# SEMICONDUCTOR ELECTRONICS : MATERIALS, DEVICES AND SIMPLE CIRCUITS

## FACT/DEFINITION TYPE QUESTIONS

**1.** In a semiconductor
(a) there are no free electrons at 0 K
(b) there are no free electrons at any temperature
(c) the number of free electrons increases with pressure
(d) the number of fre electrons is more than that in a conductor

**2.** Let $n_h$ and $n_e$ be the number of holes and conduction electrons in an extrinsic semiconductor. Then
(a) $n_h > n_e$ (b) $n_h = n_e$ (c) $n_h < n_e$ (d) $n_h \neq n_e$

**3.** A p-type semiconductor is
(a) positively charged
(b) negatively charged
(c) uncharged
(d) uncharged at 0K but charged at higher temperatures

**4.** Electric conduction in a semiconductor takes place due to
(a) electrons only
(b) holes only
(c) both electrons and holes
(d) neither electrons nor holes

**5.** The impurity atoms with which pure silicon may be doped to make it a p-type semiconductor are those of
(a) phosphorus (b) boron
(c) antimony (d) nitrogen

**6.** The electrical conductivity of pure germanium can be increased by
(a) increasing the temperature
(b) doping acceptor impurities
(c) doping donor impurities
(d) All of the above

**7.** The resistivity of a semiconductor at room temperature is in between
(a) $10^{-2}$ to $10^{-5}$ $\Omega$ cm (b) $10^{-3}$ to $10^{6}$ $\Omega$ cm
(c) $10^{6}$ to $10^{8}$ $\Omega$ cm (d) $10^{10}$ to $10^{12}$ $\Omega$ cm

**8.** Number of electrons in the valence shell of a pure semiconductor is
(a) 1 (b) 2 (c) 3 (d) 4

**9.** In a semiconductor, the forbidden energy gap between the valence band and the conduction band is of the order is
(a) 1 MeV (b) 0.1 Mev
(c) 1 eV (d) 5 eV

**10.** The forbidden energy gap for germanium crystal at 0 K is
(a) 0.071 eV (b) 0.71 eV
(c) 2.57 eV (d) 6.57 eV

**11.** In an insulator, the forbidden energy gap between the valence band and conduction band is of the order of
(a) 1 MeV (b) 0.1 MeV
(c) 1 eV (d) 5 eV

**12.** What is the resistivity of a pure semiconductor at absolute zero ?
(a) Zero
(b) Infinity
(c) Same as that of conductors at room temperature
(d) Same as that of insulators at room temperature

**13.** Temperature coefficient of resistance of semiconductor is
(a) zero (b) constant
(c) positive (d) negative

**14.** In a p-type semiconductor, the acceptor valence band is
(a) close to the valence band of the host crystal
(b) close to conduction band of the host crystal
(c) below the conduction band of the host crystal
(d) above the conduction band of the host crystal

**15.** In an n-type semiconductor, donor valence band is
(a) above the conduction band of the host crystal
(b) close to the valence band of the host crystal
(c) close to the conduction band of the host crystal
(d) below the valence band of the host crystal

**16.** The mobility of free electrons is greater than that of free holes because
(a) they are light
(b) they carry negative charge
(c) they mutually colllide less
(d) they require low energy to continue their motion

**17.** The relation between number of free electrons (n) in a semiconductor and temperature (T) is given by
(a) $n \propto T$ (b) $n \propto T^2$
(c) $n \propto \sqrt{T}$ (d) $n \propto T^{3/2}$

**18.** In semiconductors, at room temperature
(a) the conduction band is completely empty
(b) the valence band is partially empty and the conduction band is partially filled
(c) the valence band is completely filled and the conduction band is partially filled
(d) the valence band is completely filled

**19.** At absolute zero, Si acts as
(a) non-metal (b) metal
(c) insulator (d) None of these

**20.** One serious drawback of semi-conductor devices is
(a) they do not last for long time.
(b) they are costly
(c) they cannot be used with high voltage.
(d) they pollute the environment.

**21.** When an impurity is doped into an intrinsic semiconductor, the conductivity of the semiconductor
(a) increases (b) decreases
(c) remains the same (d) becomes zero

**22.** An electric field is applied to a semiconductor. Let the number of charge carriers be n and the average drift speed be v. If the temperature is increased
(a) both n and v will increase
(b) n will increase but v will decrease
(c) v will increase but n will decrease
(d) both n and v will decrease

**23.** If a small amount of antimony is added to germanium crystal
(a) it becomes a p–type semiconductor
(b) the antimony becomes an acceptor atom
(c) there will be more free electrons than holes in the semiconductor
(d) its resistance is increased

**24.** By increasing the temperature, the specific resistance of a conductor and a semiconductor
(a) increases for both (b) decreases for both
(c) increases, decreases (d) decreases, increases

**25.** A strip of copper and another of germanium are cooled from room temperature to 80K. The resistance of
(a) each of these decreases
(b) copper strip increases and that of germanium decreases
(c) copper strip decreases and that of germanium increases
(d) each of these increases

**26.** Carbon, Silicon and Germanium atoms have four valence electrons each. Their valence and conduction bands are separated by energy band gaps represented by $(E_g)_C$, $(E_g)_{Si}$ and $(E_g)_{Ge}$ respectively. Which one of the following relationship is true in their case?
(a) $(E_g)_C > (E_g)_{Si}$ (b) $(E_g)_C < (E_g)_{Si}$
(c) $(E_g)_C = (E_g)_{Si}$ (d) $(E_g)_C < (E_g)_{Ge}$

**27.** A semiconductor device is connected in a series circuit with a battery and a resistance. A current is found to pass through the circuit. If the polarity of the battery is reversed, the current drops to almost zero. The device may be a/an
(a) intrinsic semiconductor
(b) p-type semiconductor
(c) n-type semiconductor
(d) p-n junction diode

**28.** If the two ends of a p-n junction are joined by a wire
(a) there will not be a steady current in the circuit
(b) there will be a steady current from the n-side to the p-side
(c) there will be a steady current from the p-side to the n-side
(d) there may or may not be a current depending upon the resistance of the connecting wire

**29.** The drift current in a p-n junction is from the
(a) n-side to the p-side
(b) p-side to the n-side
(c) n-side to the p-side if the junction is forward-biased and in the opposite direction if it is reverse biased
(d) p-side to the n-side if the junction is forward-biased and in the opposite direction if it is reverse-biased

**30.** The diffusion current in a p-n junction is from the
(a) n-side to the p-side
(b) p-side to the n-side
(c) n-side to the p-side if the junction is forward-biased and in the opposite direction if it is reverse-biased
(d) p-side to the n-side if the junction is forward-biased and in the opposite direction if it is reverse-biased

**31.** Diffusion current in a p-n junction is greater than the drift current in magnitude
(a) if the junction is forward-biased
(b) if the junction is reverse-biased
(c) if the junction is unbiased
(d) in no case

**32.** Forward biasing is that in which applied voltage
(a) increases potential barrier
(b) cancels the potential barrier
(c) is equal to 1.5 volt
(d) None of these

**33.** In V-I characteristic of a p-n junction, reverse biasing results in
(a) leakage current
(b) the current barrier across junction increases
(c) no flow of current
(d) large current

**34.** In reverse biasing
(a) large amount of current flows
(b) potential barrier across junction increases
(c) depletion layer resistance increases
(d) no current flows

**35.** Zener diode is used for
(a) amplification (b) rectification
(c) stabilisation (d) all of the above

**36.** Filter circuit
(a) eliminates a.c. component
(b) eliminates d.c. component
(c) does not eliminate a.c. component
(d) None of these

**37.** For a junction diode the ratio of forward current $(I_f)$ and reverse current $(I_r)$ is
[e = electronic charge,
V = voltage applied across junction,
k = Boltzmann constant,
T = temperature in kelvin]
(a) $e^{-V/kT}$ (b) $e^{V/kT}$
(c) $(e^{-eV/kT} + 1)$ (d) $(e^{eV/kT} - 1)$

**38.** In a semiconductor diode, the barrier potential offers opposition to
(a) holes in P-region only
(b) free electrons in N-region only
(c) majority carriers in both regions
(d) majority as well as minority carriers in both regions

**39.** In a P -N junction
(a) the potential of P & N sides becomes higher alternately
(b) the P side is at higher electrical potential than N side.
(c) the N side is at higher electric potential than P side.
(d) both P & N sides are at same potential.

**40.** Barrier potential of a P-N junction diode does not depend on
(a) doping density (b) diode design
(c) temperature (d) forward bias

**41.** Reverse bias applied to a junction diode
(a) increases the minority carrier current
(b) lowers the potential barrier
(c) raises the potential barrier
(d) increases the majority carrier current

**42.** In forward biasing of the p–n junction
(a) the positive terminal of the battery is connected to p–side and the depletion region becomes thick
(b) the positive terminal of the battery is connected to n–side and the depletion region becomes thin
(c) the positive terminal of the battery is connected to n–side and the depletion region becomes thick
(d) the positive terminal of the battery is connected to p–side and the depletion region becomes thin

**43.** When p-n junction diode is forward biased then
(a) both the depletion region and barrier height are reduced
(b) the depletion region is widened and barrier height is reduced
(c) the depletion region is reduced and barrier height is increased
(d) Both the depletion region and barrier height are increased

**44.** The cause of the potential barrier in a p-n junction diode is
(a) depletion of positive charges near the junction
(b) concentration of positive charges near the junction
(c) depletion of negative charges near the junction
(d) concentration of positive and negative charges near the junction

**45.** The ratio of forward biased to reverse biased resistance for pn junction diode is
(a) $10^{-1} : 1$ (b) $10^{-2} : 1$
(c) $10^{4} : 1$ (d) $10^{-4} : 1$

**46.** In the middle of the depletion layer of a reverse- biased p-n junction, the
(a) electric field is zero (b) potential is maximum
(c) electric field is maximum (d) potential is zero

**47.** Bridge type rectifier uses
(a) four diodes (b) six diodes
(c) two diodes (d) one diode

**48.** The average value of output direct current in a half wave rectifier is
(a) $I_0/\pi$ (b) $I_0/2$
(c) $\pi I_0/2$ (d) $2 I_0/\pi$

**49.** The average value of output direct current in a full wave rectifier is
(a) $I_0/\pi$ (b) $I_0/2$
(c) $\pi I_0/2$ (d) $2 I_0/\pi$

**50.** In a half wave rectifier, the r.m.s. value of the a.c. component of the wave is
(a) equal to d.c. value (b) more than d.c. value
(c) less than d.c. value (d) zero

**51.** In a transistor
(a) the emitter has the least concentration of impurity
(b) the collector has the least concentration of impurity
(c) the base has the least concentration of impurity
(d) all the three regions have equal concentrations of impurity

**52.** Current gain in common emitter configuration is more than 1 because
(a) $I_c < I_b$ (b) $I_c < I_e$ (c) $I_c > I_e$ (d) $I_c > I_b$

**53.** Current gain in common base configuration is less than 1 because
(a) $I_e < I_b$ (b) $I_b < I_e$ (c) $I_c < I_e$ (d) $I_e < I_c$

**54.** Operating point of a transistor is
(a) zero signal value of $V_{CC}$ and $I_b$
(b) zero signal value of $I_c$
(c) zero signal value of $V_{cc}$
(d) zero signal value of $I_c$ and $V_{CE}$

**55.** A transistor is essentially
(a) a current operated device
(b) power driven device
(c) a voltage operated device
(d) resistance operated device

**56.** Amplifier may be
(a) multi stage (b) single stage
(c) both (a) and (b) (d) None of these

**57.** In common emitter circuit, current gain is
(a) zero
(b) same as in other configuration
(c) lowest (d) highest

**58.** In common base circuit, output resistance is
(a) very high (b) low
(c) very low (d) moderate

**59.** In common collector circuit, voltage gain is
(a) very high (b) moderate
(c) low (d) very low

**60.** In a transistor
(a) both emitter and collector have same length
(b) length of emitter is greater than that of collector
(c) length of collector is greater than that of emitter
(d) any one of emitter and collector can have greater length

**61.** In a transistor, the base is
(a) a conductor of low resistance
(b) a conductor of high resistance
(c) an insulator
(d) an extrinsic semiconductor

**62.** Negative feed back
(a) increases stability (b) decreases stability
(c) produces oscillation (d) stops current in the tube

**63.** The part of a transistor which is most heavily doped to produce large number of majority carriers is
(a) emmiter
(b) base
(c) collector
(d) can be any of the above three.

**64.** In a common base amplifier, the phase difference between the input signal voltage and output voltage is
(a) $\pi$ (b) $\frac{\pi}{4}$
(c) $\frac{\pi}{2}$ (d) 0

**65.** The current gain $\beta$ may be defined as
(a) the ratio of change in collector current to the change in emitter current for a constant collector voltage in a common base arrangement.
(b) the ratio of change in collector current to the change in the base current at constant collector voltage in a common emitter circuit
(c) the ratio of change in emitter current to the change in base current for constant emitter voltage in common emitter circuit.
(d) the ratio of change in base current to the change in collector current at constant collector voltage in common emitter circuit.

**66.** The transistor are usually made of
(a) metal oxides with high temperature coefficient of resistivity
(b) metals with high temperature coefficient of resistivity
(c) metals with low temperature coefficient of resistivity
(d) semiconducting materials having low temperature coefficient of resistivity

**67.** A transistor has three impurity regions. All the three regions have different doping levels. In order of increasing doping level, the regions are
(a) emitter, base and collector
(b) collector, base and emitter
(c) base, emitter and collector
(d) base, collector and emitter

**68.** To use a transistor as an amplifier, emitter-base junction is kept in ...*X*... and base-collector junction is kept in ...*Y*... Here, *X* and *Y* refer to
(a) forward bias, forward bias
(b) reverse bias, reverse bias
(c) reverse bias, forward bias
(d) forward bias, reverse bias

**69.** When npn transistor is used as an amplifier
(a) electrons move from collector to base
(b) holes move from emitter to base
(c) electrons move from base to collector
(d) holes move from base to emitter

**70.** An oscillator is nothing but an amplifier with
(a) positive feedback
(b) large gain
(c) negative feedback
(d) no feedback

**71.** What is the value of A.C + A.B.C where A, B and C are inputs ?
(a) A.C (b) A.B
(c) A (d) B

**72.** In Boolean algebra, $Y = A + B$ implies that
(a) output Y exists when both inputs A and B exist
(b) output Y exists when either input A exists or input B exists or both inputs A and B exist
(c) output Y exists when either input A exists or input B exists but not when both inputs A and B exist
(d) output Y exists when both inputs A and B exists but not when either input A or B exist

**73.** The gate for which output is high if atleast one input is low?
(a) NAND (b) NOR
(c) AND (d) OR

**74.** The truth-table given below is for which gate?

| A | B | C |
|---|---|---|
| 0 | 0 | 1 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 0 |

(a) XOR (b) OR
(c) AND (d) NAND

**75.** NAND and NOR gates are called universal gates primarily because they
(a) are available universally
(b) can be combined to produce OR, AND and NOT gates
(c) are widely used in Integrated circuit packages
(d) are easiest to manufacture

## STATEMENT TYPE QUESTIONS

**76.** Select the correct statement(s) from the following.
I. In conductors, the valence and conduction bands may overlap.
II. Substances with energy gap of the order of 10 eV are insulators.
III. The resistivity of a semiconductor increases with increase in temperature.
IV. The conductivity of a semiconductor increases with increase in temperature.
(a) I and II only (b) I and III only
(c) I, II and IV (d) I, II, III and IV

**77.** Which of the following statements is/are correct ?

I. Pure Si doped with trivalent impurities gives a p-type semiconductor

II. Majority carriers in a n-type semiconductor are holes

III. Minority carriers in a p-type semiconductor are electrons

IV. The resistance of intrinsic semiconductor decreases with increase of temperature

(a) I only (b) I, III and IV

(c) I and IV (d) II only

**78.** In a n-type semiconductor, which of the following statements are incorrect?

I. Electrons are minority carriers and pentavalent atoms are dopants.

II. Holes are minority carriers and pentavalent atoms are dopants.

III. Holes are majority carriers and trivalent atoms are dopants.

IV Electrons are majority carriers and trivalent atoms are dopants.

(a) I and II (b) I, III and IV

(c) III and IV (d) I, II and III

**79.** In a solid-state semiconductor, the number of mobile charge carriers can be changed by

I. using light for excitation.

II. using heat for excitation.

III. using sound for excitation.

IV. using applied voltage for excitation.

(a) I, II, III and IV (b) I, II and IV

(c) I, II and III (d) I and II only

**80.** Which of these are used for doping?

I. A trivalent impurity.

II. A tetravalent impurity.

III. A pentavalent impurity.

IV. A monovalent impurity.

(a) I and II (b) II and IV

(c) II and III (d) I and III

**81.** Due to diffusion of electrons from *n* to *p*-side

I. electron hole combination across *p*-*n* junction occurs.

II. an ionised acceptor is left in the p-region.

III. an ionised donor is left in the n-region.

IV. electrons of n-sdie comes to p-side and electron-hole combination takes place in p-side

Select the correct option from the following.

(a) I and II (b) II and III

(c) II and IV (d) I, III and IV

**82.** Which of these are correct ?

I. In forward biasing holes from *p*-sdie crosses junction and reach *n*-side.

II. In forward biasing electrons from *n*-sdie crosses junction and reach *p*-side.

III. In *n*-side holes are minority carriers.

IV. In *p*-side electrons are minority carriers.

(a) I, II and III (b) I, III and IV

(c) II, III and IV (d) I, II, III and IV

**83.** For transistor action, which of the following statements are correct ?

I. Base emitter and collector region have similar size and doping concentrations.

II. The base must be very thin and lightly doped.

III. The emitter junction is forward biased and collector junction is reverse biased.

IV. Both emitter and collector junctions are forward biased.

(a) I and II (b) II and III

(c) III and IV (d) I and IV

## MATCHING TYPE QUESTIONS

**84.** Match the column I and Column II

| **Column I** | **Column II**<br>(Rnge of resistivity, ρ) |
|---|---|
| (A) Metals | (1) $10^{11} - 10^{19}\ \Omega$ m |
| (B) Semiconductors | (2) $10^{-5} - 10^{6}\ \Omega$ m |
| (C) Insulators | (3) $10^{-2} - 10^{-8}\ \Omega$ m |
| | (4) $10^{-20} - 10^{25}\ \Omega$ m |

(a) (A) → (3); (B) → (2); (C) → (1)

(b) (A) → (1,4); (B) → (2); (C) → (3)

(c) (A) → (1); (B) → (2); (C) → (3,4)

(d) (A) → (1); (B) → (2,4); (C) → (3)

**85.** Match the elements in column I, with their respective energy gaps in column II.

| **Column I** | **Column II** |
|---|---|
| (A) Diamond | (1) 1.1 ev |
| (B) Aluminium | (2) 0.71 ev |
| (C) Germatium | (3) 0.03 ev |
| (D) Silicon | (4) 6 ev |

(a) (A) → (1); (B) → (2); (C) → (3); (D) → (4)

(b) (A) → (1); (B) → (2); (C) → (2); (D) → (3)

(c) (A) → (4); (B) → (2); (C) → (3); (D) → (1)

(d) (A) → (4); (B) → (3); (C) → (2); (D) → (1)

**86.**

| **Column I** | **Column II** |
|---|---|
| (A) Moderate size and heavily doped | (1) Base |
| (B) Very thin and lightly doped | (2) Collector |
| (C) Moderately doped and of large size | (3) Emitter |
| (D) Dopped with penta valent impurity | (4) N-type semmiconductor |

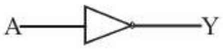
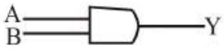
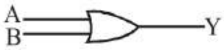
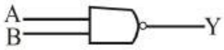
(a) (A) → (2); (B) → (1); (C) → (4); (D) → (3)

(b) (A) → (1); (B) → (2); (C) → (4); (D) → (3)

(c) (A) → (3); (B) → (1); (C) → (2); (D) → (4)

(d) (A) → (2); (B) → (1); (C) → (3); (D) → (4)

**87.**

| **Column I** | **Column II** |
|---|---|
| (A) OR gate | (1)  |
| (B) AND gate | (2)  |
| (C) NOT gate | (3)  |
| (D) NAND gate | (4)  |

(a) (A) → (3); (B) → (2); (C) → (1); (D) → (4)

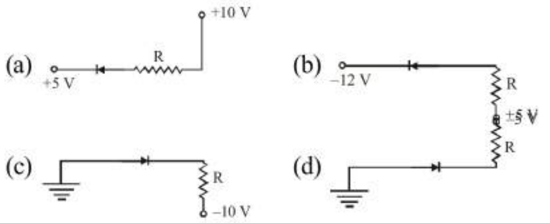
(b) (A) → (1); (B) → (2); (C) → (4); (D) → (3)

(c) (A) → (3); (B) → (1); (C) → (2); (D) → (4)

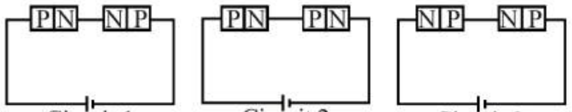
(d) (A) → (2); (B) → (1); (C) → (3); (D) → (4)

## DIAGRAM TYPE QUESTIONS

**88.** Of the diodes shown in the following diagrams, which one is reverse biased ?



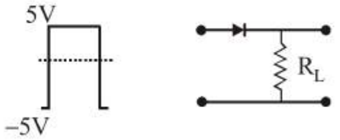
**89.** Two identical pn junctions may be connected in series, with a battery in three ways as shown in figure. The potential drops across the two pn junctions are equal in



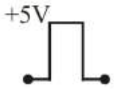
Circuit 1 Circuit 2 Circuit 3

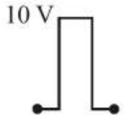
(a) circuit 1 and circuit 2
(b) circuit 2 and circuit 3
(c) circuit 3 and circuit 1
(d) circuit 1 only

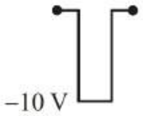
**90.** If in a p-n junction diode, a square input signal of 10 V is applied as shown

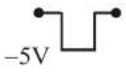


Then the output signal across $R_L$ will be

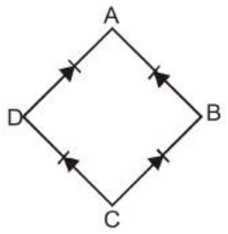
(a) 

(b) 

(c) 

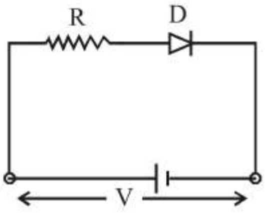
(d) 

**91.** In bridge rectifier circuit, (see fig.), the input signal should be connected between



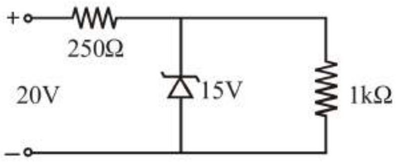
(a) A and D (b) B and C
(c) A and C (d) B and D

**92.** A d.c. battery of V volt is connected to a series combination of a resistor R and an ideal diode D as shown in the figure below. The potential difference across R will be



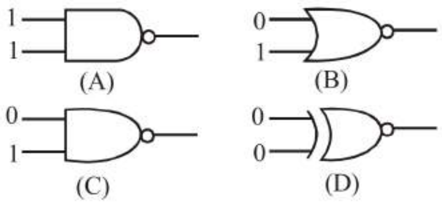
(a) 2V when diode is forward biased
(b) zero when diode is forward biased
(c) V when diode is reverse biased
(d) V when diode is forward biased

**93.** A zener diode, having breakdown voltage equal to 15V, is used in a voltage regulator circuit shown in figure. The current through the diode is



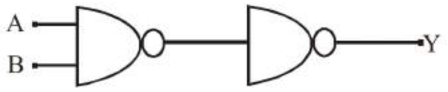
(a) 10 mA (b) 15 mA
(c) 20 mA (d) 5 mA

**94.** Which of the following gates will have an output of 1?



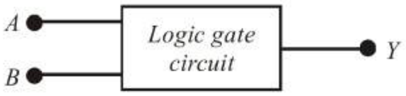
(a) D (b) A
(c) B (d) C

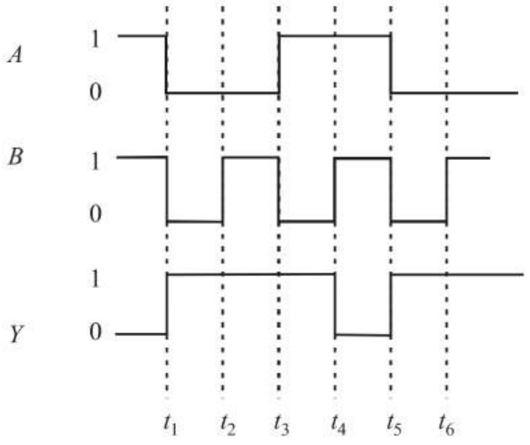
**95.** Following diagram performs the logic function of



(a) XOR gate (b) AND gate
(c) NAND gate (d) OR gate

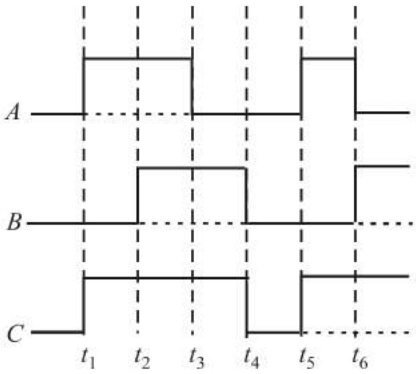
**96.** The following figure shows a logic gate circuit with two inputs *A* and *B* and the output *Y*. The voltage waveforms of A, B and Y are given. The logic gate is





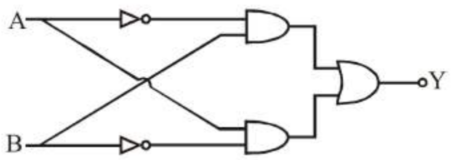
(a) NAND (b) NOR
(c) XOR (d) OR

**97.** The figure shows a logic circuit with two inputs *A* and *B* and the output *C*. The voltage wave forms across *A*, *B* and *C* are as given. The logic gate circuit is:



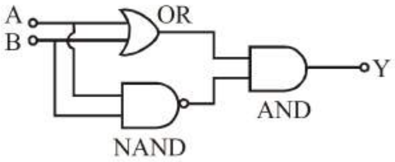
(a) OR gate (b) NOR gate
(c) AND gate (d) NAND gate

**98.** The following circut represents



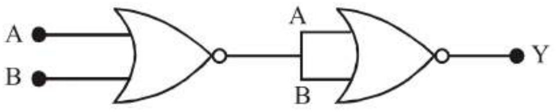
(a) OR gate (b) XOR gate
(c) AND gate (d) NAND gate

**99.** The following configuration of gate is equivalent to



(a) NAND gate (b) XOR gate
(c) OR gate (d) NOR gate

**100.** In the following circuit, the output Y for all possible inputs A and B is expressed by the truth table.



(a)

| A | B | Y |
|---|---|---|
| 0 | 0 | 1 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 0 |

(b)

| A | B | Y |
|---|---|---|
| 0 | 0 | 1 |
| 0 | 1 | 0 |
| 1 | 0 | 0 |
| 1 | 1 | 0 |

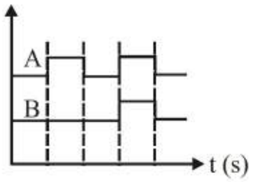
(c)

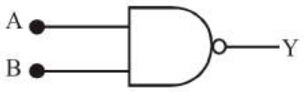
| A | B | Y |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 1 |

(d)

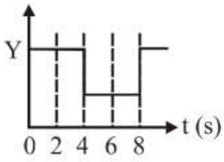
| A | B | Y |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 0 |
| 1 | 0 | 0 |
| 1 | 1 | 1 |

**101.** The real time variation of input signals A and B are as shown below. If the inputs are fed into NAND gate, then select the output signal from the following.

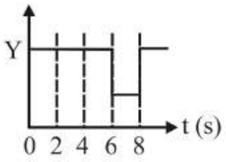




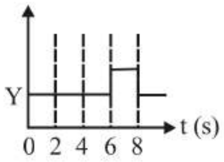
(a)



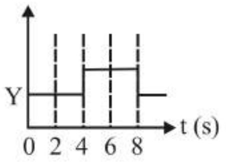
(b)



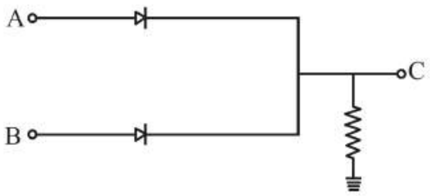
(c)



(d)

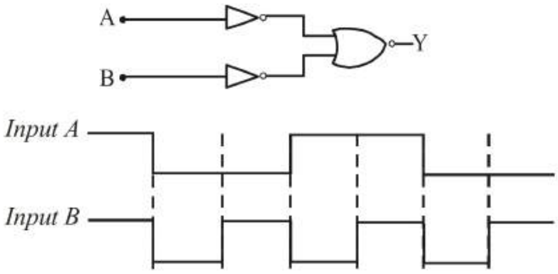


**102.** In the circuit below, A and B represent two inputs and C represents the output.



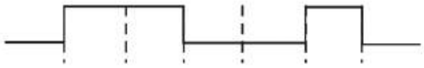
The circuit represents
(a) NOR gate (b) AND gate
(c) NAND gate (d) OR gate

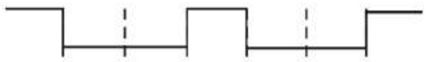
**103.** The logic circuit shown below has the input waveforms '*A*' and '*B*' as shown. Pick out the correct output waveform.

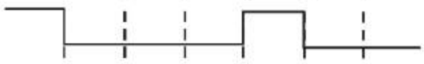


Output is

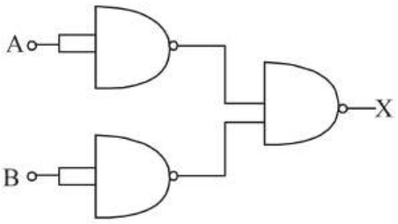
(a)


(b)


(c)


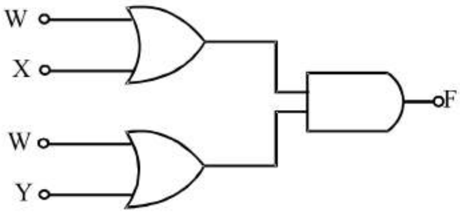
(d)


**104.** The combination of gates shown below yields



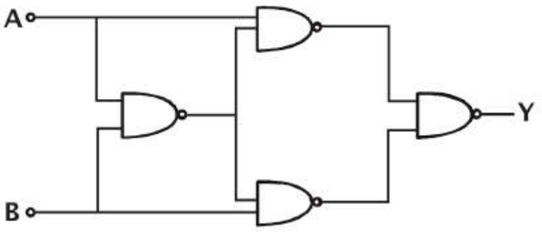
(a) OR gate (b) NOT gate
(c) XOR gate (d) NAND gate

**105.** The diagram of a logic circuit is given below. The output F of the circuit is represented by



(a) $W.(X+Y)$ (b) $W.(X.Y)$
(c) $W+(X.Y)$ (d) $W+(X+Y)$

**106.** Truth table for system of four NAND gates as shown in figure is



(a)

| A | B | Y |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 0 |

(b)

| A | B | Y |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 0 |
| 1 | 0 | 1 |
| 1 | 1 | 1 |

(c)

| A | B | Y |
|---|---|---|
| 0 | 0 | 1 |
| 0 | 1 | 1 |
| 1 | 0 | 0 |
| 1 | 1 | 0 |

(d)

| A | B | Y |
|---|---|---|
| 0 | 0 | 1 |
| 0 | 1 | 0 |
| 1 | 0 | 1 |
| 1 | 1 | 1 |

## ASSERTION- REASON TYPE QUESTIONS

**Directions** : Each of these questions contain two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

**107. Assertion :** A pure semiconductor has negative temperature coefficient of resistance.
**Reason :** In a semiconductor on raising the temperature, more charge carriers are released, conductance increases and resistance decreases.

**108. Assertion :** If the temperature of a semiconductor is increased then its resistance decreases.
**Reason :** The energy gap between conduction band and valence band is very small.

**109. Assertion :** In semiconductors, thermal collisions are respossible for taking a valence electron to the conduction band.
**Reason :** The number of conduction electrons go on increasing with time as thermal collisions continuously take place.

**110. Assertion :** A p-type semiconductors is a positive type crystal.
**Reason :** A p- type semiconductor is an uncharged crystal.

**111. Assertion :** Silicon is preferred over germanium for making semiconductor devices.
**Reason :** The energy gap in germanium is more than the energy gap in silicon.

**112. Assertion :** Electron has higher mobility than hole in a semiconductor.
**Reason :** The mass of electron is less than the mass of the hole.

**113. Assertion :** The number of electrons in a p-type silicon semiconductor is less than the number of electrons in a pure silicon semiconductor at room temperature.
**Reason :** It is due to law of mass action.

**114. Assertion :** When two semi conductor of *p* and *n* type are brought in contact, they form *p-n* junction which act like a rectifier.

**Reason :** A rectifier is used to convent alternating current into direct current.

**115. Assertion :** Diode lasers are used as optical sources in optical communication.

**Reason :** Diode lasers consume less energy.

**116. Assertion :** The diffusion current in a p-n junction is from the p-side to the n-side.

**Reason :** The diffusion current in a p-n junction is greater than the drift current when the junction is in forward biased.

**117. Assertion :** The drift current in a p-n junction is from the n-side to the p-side.

**Reason :** It is due to free electrons only.

**118. Assertion :** A p-n junction with reverse bias can be used as a photo-diode to measure light intensity.

**Reason :** In a reverse bias condition the current is small but it is more sensitive to changes in incident light intensity.

**119. Assertion :** A transistor amplifier in common emitter configuration has a low input impedence.

**Reason :** The base to emitter region is forward biased.

**120. Assertion :** NOT gate is also called invertor circuit.

**Reason :** NOT gate inverts the input order.

**121. Assertion :** NAND or NOR gates are called digital building blocks.

**Reason :** The repeated use of NAND (or NOR) gates can produce all the basis or complicated gates.

## CRITICAL THINKING TYPE QUESTIONS

**122.** Pure Si at 500K has equal number of electron ($n_e$) and hole ($n_h$) concentrations of $1.5 \times 10^{16}\ m^{-3}$. Doping by indium increases $n_h$ to $4.5 \times 10^{22}\ m^{-3}$. The doped semiconductor is of

(a) n–type with electron concentration $n_e = 5 \times 10^{22}\ m^{-3}$

(b) p–type with electron concentration $n_e = 2.5 \times 10^{10}\ m^{-3}$

(c) n–type with electron concentration $n_e = 2.5 \times 10^{23}\ m^{-3}$

(d) p–type having electron concentration $n_e = 5 \times 10^{9}\ m^{-3}$

**123.** On doping germanium with donor atoms of density $10^{17}\ cm^{-3}$ its conductivity in mho/cm will be [Given : $\mu_e = 3800\ cm^2/V\text{–}s$ and $n_i = 2.5 \times 10^{13}\ cm^{-13}$]

(a) 30.4 (b) 60.8
(c) 91.2 (d) 121.6

**124.** The ratio of electron and hole currents in a semiconductor is 7/4 and the ratio of drift velocities of electrons and holes is 5/4, then the ratio of concentrations of electrons and holes will be

(a) 5/7 (b) 7/5
(c) 25/49 (d) 49/25

**125.** The intrinsic conductivity of germanium at 27° is 2.13 mho $m^{-1}$ and mobilities of electrons and holes are 0.38 and 0.18 $m^2V^{-1}s^{-1}$ respectively. The density of charge carriers is

(a) $2.37 \times 10^{19}\ m^{-3}$ (b) $3.28 \times 10^{19}\ m^{-3}$
(c) $7.83 \times 10^{19}\ m^{-3}$ (d) $8.47 \times 10^{19}\ m^{-3}$

**126.** What is the conductivity of a semiconductor if electron density = $5 \times 10^{12}/cm^3$ and hole density = $8 \times 10^{13}/cm^3$ ($\mu_e = 2.3\ m^2\ V^{-1}\ s^{-1}$, $\mu_h = 0.01\ m^2V^{-1}\ s^{-1}$)

(a) $5.634\ \Omega^{-1}\ m^{-1}$ (b) $1.968\ \Omega^{-1}\ m^{-1}$
(c) $3.421\ \Omega^{-1}\ m^{-1}$ (d) $8.964\ \Omega^{-1}\ m^{-1}$

**127.** In a p-type semiconductor the acceptor level is situated 60 meV above the valence band. The maximum wavelength of light required to produce a hole will be

(a) $0.207 \times 10^{-5}\ m$ (b) $2.07 \times 10^{-5}\ m$
(c) $20.7 \times 10^{-5}\ m$ (d) $2075 \times 10^{-5}\ m$

**128.** If the ratio of the concentration of electrons to that of holes in a semiconductor is $\frac{7}{5}$ and the ratio of currents is $\frac{7}{4}$, then what is the ratio of their drift velocities?

(a) $\frac{5}{8}$ (b) $\frac{4}{5}$
(c) $\frac{5}{4}$ (d) $\frac{4}{7}$

**129.** In a p-n junction having depletion layer of thickness $10^{-6}$ m the potential across it is 0.1 V. The electric field is

(a) $10^7$ V/m (b) $10^{-6}$ V/m
(c) $10^5$ V/m (d) $10^{-5}$ V/m

**130.** In a reverse biased diode when the applied voltage changes by 1 V, the current is found to change by 0.5 μA. The reverse bias resistance of the diode is

(a) $2 \times 10^5\ \Omega$ (b) $2 \times 10^6\ \Omega$
(c) 200 Ω (d) 2 Ω.

**131.** When the forward bias voltage of a diode is changed from 0.6 V to 0.7 V, the current changes from 5 mA to 15 mA. Then its forward bias resistance is

(a) 0.01 Ω (b) 0.1 Ω
(c) 10 Ω (d) 100 Ω

**132.** A diode having potential difference 0.5 V across its junction which does not depend on current, is connected in series with resistance of 20Ω across source. If 0.1 A current passes through resistance then what is the voltage of the source?

(a) 1.5 V (b) 2.0 V
(c) 2.5 V (d) 5 V

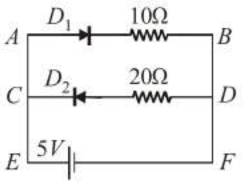
**133.** If the forward bias on p-n junction is increased from zero to 0.045 V, then no current flows in the circuit. The contact potential of junction i.e. $V_B$ is

(a) zero (b) 0.045 V
(c) more than 0.045 V (d) less than 0.045 V

**134.** The peak voltage in the output of a half-wave diode rectifier fed with a sinusoidal signal without filter is 10V. The d.c. component of the output voltage is

(a) 20/π V (b) $10/\sqrt{2}$ V
(c) 10/π V (d) 10V

**135.** Two ideal diodes are connected to a battery as shown in the circuit. The current supplied by the battery is



(a) 0.75 A (b) zero
(c) 0.25 A (d) 0.5 A

**136.** In the half wave rectifier circuit operating from 50 Hz mains frequency, the fundamental frequency in the ripple would be

(a) 25 Hz (b) 50 Hz
(c) 70.7 Hz (d) 100 Hz

**137.** In a full wave rectifier circuit operating from 50 Hz mains frequency, the fundamental frequency in the ripple would be

(a) 25 Hz (b) 50 Hz
(c) 70.7 Hz (d) 100 Hz

**138.** A half-wave rectifier is being used to rectify an alternating voltage of frequency 50 Hz. The number of pulses of rectified current obtained in one second is

(a) 50 (b) 25
(c) 100 (d) 2000

**139.** For a transistor amplifier in common emitter configuration for load impedance of 1k $\Omega$ ($h_{fe} = 50$ and $h_{oe} = 25\mu s$) the current gain is

(a) $-24.8$ (b) $-15.7$
(c) $-5.2$ (d) $-48.78$

**140.** In a common base mode of a transistor, the collector current is 5.488 mA for an emitter current of 5.60 mA. The value of the base current amplification factor ($\beta$) will be

(a) 49 (b) 50
(c) 51 (d) 48

**141.** A transistor has a base current of 1 mA and emitter current 90 mA. The collector current will be

(a) 90 mA (b) 1 mA
(c) 89 mA (d) 91 mA

**142.** In a common emitter transistor amplifier $\beta = 60$, $R_o = 5000\,\Omega$ and internal resistance of a transistor is 500 Ω. The voltage amplification of amplifier will be

(a) 500 (b) 460
(c) 600 (d) 560

**143.** For a common base amplifier, the values of resistance gain and voltage gain are 3000 and 2800 respectively. The current gain will be

(a) 1.1 (b) 0.98
(c) 0.93 (d) 0.83

**144.** What is the voltage gain in a common emitter amplifier, where input resistance is 3 Ω and load resistance 24 Ω, $\beta = 0.6$ ?

(a) 8.4 (b) 4.8
(c) 2.4 (d) 480

**145.** The current gain of a transistor in common base mode is 0.995. The current gain of the same transistor in common emitter mode is

(a) 197 (b) 201
(c) 198 (d) 199

**146.** In a npn transistor $10^{10}$ electrons enter the emitter in $10^{-6}$ s. 4% of the electrons are lost in the base. The current transfer ratio will be

(a) 0.98 (b) 0.97
(c) 0.96 (d) 0.94

**147.** The transfer ratio $\beta$ of transistor is 50. The input resistance of a transistor when used in C.E. (Common Emitter) configuration is 1kΩ. The peak value of the collector A.C current for an A.C input voltage of 0.01 V peak is

(a) 100 μA (b) .01 mA
(c) .25 mA (d) 500 μA

**148.** In a transistor, the change in base current from 100 μA to 125 μA causes a change in collector current from 5 mA to 7.5 mA, keeping collector-to-emitter voltage constant at 10 V. What is the current gain of the transistor?

(a) 200 (b) 100
(c) 50 (d) 25

**149.** In common emitter amplifier, the current gain is 62. The collector resistance and input resistance are 5 kΩ an 500Ω respectively. If the input voltage is 0.01 V, the output voltage is

(a) 0.62 V (b) 6.2 V
(c) 62 V (d) 620 V

**150.** A common emitter amplifier has a voltage gain of 50, an input impedance of 100Ω and an output impedance of 200Ω. The power gain of the amplifier is

(a) 500 (b) 1000
(c) 1250 (d) 50

**151.** A transistor is operated in common emitter configuration at $V_C = 2$V such that a change in the base current from 100 μA to 300 μA produces a change in the collector current from 10mA to 20 mA. The current gain is

(a) 50 (b) 75
(c) 100 (d) 25

**152.** In a *CE* transistor amplifier, the audio signal voltage across the collector resistance of 2kΩ is 2V. If the base resistance is 1kΩ and the current amplification of the transistor is 100, the input signal voltage is

(a) 0.1 V (b) 1.0 V
(c) 1 mV (d) 10 mV

**153.** The input resistance of a silicon transistor is 100 W. Base current is changed by 40 μ*A* which results in a change in collector current by 2 mA. This transistor is used as a common emitter amplifier with a load resistance of 4 KΩ. The voltage gain of the amplifier is

(a) 2000 (b) 3000
(c) 4000 (d) 1000

**154.** In a common emitter (CE) amplifier having a voltage gain G, the transistor used has transconductance 0.03 mho and current gain 25. If the above transistor is replaced with another one with transconductance 0.02 mho and current gain 20, the voltage gain will be

(a) 1.5 G (b) $\frac{1}{3}$ G
(c) $\frac{5}{4}$ G (d) $\frac{2}{3}$ G

# HINTS AND SOLUTIONS

## FACT/DEFINITION TYPE QUESTIONS

**1. (a)**

**2. (d)** In extrinsic semi conductor the number of holes are not equal to number of electrons i.e.,

$$n_h \neq n_e$$

In p - type $\quad n_h > n_e$

In n - type $\quad n_e > n_h$

**3. (c)** By doping, the band gap reduce from 1eV to 0.3 to 0.7 eV & electron can achieve this energy (0.3eV to 0.7eV) at room temperature & reach in C.B (conduction band).

**4. (c)** Electric conduction, in a semi conductors occurs due to both electrons & holes.

**5. (b)** **6. (d)**

**7. (b)** Resistivity of a semiconductor at room temp. is in between $10^{-5}\ \Omega$m to $10^{4}\ \Omega$m i.e. $10^{-3}$ to $10^{6}\ \Omega$cm

**8. (d)** The valency of semiconductor (Ge or Si) is four, hence it has 4 valence electrons in the outermost orbit of the Ge or Si-atom

**9. (c)**

**10. (b)** The forbidden energy gap for germanium crystal is 0.71 eV.

**11. (d)**

**12. (b)** The electrical conductivity of a semiconductor at 0 K is zero. Hence resistivity (= 1/electrical conductivity) is infinity.

**13. (d)** The temperature coefficient of resistance of a semiconductor is negative. It means that resistance decrease with increase of temperature.

**14. (a)** The acceptor valence band is close to the valence band of host crystal

**15. (c)** The donor valence band lies little below the conduction band of the host crystal

**16. (a)**

**17. (d)** For semiconductor, $n = AT^{3/2} e^{-\frac{E_g}{2KT}}$ ;

so $\; n \propto T^{3/2}$

**18. (c)**

**19. (c)** Semiconductors are insulators at low temperature

**20. (c)** **21. (a)** **22. (a)**

**23. (c)** When small amount of antimony (pentavalent) is added to germanium crystal then crystal becomes n-type semi conductor. Therefore, there will be more free electrons than holes in the semiconductor.

**24. (c)** The resistivity of conductor increases with increase in temperature. The resistivity of semiconductor decreases as the temperature increases.

**25. (c)** Copper is a conductor so its resistance decreases on decreasing temperature as thermal agitation decreases whereas germanium is semiconductor therefore on decreasing temperature resistance increases.

**26. (a)** Due to strong electronegativity of carbon.

**27. (d)** **28. (a)** **29. (a)** **30. (b)** **31. (a)**

**32. (b)** Forward bias opposes the potential barrier and if the applied voltage is more than knee voltage it cancels the potential barrier.

**33. (a)** Leakage current is the name given to the reverse current.

**34. (b)** In the reverse biasing of p-n junction, the voltage applied supports the barrier voltage across junction, which increases the width of depletion layer and hence increases its resistance.

**35. (c)** Zener diode is used as a voltage regulator i.e. for stabilization purposes.

**36. (a)** filter circuit eliminates a.c. component of rectified voltage obtained from p-n junction as a rectifier.

**37. (d)** Current in junction diode, $I = I_0\,(e^{eV/kT} - 1)$

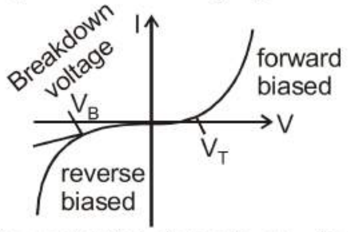
In forward biasing, V is positive ; In reverse bias V is negative. Then $I_r = I_0$

$$\frac{I_F}{I_r} = \frac{I_0\,(e^{eV/kT} - 1)}{I_0} = (e^{eV/kT} - 1)$$

**38. (c)**

**39. (b)** For easy flow of current the P side must be connected to +ive terminal of battery i.e., it is connected to higher potential in comparison to N. This connection is called forward biased. In this case the input resistance is very low.

In reverse-biased, the P-side is connected to –ive terminal & N side to (+ive) terminal to battery. In this case input resistance is very high.



**40. (b)** Barrier potential depends on, doping density, temperature, forward/reverse bias but does not depend on diode design.

**41. (c)** In reverse biasing, the conduction across the p-n junction does not take place due to majority carriers, but takes place due to minority carriers if the voltage of external battery is large. The size of the depletion region increases thereby increasing the potential barrier.

**42. (d)** In forward biasing of the p-n junction, the positive terminal of the battery is connected to p-side and the negative terminal of the battery is connected to n-side. The depletion region becomes thin.

**43. (a)** Both the depletion region and barrier height are reduced.

**44. (d)** During the formation of a junction diode, holes from p-region diffuse into n-region and electrons from n-region diffuse into p-region. In both cases, when an electrons meets a hole, they cancel the effect at each other and as a result, a thin layer at the junction becomes free from any of charges carriers. This is called depletion layer. There is a potential gradient in the depletion layer, negative on the p-side, and positive on the n-side. The potential difference thus developed across the junction is called potential barrier.

**45. (d)** **46. (c)** **47. (a)**

**48. (a)** The average value of output direct current in a half wave rectifier is = (average value of current over a cycle)/2 = $(2\,I_0/\pi)/2 = I_0/\pi$

**49. (d)** The average value of output direct current in a full wave rectifier = average value of current over a cycle = $2\,I_0/\pi$

**50. (b)** The r.m.s. value of a.c. component of wave is more than d.c. value due to barrier voltage of p-n junction used as rectifier.

**51. (c)** In transistor base is least doped, so that most of electrons emitted (in case of npn) from emitter reach to collector & less number of electrons are destroyed due to recombination with holes in base.

**52. (d)** $\beta = \frac{I_c}{I_b} > 1$ or $I_c > I_b$

**53. (c)** $\alpha = \frac{I_c}{I_e} < 1$ or $I_c < I_e$

**54. (d)** Operating point of a transistor is zero signal value of $I_c$ and $V_{CE}$.

**55. (d)** A transistor is a current operating device in which the emitter current controls the collector current

**56. (c)** An amplifier can be both a single stage and multistage

**57. (d)** In common emitter circuit, the current gain is highest

**58. (d)** **59. (a)**

**60. (c)** The size (or length) of collector is large in comparison to emitter (base is very small in comarison to both collector & emitter) to dissipate the heat.

**61. (d)**

**62. (a)** Negative feed back to a transistor increases stability in the working of transistor.

**63. (a)**

**64. (d)** Zero; In common base amplifier circuit, input and output voltage are in the same phase.

**65. (b)**

**66. (a)** Metal oxides with high temperature coefficient of resistivity.

**67. (d)**

**68. (d)** The biasing of the transistor is done differently for different uses. The transistor works as an amplifier with its emitter-base junction forward biased and the base-collector junction reverse biased.

**69. (d)** Holes move from base to emmitter.

**70. (a)** **71. (b)** **72. (a)**

**73. (d)** Relation between A, B and C shows that $C = \overline{AB}$
So NAND Gate

**74. (d)** The given truth table is for NAND gate.

**75. (b)** Combination of NAND & NOR gates can produce OR, AND & NOT gates

## STATEMENT TYPE QUESTIONS

**76.** **(c)**

**77.** **(b)** Majority carriers in an n-type semiconductor are electrons.

**78.** **(b)** In a n-type semiconductor holes are minority carriers and pentavalent atoms are dopants.

**79.** **(b)** Simple excitations like light, heat or small applied voltage can change the number of mobile charges in a semiconductor. In general energy of sound is not sufficient to excite electrons.

**80.** **(d)** A necessary condition to attain this is that the sizes of the dopant and the semiconductor atoms should be nearly the same.
There are two types of dopants used in doping the tetravalent Si or Ge :
(i) Pentavalent (valency 5) like Arsenic (As), Antimony (Sb), Phosphorous (P), etc.
(iii) Trivalent (valency 3) like Indium (In), Boron (B) , Aluminium (Al), etc.

**81.** **(d)** When an electlron diffuses from $n \rightarrow$ P, it leaves behind an ionised donor (species which has becomes ion by donating electron) on *n*-side. This ionised donor (positive charge) is immobile as it is bonded to the surrounding atoms. As the electrons continue to diffuse from *n*-P, a layer of positive charge (or positive space-charge region) on n-side of the juction is developed. On P-side atom receiving electrons is ionised acceptor.

**82.** **(d)** In forward biasing due to the applied voltage, electrons from n-sdie cross the depletion region and reach P-side (where they are minority carriers).

**83.** **(b)** Base of a transistor is thin and lightly doped, base-emitter region is in forward biased whereas collector is in reverse biased.

## MATCHING TYPE QUESTIONS

**84.** **(a)** (A) → (3); (B) → (2); (C) → (1)
**85.** **(d)** (A) → (4); (B) → (3); (C) → (2); (D) → (1)
**86.** **(c)** (A) → (3); (B) → (1); (C) → (2); (D) → (4)
**87.** **(b)** (A) → (3); (B) → (2); (C) → (1); (D) → (4)

## DIAGRAM TYPE QUESTIONS

**88. (d)** Positive terminal is at lower potential (0V) and negative terminal is at higher potential 5V.

**89. (b)** In circuit 2, each p-n junction is forward biased, hence same current flows giving same potential difference across p-n junction.

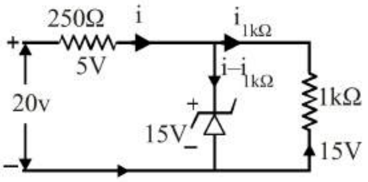
In circuit 3, each p-n junction is reverse biased, and due to the flow of same leakage current, giving equal potential difference across p-n junction.

**90.** **(a)** The current will flow through $R_L$ when the diode is forward biased.

**91.** **(d)** The input signal should be connected between two points of bridge rectifier such that in positive half wave of input signal, one p-n junction should be forward biased and other should be reverse biased and in negative half wave of input signal, the reverse should take place. It will be so when input is connected between B and D.

**92.** **(d)** In forward biasing, the diode conducts. For ideal junction diode, the forward resistance is zero; therefore, entire applied voltage occurs across external resistance R i.e., there occur no potential drop, but potential across R is V in forward biased.

**93.** **(d)** Voltage across zener diode is constant.



Current in 1kΩ resistor,

$$(i)_{1k\Omega}=\frac{15\text{volt}}{1k\Omega}=15\text{ mA}$$

Current in 250Ω resistor,

$$(i)_{250\Omega}=\frac{(20-15)V}{250\Omega}=\frac{5V}{250\Omega}$$

$$=\frac{20}{1000}A=20\text{ mA}$$

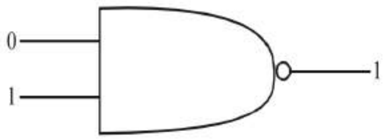
$$\therefore\ (i)_{\text{zener diode}}=(20-15)=5\text{mA}.$$

**94.** **(d)** (A) is a NAND gate so output is $\overline{1\times1}=\bar{1}=0$

(B) is a NOR gate so output is $\overline{0+1}=\bar{1}=0$

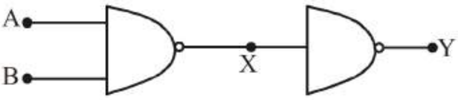
(C) is a NAND gate so output is $\overline{0\times1}=\bar{0}=1$

(D) is a XOR gate so output is $0\oplus0=0$



Following is NAND Gate $Y=\overline{AB}$

**95.** **(b)**



$X=\overline{AB}$

$\therefore Y=\overline{X}=\overline{\overline{AB}}$

$Y=AB$ by Demorgan theorem

∴ This diagram performs the function of AND gate.

**96.** **(a)** From the given waveforms, the truth table is as follows.

| *A* | *B* | *Y* |
|---|---|---|
| 1 | 1 | 0 |
| 0 | 0 | 1 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |

The above truth table is for NAND gate.

Therefore, the logic gate is NAND gate.

**97.** **(a)**

| *A* | 0 | 1 | 1 | 0 |
|---|---|---|---|---|
| *B* | 0 | 0 | 1 | 1 |
| *C* | 1 | 1 | 1 | 1 |

OR gate

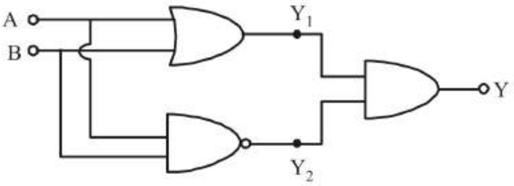
**98.** **(b)** Output of upper AND gate $=\overline{A}B$

Output of lower AND gate $=A\overline{B}$

$\therefore$ Output of OR gate, $Y=A\overline{B}+B\overline{A}$

This is boolean expression for XOR gate.

**99.** **(b)**



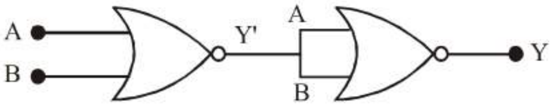
$Y_1=A+B,\ Y_2=\overline{A.B}$

$Y=(A+B)\bullet\overline{AB}=A\bullet\overline{A}+A\bullet\overline{B}+B\bullet\overline{A}+B\bullet\overline{B}$

$=0+A\bullet\overline{B}+B\bullet\overline{A}+0=A\bullet\overline{B}+B\bullet\overline{A}$

This expression is for XOR

**100.** **(c)**



$Y'=\overline{A+B}.\quad Y=\overline{\overline{A+B}}=A+B.$

Truth table of the given circuit is given by

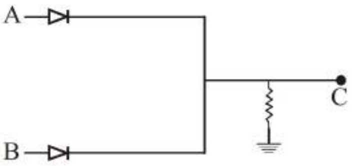
| A | B | Y' | Y |
|---|---|---|---|
| 0 | 0 | 1 | 0 |
| 0 | 1 | 0 | 1 |
| 1 | 0 | 0 | 1 |
| 1 | 1 | 0 | 1 |

**101. (b)** From input signals, we have,

| A | B | Output NAND gate |
|---|---|---|
| 0 | 0 | 1 |
| 1 | 0 | 1 |
| 0 | 0 | 1 |
| 1 | 1 | 0 |
| 0 | 0 | 1 |

The output signal is shown at B.

**102. (d)**



The truth table for the above logic gate is :

| A | B | C |
|---|---|---|
| 1 | 1 | 1 |
| 1 | 0 | 1 |
| 0 | 1 | 1 |
| 0 | 0 | 0 |

This truth table follows the boolean algebra

C = A + B which is for OR gate

**103. (d)** Here $Y = \overline{(\overline{A}+\overline{B})} = \overline{\overline{A}}.\overline{\overline{B}} = A \cdot B$. Thus it is an AND gate for which truth table is

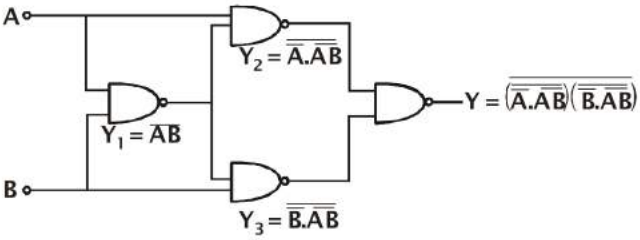
| $A$ | $B$ | $Y$ |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 0 |
| 1 | 0 | 0 |
| 1 | 1 | 1 |

**104. (a)** The final boolean expression is,

$$X = \overline{\left(\overline{A}.\overline{B}\right)} = \overline{\overline{A}} + \overline{\overline{B}} = A + B \Rightarrow \text{OR gate}$$

**105. (c)** (W + X) . (W + Y) = W + (X . Y)

**106. (a)**



By expanding this Boolen expression

$$Y = A.\overline{B} + B.\overline{A}$$

Thus the truth table for this expression should be (a).

## ASSERTION- REASON TYPE QUESTIONS

**107. (a)** In semiconductors, by increasing temperature, covalent bond breaks and conduction hole and electrons increase.

**108. (a)** In semiconductors the energy gap between conduction band and valence band is small (≈1 eV). Due to temperature rise, electron in the valence band gain thermal energy and may jumpy across the small energy gap, (to the conduction band). Thus conductivity increases and hence resistance decreases.

**109. (c)**

**110. (d)** There is no charge on P-type semiconductor, because each atom of semiconductor is itself neutral.

**111. (c)** Silicon is cheaper than germanium, so it is preferred over germanium. But energy gap in germanium is smaller than silicon.

**112. (a)** **113. (a)**

**114. (b)** Study of junction diode characteristics shows that the junction diode offers a low resistance path, when forward biased and high resistance path when reverse biased. This feature of the junction diode enables it to be used as a rectifier.

**115. (c)** Statement - 1 is True, Statement- 2 is False

**116. (b)** Diffusion current is due to the migration of holes and electrons into opposite regions, so it will be from p-side to n-side. Also in forward bias it will increases.

**117. (a)** **118. (a)**

**119. (a)** Input impedance of common emitter configuration.

$$= \left|\frac{\Delta V_{BE}}{\Delta i_B}\right|_{V_{CE} = \text{constant}}$$

where $\Delta V_{BE}$ = voltage across base and emitter (base emitter region is forward biased)

$\Delta i_B$ = base current which is order of few microampere.

**120. (a)** A NOT gate puts the input condition in the opposite order, means for high input it give low output and for low input it give high output. For this reason NOT gate is known as invertor circuit.

**121. (a)** These gates are called digital building blocks because using these gates only (either NAND or NOR) we can compile all other gates also (like OR, AND, NOT, XOR)

## CRITICAL THINKING TYPE QUESTIONS

**122. (d)** $n_i^2 = n_e n_h$

$(1.5 \times 10^{16})^2 = n_e(4.5 \times 10^{22})$

$\Rightarrow \quad n_e = 0.5 \times 10^{10}$

or $\quad n_e = 5 \times 10^9$

Given $\quad n_h = 4.5 \times 10^{22}$

$\Rightarrow n_h >> n_e$

$\therefore$ Semiconductor is p-type and

$n_e = 5 \times 10^9\ m^{-3}$.

**123. (b)** Conductivity $\sigma = n_i e \mu_e = 10^{17} \times (1.6 \times 10^{-19}) \times 3800$

$= 60.8$ mho/cm

**124. (b)** $I = nAev_d$ or $I \propto nv_d$

$$\therefore \quad \frac{I_e}{I_h} = \frac{n_e v_e}{n_h v_h} \text{ or } \frac{n_e}{n_h} = \frac{I_e}{I_h} \times \frac{v_h}{v_e} = \frac{7}{4} \times \frac{4}{5} = \frac{7}{5}$$

**125. (a)** Conductivity, $\sigma = \frac{1}{\rho} = e(n_e\mu_e + n_h\mu_h)$

ie, $2.13 = 1.6 \times 10^{-19}(0.38 + 0.18)\, n_i$

(Since in intrinsic semi-conductor, $n_e = n_h = n_i$)

$\therefore$ density of charge carriers, $n_i$

$$= \frac{2.13}{1.6 \times 10^{-19} \times 0.56} = 2.37 \times 10^{19}\ m^{-3}$$

**126. (b)** Given : $\mu_e = 2.3\ m^2\ V^{-1}\ s^{-1}$

$\mu_h = 0.01\ m^2\ V^{-1}\ s^{-1}$, $n_e = 5 \times 10^{12} / cm^3$

$= 5 \times 10^{18}/m^3\ n_h = 8 \times 10^{13}/cm^3 = 8 \times 10^{19}/m^3$.

Conductivity $\sigma = e[n_e\mu_e + n_h\mu_h]$

$= 1.6 \times 10^{-19}[5 \times 10^{18} \times 2.3 + 8 \times 10^{19} \times 0.01]$

$= 1.6 \times 10^{-1}[11.5 + 0.8]$

$= 1.6 \times 10^{-1} \times 12.3 = 1.968\ \Omega^{-1}\ m^{-1}$.

**127. (b)** $\lambda = \frac{hc}{E} = \frac{6.62 \times 10^{-34} \times 3 \times 10^8}{(60 \times 10^{-3} \times 1.6 \times 10^{-19})} = 2.07 \times 10^{-5}$ m

**128. (c)** $\frac{I_e}{I_h} = \frac{n_e eAv_e}{n_h eAv_h} \Rightarrow \frac{7}{4} = \frac{7}{5} \times \frac{v_e}{v_h}$

$$\Rightarrow \frac{v_e}{v_h} = \frac{5}{4}$$

**129. (c)** $E = \frac{V}{d} = \frac{0.1}{10^{-6}} = 10^5\ V/m$

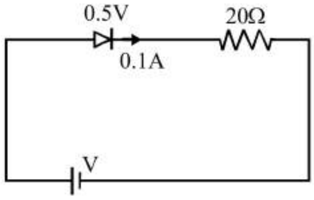
**130. (b)** Reverse resistance

$$= \frac{\Delta V}{\Delta I} = \frac{1}{0.5 \times 10^{-6}} = 2 \times 10^6\,\Omega$$

**131. (c)** Forward bias resistance $= \frac{\Delta V}{\Delta I}$

$$= \frac{(0.7 - 0.6)V}{(15 - 5)mA} = \frac{0.1}{10 \times 10^{-3}} = 10\,\Omega.$$

**132. (c)** $V' = V + IR = 0.5 + 0.1 \times 20 = 2.5\ V$



**133. (c)** When no current flows at the junction plane, then contact potential of junction plane is equal to the forward voltage applied = 0.045 V

**134. (c)** $V = \frac{V_o}{\pi} = \frac{10}{\pi} V$

**135. (d)** Here $D_1$ is in forward bias and $D_2$ is in reverse bias so, $D_1$ will conduct and $D_2$ will not conduct. Thus, no current will flow through *DC*.

$$I = \frac{V}{R} = \frac{5}{10} = \frac{1}{2}\text{ Amp.}$$

**136. (b)** In half wave rectifier, we get the output only in one half cycle of input a.c. therefore, the frequency of the ripple of the output is same as that of input a.c. i.e. 50 Hz

**137. (d)** In full wave rectifier, we get the output for the positive and negative cycle of input a.c. Hence the frequency of the ripple of the output is twice than that of input a.c. i.e. 100 Hz

**138. (b)** In half wave rectifier only half of the wave is rectified

**139. (d)** In common emitter configuration current gain

$$A_i = \frac{-h_{fe}}{1 + h_{oe}R_L} = \frac{-50}{1 + 25 \times 10^{-6} \times 1 \times 10^3} = -48.78$$

Where $h_{fe}$ = forward current ratio

$h_{oe}$ = output admittance.

**140. (a)** $I_C = 5.488$ mA, $I_e = 5.6$ mA

$$\alpha = \frac{5.488}{5.6}, \ \beta = \frac{\alpha}{1 - \alpha} = 49$$

**141. (c)** $I_C = I_E - I_B = 90 - 1 = 89$ m A

**142. (c)** Voltage amplification $A_v = \beta\frac{R_o}{R_i} = 60 \times \frac{5000}{500} = 600$

**143. (c)** Current gain, $\alpha = \frac{A_V}{A_R} = \frac{2800}{3000} = 0.93$

**144. (b)** Voltage gain, $A_v = \beta\frac{R_L}{R_i} = 0.6 \times \frac{24}{3} = 4.8$

**145. (d)** Current gain in common emitter mode

$$= \frac{\alpha}{1 - \alpha} = \frac{0.995}{1 - 0.995} = \frac{0.995}{0.005} = 199.$$

**146. (c)** No. of electrons reaching the collector,

$$n_C = \frac{96}{100} \times 10^{10} = 0.96 \times 10^{10}$$

Emitter current, $I_E = \frac{n_E \times e}{t}$

Collector current, $I_C = \frac{n_C \times e}{t}$

∴ Current transfer ratio,

$$\alpha = \frac{I_C}{I_E} = \frac{n_C}{n_E} = \frac{0.96 \times 10^{10}}{10^{10}} = 0.96$$

**147. (d)** $i_B = \frac{V_s}{R_{in}} = \frac{0.01}{10^3} = 1 \times 10^{-5} \text{ A}$

Now β of transistor is defined as $\beta_{ac} = \frac{i_c}{i_b}$

or $i_c = 50 \times 10^{-5} = 500 \mu\text{A}$ ]

**148. (b)** Current gain $= \frac{\Delta I_C}{\Delta I_B}$ when $V_{CE}$ is constant.

$$= \frac{2.5 \times 10^{-3}}{25 \times 10^{-6}} = 0.1 \times 10^3 = 100$$

$[\Delta I_B = 125\ \mu\text{A} - 100\ \mu\text{A} = 25\ \mu\text{A}$

$\Delta I_C = 7.5\text{ mA} - 5\text{ mA} = 2.5\text{ mA}]$

**149. (b)** $\frac{V_o}{V_{in}} = \frac{R_o}{R_{in}} \times \beta = \frac{5 \times 10^3 \times 62}{500} = 10 \times 62 = 620$

$V_o = 620 \times V_{in} = 620 \times 0.01 = 6.2\text{ V}$

$\therefore V_o = 6.2$ volt.

**150. (c)** Power gain = voltage gain × current gain

$$= V_G \cdot I_G = \frac{V_0}{V_i} \cdot \frac{I_0}{I_i}$$

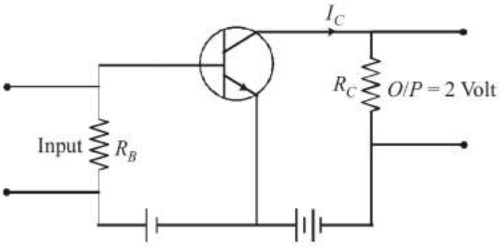
$$= \frac{V_0^2}{V_i^2} \cdot \frac{R_i}{R_0} = 50 \times 50 \times \frac{100}{200}$$

$$= \frac{2500}{2} = 1250$$

**151. (a)** The current gain

$$\beta = \frac{\Delta I_C}{\Delta I_B} = \frac{10\text{mA}}{200\mu\text{A}} = \frac{10 \times 10^3}{200} = 50$$

**152. (d)**



The output voltage, across the load $R_C$

$V_0 = I_C R_C = 2$

The collector current $(I_C)$

$$I_C = \frac{2}{2 \times 10^3} = 10^{-3} \text{ Amp}$$

Current gain (β)

$$(\beta) \text{ current gain} = \frac{I_C}{I_B} = 100$$

$$I_B = \frac{I_C}{100} = \frac{10^{-3}}{100} = 10^{-5} \text{ Amp}$$

Input voltage $(V_i)$

$V_i = R_B I_B = 1 \times 10^3 \times 10^{-5} = 10^{-2}$ Volt

$V_i = 10\text{mV}$

**153. (a)** Voltage gain $(A_V) = \frac{V_{out}}{V_{in}} = \frac{I_{out}}{I_{in}} \times \frac{R_{out}}{R_{in}}$

$$A_V = \frac{2 \times 10^{-3}}{40 \times 10^{-6}} \times \frac{4 \times 10^3}{100} = 2 \times 100 = 2000$$

**154. (d)** Voltage gain $\Delta_V = \beta \frac{R_{out}}{R_{in}}$

$$\Rightarrow G = 25 \frac{R_{out}}{R_{in}} \qquad \text{...(i)}$$

Transconductance $g_m = \frac{\beta}{R_{in}}$

$$\Rightarrow R_{in} = \frac{\beta}{g_m} = \frac{25}{0.03}$$

Putting this value of $R_{in}$ in eqn. (i)

$$G = 25 \frac{R_{out}}{25} \times 0.03 \qquad \text{...(ii)}$$

$$\therefore \quad G' = 20 \frac{R_{out}}{20} \times 0.02 \qquad \text{...(iii)}$$

From eqs. (ii) and (iii)

Voltage gain of new transistor $G' = \frac{2}{3} G$