a transistor is 105 μA and collector current is 2.05 mA. Deterine the value of β , Ie , and α

A change of 27 μA in the base current produces a change of 0.65 mA in the collector current . Find βa.c.

$$Ib = 105 \times 10^{-6} \ A \quad Ic = 2.05 \times 10^{-3}A$$
$$\beta = Ic / Ib = \ 19.5$$
Also,
$$Ie = Ib + Ic \ = \ 2.155 \times 10^{-3} \ A$$
$$\alpha = Ic / Ie \ = \ 0.95$$
$$\triangle Ib = 27\mu A = 27 \times 10^{-6} \ A$$
$$\beta = \triangle Ic / \triangle Ib \ = \ 24.1$$

61.In a silicon transistor, a change of 7.89mA in the emitter current produces a change of 7.8 mA in the collector current. What change in the base current is necessary to produce an equivalent change in the collector current?

Here
$$\triangle Ie = 7.89 \times 10^{-3} \ A$$
$$\triangle Ic = 7.8 \times 10^{-3} \ A$$
Now
$$\alpha_{a.c.} = \triangle I_c / \triangle I_e \ = \ 0.9886$$

We have,

$$\beta_{ac} = \alpha_{ac} / (1-\alpha_{ac}) = 86.72$$

Also,

$$\beta_{ac} = \triangle I_c / \triangle I_b$$
$$\therefore \triangle I_b = \triangle I_c / \beta_{ac}$$
$$\triangle I_b = (7.8 \times 10^{-3}) / (86.72)$$
$$\triangle I_b = 89.94 \times 10^{-6} A$$