SEMICONDUCTOR ELECTRONICS-MATERIALS, DEVICES AND SIMPLE CIRCUITS

Single Correct Answer Type

1. In a common emitter configuration of a transistor, the voltage drop across a 500Ω resistor in the collector circuit is $0.5\ V$ when the collector supply voltage is 0.96, the base current is
a) $\frac{1}{20}\mu A$ b) $\frac{1}{5}\mu A$ c) $\frac{1}{20}mA$ d) $\frac{1}{24}mA$

2. A Zener diode is used for
a) Rectification b) Modulation c) Detection d) Voltage regulation

3. The output form of a full wave rectifier is
a) An AC voltage b) A DC voltage
c) Zero d) A pulsating unidirectional voltage

4. If n_E and n_H represent the number of free electrons and holes respectively in a semiconducting material, then for n-type semiconducting material
a) $n_E << n_H$ b) $n_E >> n_H$ c) $n_E = n_H$ d) $n_E = n_H = 0$

5. To a germanium sample, traces of gallium are added as an impurity. The resultant sample would behave like
a) A conductor b) A P-type semiconductor
c) An N-type semiconductor d) An insulator

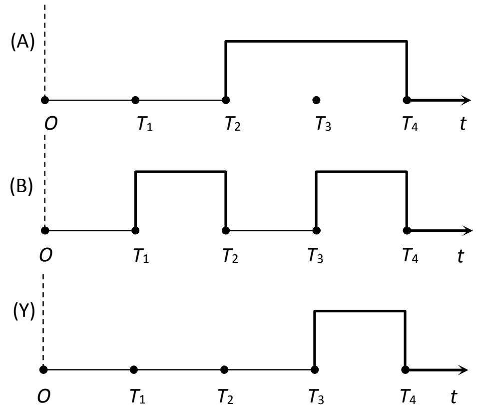
6. A solid which is not transparent to visible light and whose conductivity increases with temperature is formed by
a) Ionic binding b) Covalent binding
c) van der Waal's binding d) Metallic binding

7. Which of the following is an amorphous solid
a) Glass b) Diamond c) Salt d) Sugar

8. In a NPN transistor, 108 electrons enter the emitter in $10^{-8}s$. If 1% electrons are lost in the base, the fraction of current that enters the collector and current amplification factor are respectively
a) 0.8 and 49 b) 0.9 and 90 c) 0.7 and 50 d) 0.99 and 99

9. In the middle of the depletion layer of reverse biased p-n junction, the
a) Electric field is zero b) Potential is maximum
c) Electric field is maximum d) Potential is zero

10. The given figure shows the wave forms for two inputs A and B and that for the output Y of a logic circuit. The logic circuit is



a) An AND gate b) An OR gate c) A NAND gate d) An NOT gate

11. A gate has the following truth table

P	1	1	0	0
Q	1	0	1	0
R	1	0	0	0

The gate is

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

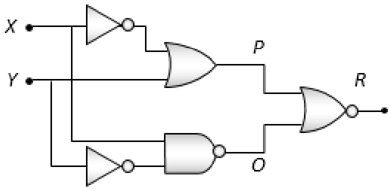
12. An intrinsic semiconductor at 0 K temperature behaves like

a) Conductor b) p-type semiconductor
c) n-type semiconductor d) Insulator

13. Silicon is a semiconductor. If a small amount of As is added to it, then its electrical conductivity

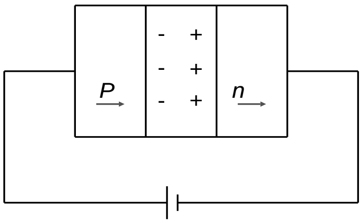
A) Decreases b) Increases c) Remains unchanged d) Becomes zero

14. Figure gives a system of logic gates. From the study of truth table it can be found that to produce a high output (1) at R, we must have

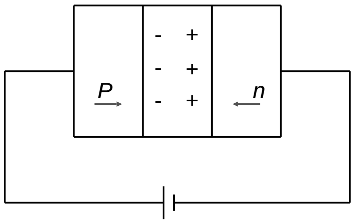


a) $X = 0, Y = 1$ b) $X = 1, Y = 1$ c) $X = 1, Y = 0$ d) $X = 0, Y = 0$

15. In the case of forward biasing of a p-n junction diode, which one of the following figures correctly depicts the direction of conventional current (indicated by an arrow mark)?



a)



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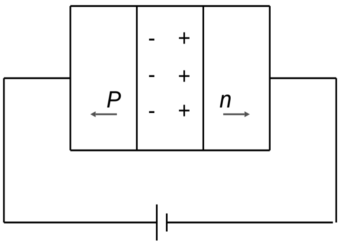
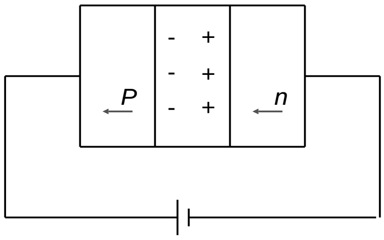


c)



d)

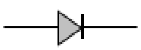
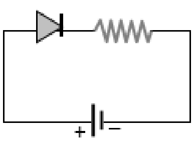
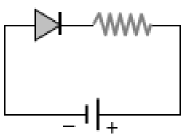
16. The current gain α of a transistor is 0.9. The transistor is connected to common base configuration. What would be the change in collector current when base current changes by 4 mA?

a) 1.2 mA b) 12 mA c) 24 mA d) 36 mA

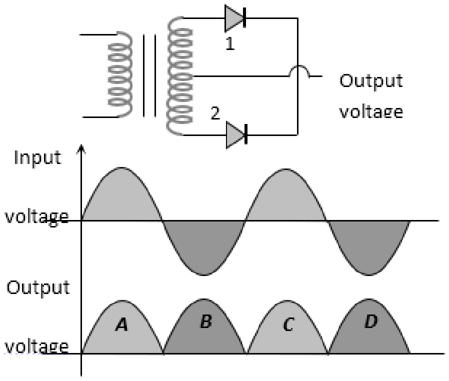
17. In a junction diode, the direction of diffusion current is

a) From n-region to p-region
b) From p-region to n-region
c) From n-region to p-region if the junction is forward baised and *vice versa* if it is reverse baised
d) From p-region to n-region if the junction is forward baised and *vice versa* if it is reversed baised

18. Which one is in forward bias

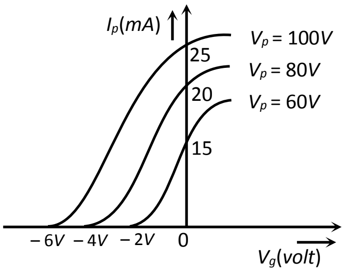
a)  b)  c)  d) None of these

19. Doping of intrinsic semiconductor is done
a)To neutralize charge carriers
b)To increase the concentration of majority charge carriers
c)To make it neutral before disposal
d)To carry out further purification
20. The average value of output direct current in a half wave rectifier is
a) I_0/π b) $I_0/2$ c) $\pi I_0/2$ d) $2I_0/\pi$
21. The device that can act as a complete electronic circuit is
a)Zener diode b) Junction diode c) Integrated circuit d) Junction transistor
22. An amplifier has a voltage gain $A_V = 1000$. The voltage gain in dB is
a) 30 dB b) 60 dB c) 3 dB d) 20 dB
23. A full wave rectifier circuit along with the input and output voltages is shown in the figure



The contribution to output voltage from diode −2 is
a) A, C b) B, D c) B, C d) A, D
24. Consider an NPN transistor amplifier in common-emitter configuration. The current gain of the transistor is 100. If the collector current changes by 1 mA, what will be the change in emitter current
a) 1.1 mA b) 1.01 mA c) 0.01 mA d) 10 mA
25. The depletion layer in a silicon diode is 1 μm wide and its knee potential is 0.6 V, then the electric field in the depletion layer will be
a) 0.6 Vm^{-1} b) $6 \times 10^4 \text{ Vm}^{-1}$ c) $6 \times 10^5 \text{ Vm}^{-1}$ d) Zero
26. In a properly biased transistor
a)Both depletion layers are equally large
b)Both depletion layers are equally small
c)Emitter-base depletion layer is large but base-collector depletion layer is small
d)Emitter-base depletion layer is small but base-collector depletion layer is large
27. Boolean algebra is essentially based on
a)Truth b) Logic c) Symbol d) Numbers
28. The energy gap between conduction band and the valence band is of the order of 0.7 eV. Then it is
a)An insulator b)A conductor c) A semiconductor d) An alloy
29. For a triode
a) $\mu = r_p \times g_m$ b) $g_m = \mu \times r_p$ c) $r_p = \mu \times g_m$ d) $\mu = \frac{r_p}{(r_p + g_m)}$
30. The amplification factor of a triode valve is 15. If the grid voltage is changed by 0.3 $volt$ the change in plate voltage in order to keep the plate current constant (in volt) is
a) 0.02 b) 0.002 c) 4.5 d) 5.0

31. The variation of anode current in a triode corresponding to a change in grid potential at three different values of the plate potential is shown in the diagram. The mutual conductance of the triode is

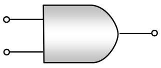


a) 2.5 $m\ mho$ b) 5.0 $m\ mho$ c) 7.5 $m\ mho$ d) 10.0 $m\ mho$

32. A piece of semiconductor is connected in series in an electric circuit. On increasing the temperature, the current in the circuit will

a) Decrease b) Remain unchanged c) Increase d) Stop flowing

33. Which logic gate is represented by following diagram



a) AND b) OR c) NOR d) XOR

34. Solids having highest energy level partially filled with electrons are

a) Semiconductor b) Conductor c) Insulator d) None of these

35. In a PN-junction

a) P and N both are at same potential
b) High potential at N side and low potential at P side
c) High potential at P side and low potential at N side
d) Low potential at N side and zero potential at P side

36. In a diode, when there is a saturation current, the plate resistance will be

a) Data insufficient b) Zero c) Some finite quantity d) Infinite quantity

37. As n-type and a p-type silicon semiconductor can be obtained by doping pure silicon with

a) Sodium and magnesium
b) Phosphorus and boron respectively
c) Boron and phosphorus respectively
d) Indium and sodium respectively

38. In a triode amplifier, $\mu = 25, r_p = 40$ kilo ohm and load resistance $R_L = 10$ kilo ohm. If the input signal voltage is 0.5 volt, then output signal voltage will be

a) 1.25 $volt$ b) 5 $volt$ c) 2.5 $volt$ d) 10 $volt$

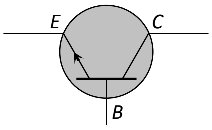
39. The main cause of zener breakdown is

a) The base semiconductor being germanium
b) Production of electron-hole pairs due to thermal excitation
c) Low doping
d) High doping

40. A pure semiconductor behaves slightly as a conductor at

a) Room temperature b) Low temperature c) High temperature d) Both (b) and (c)

41. The symbol given in figure represents



a) NPN transistor b) PNP transistor
c) Forward biased PN junction diode d) Reverse biased NP junction diode

42. Wires P and Q have the same resistance at ordinary (room) temperature. When heated, resistance of P increases and that of Q decreases. We conclude that
a) P and Q are conductors of different materials
b) P is N-type semiconductor and Q is P-type semiconductor
c) P is semiconductor and Q is conductor
d) P is conductor and Q is semiconductor

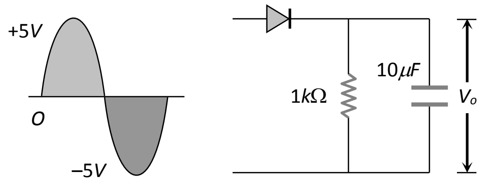
43. Least doped region in a transistor
a) Either emitter or collector b) Base
c) Emitter d) Collector

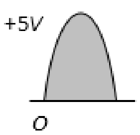
44. A strip of copper and another of germanium are cooled from room temperature to 80 K. the resistance of
a) Each of these decreases
b) Copper strip increases and that of germanium decreases
c) Copper strip decreases and that of germanium increases
d) Each of the above increases

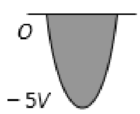
45. Boolean expression for OR gate is
a) $Y = A.B$ b) $Y = \bar{A} + \bar{B}$ c) $Y = A + B$ d) $Y = \bar{A}$

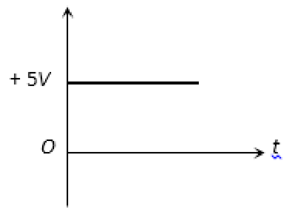
46. A silicon diode has a threshold voltage of 7 V. If an input voltage given by 2 sin $(\pi\, t)$ is supplied to a half-wave rectifier circuit using this diode, the rectified output has a peak value of
a) 2 V b) 1.4 V c) 1.3 V d) 0.7 V

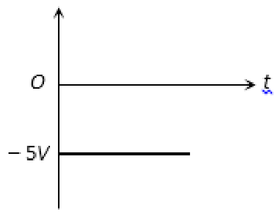
47. The output in the circuit of figure is taken across a capacitor. It is as shown in figure



a) 

b) 

c) 

d) 

48. Energy bands in solids are a consequence of
a) Ohm's law b) Pauli's exclusion principle
c) Bohr's theory d) Heisenberg's uncertainty principle

49. Diode is used as a/an
a) Oscillator b) Amplifier c) Rectifier d) Modulator

50. Why is there sudden increase in current in zener diode?
a) Due to rupture of bonds
b) Resistance of depletion layer becomes less
c) Due to high doping
d) None of the above

51. The impurity atom added to germanium to make it N-type semiconductor is
a) Arsenic b) Iridium c) Aluminium d) Iodine

52. The value of ripple factor for full wave rectifier is
a) 40.6% b) 48.2% c) 81.2% d) 121%

53. Mutual conductance of triode is 2 mΩ^{-1} and the amplification factor is 50. Its anode is connected with a source of 250 V and a resistance of 25 kΩ. The voltage gain of this amplifier is
a) 12.5 b) 10 c) 25 d) 50

54. In an experiment, the saturation in the plate current in a diode is observed at $240V$. But a student still wants to increase the plate current. It can be done, if
a) The plate voltage is increased further
b) The plate voltage is decreased
c) The filament current is decreased
d) The filament current is increased

55. The addition of antimony atoms to a sample of intrinsic germanium transforms it to a material which is
a) Superconductor
b) An insulator
c) N-type semiconductor
d) P-type semiconductor

56. Which one of the following statement is FALSE
a) The resistance of intrinsic semiconductor decreases with increase of temperature
b) Pure SI doped with trivalent impurities gives a p-type semiconductor
c) Majority carriers in a n-type semiconductor are holes
d) Minority carriers in a p-type semiconductor are electrons

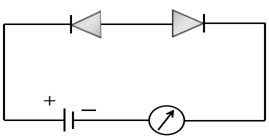
57. Number of secondary electrons emitted per number of primary electrons depends on
a) Material of target
b) Frequency of primary electrons
c) Intensity
d) None of the above

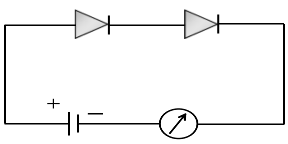
58. The concentration of impurities in a transistor are
a) Equal for the emitter, base and collector regions
b) Least for the emitter region
c) Largest for the emitter region
d) Largest for the base region

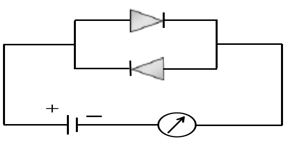
59. The probability of electrons to be found in the conduction band of an intrinsic semiconductor at a finite temperature
a) Decreases exponentially with increasing band gap
b) Increases exponentially with increasing band gap
c) Decreases with increasing temperature
d) Is independent of the temperature and the band gap

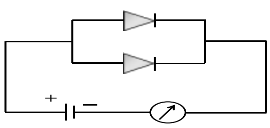
60. When A is the internal stage gain of an amplifier and β is the feedback ratio, then the amplifier becomes as oscillator if
a) β is negative and magnitude of $\beta = A/2$
b) β is negative and magnitude of $\beta = 1/A$
c) β is negative and magnitude of $\beta = A$
d) β is positive and magnitude of $\beta = 1/A$

61. Which circuit will not show current in ammeter

a) 

b) 

c) 

d) 

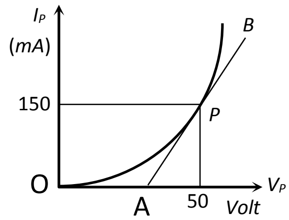
62. When the plate voltage of a triode is 150V, its cut-off voltage is −5 V. On increasing the plate voltage to 200 V, the cut-off voltage can be
a) −4.5 V b) −5.0 V c) −2.3 V d) −6.66 V

63. For germanium crystal, the forbidden energy gap in joules is
a) 1.12×10^{-19} b) 1.76×10^{-19} c) 1.6×10^{-19} d) Zero

64. The peak voltage in the output of a half-wave diode rectifier fed with a sinusoidal signal without filter is $10\ V$. The dc compound of the output voltage is
a) $10/\sqrt{2}\ V$ b) $10/\pi\ V$ c) $10\ V$ d) $20/\pi\ V$

65. If the ends p and n of $p-n$ diode 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 n-side to p-side
c) There will be a steady current from p-side to n-side
d) There will not be a current depending upon the resistance of the connecting wire

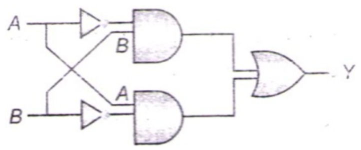
66. The plate characteristic curve of a diode in space charge limited region is as shown in the figure. The slope of curve at point P is $5.0\ mA/V$. The static plate resistance of diode will be



a) 111.1Ω b) 222.2Ω c) 333.3Ω d) 444.4Ω

67. To obtain electrons as majority charge carriers in a semiconductor, the impurity mixed is
a) Monovalent b) Divalent c) Trivalent d) Pentavalent

68. The truth table for the following logic circuit 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	1
1	0	1
1	1	1

c)

A	B	Y
0	0	1
0	1	0
1	0	1
1	1	0

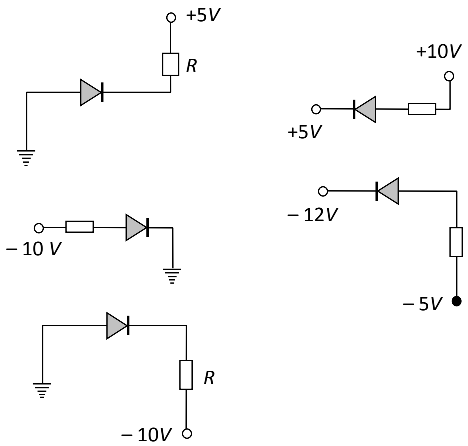
d)

A	B	Y
0	0	1
0	1	1
1	0	0
1	1	1

69. The voltage gain of an amplifier with 9% negative feedback is 10. The voltage gain without feedback will be
a) 1.25 b) 100 c) 90 d) 10

70. C and Si both have same lattice structure, having 4 bonding electrons in each. However, C is insulator where as Si is intrinsic semiconductor. This is because
a) In case of C the valance band is not completely filled at absolute zero temperature
b) In case of C the conduction band is partly filled even at absolute zero temperature
c) The four bonding electrons in the case of C lie in the second orbit, whereas in the case of Si they lie in the third
d) The four bonding electrons in the case of C lie in the third orbit, whereas for Si they lie in the fourth orbit

71. In the given figure, which of the diodes are forward biased



a) 1, 2, 3 b) 2, 4, 5 c) 1, 3, 4 d) 2, 3, 4

72. Suitable impurities are added to a semiconductor depending on its use. This is done to

a) Increase its life b) Enable it to withstand high voltage

c) Increase its electrical conductivity d) Increase its electrical resistivity

73. A change of 0.8 mA in the anode current of a triode occurs when the anode potential is changed by 10 V. If $\mu = 8$ for the triode, then what change in the grid voltage would be required to produce a change of 4 mA in the anode current

a) 6.25 V b) 0.16 V c) 15.2 V d) None of these

74. 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

75. The decimal equivalent of the binary number $(11010.101)_2$ is

a) 9.625 b) 25.265 c) 26.625 d) 26.265

76. Let n_e and n_h represent the number density of electrons and holes in a semiconductor. Then

a) $n_e > n_h$ if the semiconductor is intrinsic

b) $n_e < n_h$ if the semiconductor is intrinsic

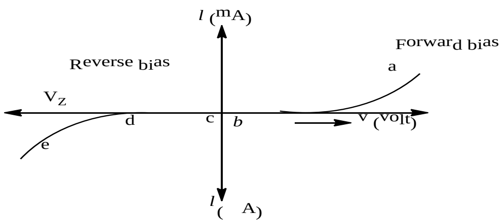
c) $n_e \neq n_h$ if the semiconductor is intrinsic

d) $n_e = n_h$ if the semiconductor is intrinsic

77. GaAs (with a band gap = 1.5 eV) as an LED can emit

a) Blue light b) Green light c) Ultraviolet rays d) Infrared rays

78. The graph given below represents the I-V characteristics of a zener diode. Which part of the characteristics curve is most relevant for its operation as a voltage regulator?



a) ab b) bc c) cd d) de

79. Electric conduction in semi-conductor takes place due to

a) Electrons only b) Holes only

c) Both electrons and holes d) None of the above

80. If the output of a logic gate is 0 when all its inputs are at logic 1, then the gate is either

a) NAND or Ex-NOR b) NOR or OR c) Ex-OR or NOR d) AND or NOR

81. $p - n$ junction is said to be forward biased, when

a)The positive pole of the battery is joined to the p-semiconductor and negative pole to the n-semiconductor
b)The positive pole of the battery is joined to the n-semiconductor and negative pole to the n-semiconductor and p-semiconductor
c)The positive pole of the battery is connected to n-semiconductor and p-semiconductor
d)A mechanical force is applied in the forward direction

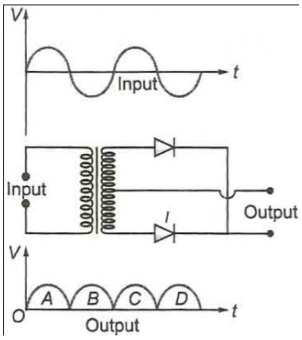
82. The voltage gain of triode amplifier is 30 and input voltage is $V_i = \sin 100\pi t$, then output voltage will be
a)$30 \sin 100\,\pi t$ b)$\sin 100\,\pi t$ c) $-30 \sin 100\,\pi t$ d)$-\sin 100\,\pi t$

83. Which one of the following is the weakest kind of bonding in solids
a)Ionic b)Metallic c) Vander Waals d)Covalent

84. If control grid is made negative, then the plate current will
a)Increase b)Remain constant
c)Decrease d)Cannot say from given data

85. 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)$I_e < I_c$

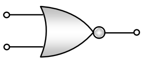
86. A full wave rectifier circuit along with the input and output are shown in the figure, the contribution from the diode I is (are)



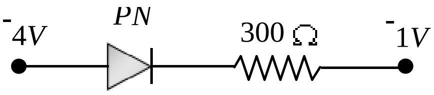
a)C b)A, C c) B, D d)A, B, C, D

87. The electrical conductivity of a semiconductor increases when electromagnetic radiation of wavelength shorter than 2480 nm, is incident on it. The band gap in (eV) for the semiconductor is
a)1.1 eV b)2.5 eV c) 0.5 eV d)0.7 eV

88. A common emitter amplifier given an output of 3 V for an input of 0.01 V. If β of the transistor is 100 and the input resistance is 1 kΩ, then the collector resistance is
a)1 kΩ b)3 kΩ c) 30 kΩ d)30 Ω

89. Symbol  represents
a)NAND gate b) NOR gate c) NOT gate d) XNOR gate

90. What is the current in the circuit shown below

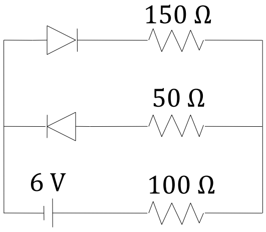


a)0 A b)10^{-2} A c) 1 A d)0.10 A

91. Two diodes have resistance 20 Ω and is centretapped with rms secondary voltage from centre tap to each end of secondary 50 V. If external resistance is 980 Ω. What is mean load?
a)0.05 A b)45 mA c) 0.25 A d)25 mA

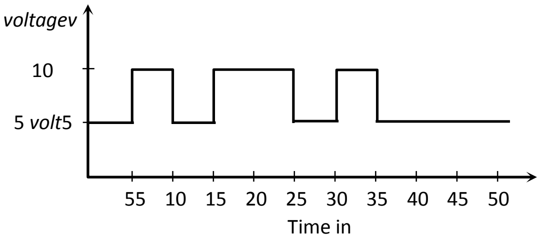
92. In a common emitter amplifier the input signal is applied across
a)Anywhere b)Emitter-collector c)Collector-base d)Base-emitter

93. The circuit shown in the figure contains two diodes each with a forward resistance of 50 Ω and with infinite backward resistance. If the battery is 6 V, the current through the 100 Ω resistance (in ampere) is



a)Zero b) 0.02 c)0.03 d)0.036

94. In a negative logic the following wave form corresponds to the



a)0000000000 b)0101101000 c) 1111111111 d)1010010111

95. In a transistor the collector current is always less than the emitter current because
a)Collector side is reverse biased and the emitter side is forward biased
b)A few electrons are lost in the base and only remaining ones reach the collector
c)Collector being reverse biased, attracts less electrons
d)Collector side is forward biased and the emitter side is reverse biased

96. For a crystal system, $a = b = c, \alpha = \beta = \gamma \neq 90°$, the system is
a) Tetragonal system b)Cubic system
c)Orthorhombic system d)Rhombohedral system

97. A gate in which all the inputs must be low to get a high output is called
a)A NAND gate b)An inverter c) A NOR gate d)An AND gate

98. Current gain in common emitter configuration is more than 1 becomes
a)$I_c < I_b$ b)$I_c < I_e$ c) $I_c > I_e$ d)$I_e > I_b$

99. For a common base configuration of PNP transistor $\frac{I_C}{I_E} = 0.96$ then maximum current gain in common emitter configuration will be
a)12 b)24 c) 6 d)5

100. In semiconductors at a room temperature
a)The valence band is partially empty and the conduction band is partially filled
b)The valence band is completely filled and the conduction band is partially filled
c)The valence band is completely filled
d)The conduction band is completely empty

101. A P-type semiconductor can be obtained by adding
a)Arsenic to pure silicon b)Gallium to pure silicon
c)Antimony to pure germanium d)Phosphorous to pure germanium

102. In a common base transistor circuit, the current gain is 0.98. On changing emitter current by 5.00 mA, the change in collector current is
a)0.196 mA b)2.45 mA c) 4.9 mA d)5.1 mA

103. The current gain α of a transistor in common base mode is 0.995. Its gain β in the common emitter mode is
a) 200 b) 99 c) 0.995 d) None of these

104. Which of the following has negative temperature coefficient of resistance
a) Copper b) Aluminium c) Iron d) Germanium

105. In the half wave rectifier circuit operating from 50 Hz mains frequency, the fundamental frequency in the rippel would be
a) 25 Hz b) 50 Hz c) 70.7 Hz d) 100 Hz

106. The truth table shown in figure is for

A	0	0	1	1
B	0	1	0	1
Y	1	0	0	1

a) XOR b) AND c) XNOR d) OR

107. When N-type of semiconductor is heated
a) Number of electrons increases while that of holes decreases
b) Number of holes increases while that of electrons decreases
c) Number of electrons and holes remains same
d) Number of electrons and holes increases equally

108. The valence band and conduction band of a solid overlap at low temperature, the solid may be
a) A metal b) A semiconductor c) An insulator d) None of these

109. Semiconductor is damaged by the strong current due to
a) Lack of free electron b) Excess of electrons
c) Excess of proton d) None of these

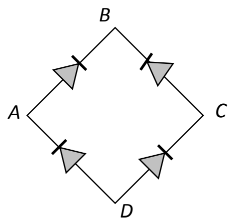
110. The charge on a hole is equal to the charge of
a) Zero b) Proton c) Neutron d) Electron

111. A truth table is given below. Which of the following has this type of truth table

A	0	1	0	1
B	0	0	1	1
y	1	0	0	0

a) XOR gate b) NOR gate c) AND gate d) OR gate

112. In the diagram, the input is across the terminals A and C and the output is across the terminals B and D, then the output is



a) Zero b) Same as input c) Full wave rectifier d) Half wave rectifier

113. A common emitter amplifier has a voltage gain of 50, an input impedance of 100 Ω and an output impedance of 200 Ω. The power gain of the amplifier is
a) 500 b) 1000 c) 1250 d) 100

114. The depletion layer in the P-N junction region is caused by
a) Drift of holes b) Diffusion of charge carriers
c) Migration of impurity ions d) Drift of electrons

115. Electrical conductivity of a semiconductor

a) Increases with the rise in its temperature
b) Decrease with the rise in its temperature
c) Decrease does not change with the rise in its temperature
d) First increase and then decreases with the rise in its temperature

116. In case of a $p - n$ junction diode at high value of reverse dias, the current rises sharply. The value of reverse bias is known as
a) Cut-off voltage b) Zener voltage c) Inverse voltage d) Critical voltage

117. In a common emitter transistor, the current gain is 80. What is the change in collector current, when the change in base current is 250 μA
a) $80 \times 250\ \mu A$ b) $(250 - 80)\mu A$ c) $(250 + 80)\mu A$ d) $250/80\ \mu A$

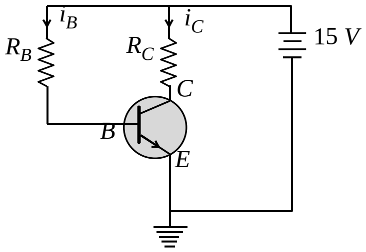
118. For a transistor the parameter $\beta = 99$. The value of the parameter is
a) 0.9 b) 0.99 c) 1 d) 9

119. In an NPN transistor the collector current is 24 mA. If 80% of electrons reach collector its base current in mA is
a) 36 b) 26 c) 16 d) 6

120. For a common emitter amplifier, the audio signal voltage across the collector resistance 2kΩ is 2 V. If the current amplification factor of the transistor is 220, and the base resistance is 1.5 Ω, the input signal voltage and base current are
a) 0.1 V and 1 μA b) 0.15 V and 10 μA c) 1.015 V and 1 A d) 0.0075 V and 5 μA

121. If a full wave rectifier circuit is operating from 50Hz mains, the fundamental frequency in the ripple will be
a) 70.7 Hz b) 100 Hz c) 25 Hz d) 59 Hz

122. In the following common emitter circuit if $\beta = 100, V_{CE} = 7V, V_{BE} =$ negligible, $R_C = 2\ k\Omega$ then $I_B =$?



a) 0.01 mA b) 0.04 mA c) 0.02 mA d) 0.03 mA

123. While a collector to emitter voltage is constant in a transistor, the collector current changes by 8.2 mA when the emitter current changes by 8.3 mA. The value of forward current ratio h_{fe} is
a) 82 b) 83 c) 8.2 d) 8.3

124. In NPN transistor, if doping in base region is increased then collector current
a) Increases b) Decreases c) Remains same d) None of these

125. GaAs is
a) Element semiconductor b) Alloy semiconductor
c) Bad conductor d) Metallic semiconductor

126. A silicon specimen is made into a p-type semiconductor by doping, on an average, one indium atom per 5×10^7 silicon atoms. If the number density of atoms in the silicon specimen is 5×10^{28} atoms m^{-3}, then the number of acceptor atoms in silicon per cubic centimeter will be
a) 2.5×10^{30} atom cm^{-3}
b) 2.5×10^{35} atom cm^{-3}
c) 1×10^{13} atom cm^{-3}
d) 1×10^{15} atom cm^{-3}

127. In a P-type semiconductor, the acceptor impurity produces an energy level
a) Just below the valence band b) Just above the conduction band

c) Just below the conduction band   d) Just above the valence band

128. When phosphorus and antimony are mixed in germanium, then

a) P-type semiconductor is formed   b) N-type semiconductor is formed

c) Both (a) and (b)   d) none of these

129. Consider the following statement A and B and identify the correct choice of the given answers

(A) A zener diode is always connected in reverse bias

(B) The potential barrier of a PN junction lies between 0.1 to 0.3 V approximately

a) A and B are correct   b) A and B are wrong

c) A is correct but B is wrong   d) A is wrong but B is correct

130. The relation between dynamic plate resistance (r_p) of a vacuum diode and plate current in the space charge limited region, is

a) $r_p \propto I_p$ b) $r_p \propto I_p^{3/2}$ c) $r_p \propto \frac{1}{I_p}$ d) $r_p \propto \frac{1}{(I_p)^{1/3}}$

131. When a semiconductor is heated, its resistance

a) Decreases   b) Increases   c) Remains unchanged   d) Nothing is definite

132. Energy gap between valence band and conduction band of a semiconductor is

a) Zero   b) Infinite   c) 1 eV   d) 10 eV

133. For a junction diode the ratio of forward current (I_F) and reverse current (I_r) is

$[I_e$ =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) $(e^{V/kT}-1)$

134. If no external voltage is applied across P-N junction, there would be

a) No electric field across the junction

b) An electric field pointing from N-type to P-type side across the junction

c) An electric field pointing from P-type to N-type side across the junction

d) A temporary electric field during formation of P-N junction that would subsequently disappear

135. In CE mode, the input characteristics of a transistor is the variation of

a) I_B against V_{BE} at constant V_{CE} b) I_C against V_{CE} at constant V_{BE}

c) I_B against I_C d) I_E against I_C

136. For a cubic crystal structure which one of the following relations indicating the cell characteristic is correct?

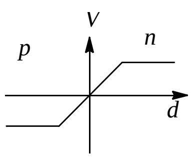
a) $a \neq b \neq c$ and $\alpha \neq \beta$ and $\gamma \neq 90^0$ b) $a \neq b \neq c$ and $\alpha = \beta = \gamma = 90^0$

c) $a = b = c$ and $\alpha \neq \beta \neq \gamma = 90^0$ d) $a = b = c$ and $\alpha = \beta = \gamma = 90^0$

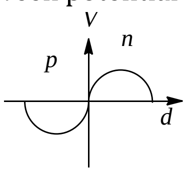
137. In a transistor in common-emitter configuration, the ratio of power gain to voltage gain is

a) α   b) $\frac{\beta}{\alpha}$ c) β × β   d) β

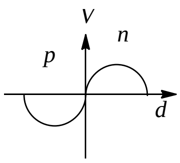
138. The correct curve between potential (V) and distance (d) near $p-n$ junction is



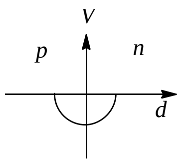
a)



b)



c)



d)

139. If β, R_L and r are the ac current gain, load resistance and the input resistance of a transistor respectively in CE configuration, the voltage and the power gains respectively are

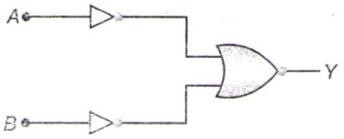
a) $\beta\frac{R_L}{r}$ and $\beta^2\frac{R_L}{r}$ b) $\beta\frac{r}{R_L}$ and $\beta^2\frac{r}{R_L}$ c) $\beta\frac{R_L}{r}$ and $\beta\left(\frac{R_L}{r}\right)^2$ d) $\beta\frac{r}{R_L}$ and $\beta\left(\frac{r}{R_L}\right)^2$

140. Pick out the statement which is not correct

a) At a low temperature, the resistance of a semiconductor is very high
b) Movement of holes is restricted to the valence band only
c)Width of the depletion region increases as the forward bias voltage increases in case of a N-P junction diode
d)In a forward bias condition, the diode heavily conducts

141. For transistor action
(1) Base, emitter and collector regions should have similar size and doping concentrations
(2) The base region must be very thin and lightly doped
(3) The emitter-base junction is forward biased and base-collector junction is reverse biased
(4) Both the emitter-base junction as well as the base collector junction are forward biased
Which of the following pairs of statements is correct
a)(4), (1) b) (1), (2) c) (2), (3) d) (3), (4)

142. Which logic gate is represented by the following combination of logic gates?



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

143. Biaxial crystal among the following is
a)Calcite b) Quartz c) Selenite d) Tourmaline

144. The gate for which output is high, if at least one input is low?
a)NAND b) NOR c) AND d) OR

: ANSWER KEY :

1)	d	2)	d	3)	d	4)	b	5)	b	6)	b	7)	a	8)	d
9)	a	10)	a	11)	d	12)	d	13)	b	14)	c	15)	a	16)	d
17)	b	18)	b	19)	b	20)	a	21)	c	22)	a	23)	b	24)	b
25)	c	26)	d	27)	b	28)	c	29)	a	30)	c	31)	a	32)	c
33)	a	34)	b	35)	b	36)	d	37)	b	38)	c	39)	b	40)	a
41)	a	42)	d	43)	b	44)	c	45)	c	46)	c	47)	c	48)	b
49)	c	50)	a	51)	a	52)	b	53)	c	54)	d	55)	c	56)	c
57)	c	58)	c	59)	a	60)	d	61)	a	62)	d	63)	a	64)	b
65)	c	66)	c	67)	d	68)	a	69)	b	70)	c	71)	b	72)	c
73)	a	74)	c	75)	c	76)	d	77)	d	78)	d	79)	c	80)	a
81)	a	82)	c	83)	c	84)	c	85)	c	86)	c	87)	c	88)	b
89)	b	90)	a	91)	b	92)	d	93)	b	94)	d	95)	b	96)	d
97)	b	98)	d	99)	b	100)	a	101)	b	102)	c	103)	a	104)	d
105)	b	106)	c	107)	d	108)	a	109)	b	110)	b	111)	b	112)	c
113)	c	114)	b	115)	a	116)	b	117)	a	118)	b	119)	d	120)	d
121)	b	122)	b	123)	a	124)	b	125)	b	126)	d	127)	d	128)	b
129)	c	130)	b	131)	a	132)	c	133)	d	134)	b	135)	a	136)	d
137)	d	138)	a	139)	a	140)	c	141)	c	142)	c	143)	c	144)	a

: HINTS AND SOLUTIONS :

1 **(d)**

$\alpha = 0.96$

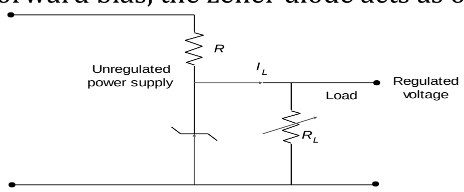
$\beta = \frac{\alpha}{1-\alpha} = \frac{0.96}{1-0.96} = 24$

$I_C = \frac{V_C}{R} = \frac{0.5}{500} = 10^{-3}A$

$I_b = \frac{I_c}{\beta} = \frac{10^{-3}}{24} = \frac{1}{24}mA$

2 **(d)**

Zener diode is a highly doped p-n junction which is not damaged by high reverse current. It can operate continuously without being damaged in the region of reverse breakdown voltage. In the forward bias, the zener diode acts as ordinary diode. It can be used as voltage regulator.



3 **(b)**

In an n-type semiconductor, majority charge carriers are electrons and minority charge carriers are holes.

Therefore, $n_E >> n_H$

5 **(b)**

Gallium is trivalent impurity

8 **(d)**

108 electrons enter the emitter in 10^{-8} s

$i.e., i_E = \frac{108 \times 1.6 \times 10^{-19}}{10^{-8}}A = 172.8 \times 10^{-11}A$

$\therefore$ 1% of i_E is lost in base $i.e., i_B = \frac{i_E}{100}$

$\Rightarrow$ 99% i_E $i.e., \frac{99}{100}i_E$ enters the collector

$\Rightarrow I_C = 0.99\ i_E$

Current amplification factor

$\beta = \frac{i_C}{i_B} = \frac{0.99i_E}{0.01i_E} = 99$

9 **(a)**

Due to the reverse biasing the width of depletion region increases and current flowing through the diode is almost zero. In this case electric field is almost zero at the middle of the depletion region.

10 **(a)**

From the given waveforms, the following truth table can be made

Time interval	Inputs A	Inputs B	Output Y
$0 \rightarrow T_1$	0	0	0
$T_1 \rightarrow T_2$	0	1	0
$T_2 \rightarrow T_3$	1	0	0
$T_3 \rightarrow T_4$	1	1	1

This truth table is equivalent to 'AND' gate

11 **(d)**

The Boolean expression for 'AND' gate is $R + P.Q$

$\Rightarrow 1.1 = 1, 1.0 = 0, 0.1 = 0, 0.0 = 0$

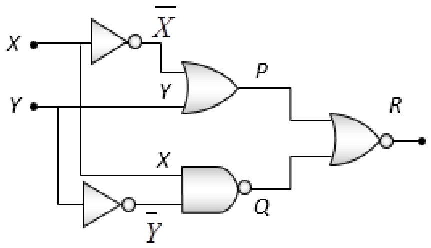
12 **(d)**

At 0K there is no free electrons for conduction. Therefore, at 0K an intrinsic semiconductor behaves as insulator.

13 **(b)**

Impurity increases the conductivity

14 **(c)**



The truth table can be written as

X	Y	$\overline{X}$	$\overline{Y}$	$P = \overline{X} + Y$	$Q = \overline{X.Y}$	$R = P +$
0	1	1	0	1	1	0
1	1	0	0	1	1	0
1	0	0	1	0	0	1
0	0	1	1	1	1	0

Hence $X = 1, Y = 0$ gives output $R = 1$

15 **(a)**

In p-region direction of conventional current is same as flow of holes. In n-regoin direction of conventional current is opposite to direction of flow electrons.

16 **(d)**

The ratio of collector current (I_c) to emitter current (I_e) is known as current gain (α) of a transistor. Therefore,

$\alpha = \frac{\Delta I_c}{\Delta I_e}$ ...(i)

Also, emitter current is equal to sum of change of base current and collector current. Therefore,

$\Delta I_e = \Delta I_b + \Delta I_c$ ...(ii)

From Eqs. (i) and (ii), we get

$$\alpha = \frac{I_c}{\Delta I_b + \Delta I_c}$$

Given, $\alpha = 0.9, \Delta I_b = 4$ mA

$0.9 = \frac{I_c}{4 + \Delta I_c}$

$\Rightarrow 0.9\,(4 + I_c) = I_c$

$\Rightarrow 3.6 + 0.9\,I_c = I_c$

$\Rightarrow 3.6 = 0.1\,I_c$

$\Rightarrow I_c = 36$ mA

17 **(b)**

In a $p - n$ junction, the direction of diffusion current is from p-region to n-region only.

18 **(b)**

In forward biasing P-side is connected with positive terminal and N-side with negative terminal of the battery

20 **(a)**

The average value of output direct current in a half wave rectifier is

= (average value of current over a cycle)/2

$= (2I_0/\pi)/2 = I_0/\pi$.

21 **(a)**

Voltage gain, $A_V = 1000$
In dB, voltage gain
$A = 10 \log_{10} 1000$ dB
$= (10 \times 3)\ \log_{10} 10$ dB
$= \because \log_{10} 10 = 1$

23 **(b)**
In the positive half cycle of input ac signal diode D_1 is forward biased and D_2 is reverse biased so in the output voltage signal, A and C are due to D_1. In negative half cycle of input ac signal D_2 conducts, hence output signals B and D are due to D_2

24 **(b)**
Current gain $\beta = \frac{\Delta i_c}{\Delta i_b} \Rightarrow \Delta_b = \frac{1\times10^{-3}}{100} = 10^{-5}A = 0.01\ mA$
By using $\Delta i_e = \Delta i_b + \Delta i_c \Rightarrow \Delta i_e = 0.01 + 1 = 1.01mA$

25 **(c)**
$E = -\frac{dV}{dr} = \frac{0.6}{10^{-6}} = 6 \times 10^5\ \mathrm{Vm^{-1}}$

26 **(d)**
In a properly biased transistor, emitter-base depletion layer is small but base-collector depletion layer is large.

28 **(c)**
It is a semiconductor,
For Ge, $\Delta E_g = 0.72$ eV
For Si, $\Delta E_g = 1.1$ eV

30 **(c)**
$\mu = \frac{\Delta V_p}{\Delta V_g} \Rightarrow \Delta V_p = \mu \Delta V_g = 15 \times 0.3 = 4.5\ volt$

31 **(a)**
$g_m = \frac{\Delta i_p}{\Delta V_g} = \frac{(20-15)\times 10^{-3}}{(4-2)} = 2.5\ milli\ mho$

32 **(c)**
Because with rise in temperature, resistance of semiconductor decreases, hence overall resistance of the circuit decreases which in turn increases the current in the circuit

33 **(a)**
The given symbol is of 'AND' gate

36 **(d)**
We know that plate resistance is given by
$r_p = \frac{\delta V}{\delta I}$
where δV is change in voltage and δI is change in current.
Also, at saturation change in current is zero.
$\therefore r_p = \frac{\delta V}{0} = \infty$
Hence, plate resistance will be infinite.

37 **(b)**
Phosphorous is pentavalent and Boron is trivalent material.

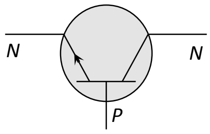
38 **(c)**
Voltage gain $= \frac{V_{\text{out}}}{V_{\text{in}}} = \frac{\mu}{1+\frac{r_p}{R_L}} \Rightarrow \frac{V_{\text{out}}}{0.05} = \frac{25}{1+\frac{40\times10^3}{10\times10^3}}$
$\Rightarrow V_{\text{out}} = 2.5\ V$

39 **(b)**
The main cause of zener breakdown is production of electron-hole pairs due to thermal excitation.

40 **(a)**

At room temperature some covalent bonds break and semiconductor behaves slightly as a conductor

41 **(a)**



The arrow head in the transistor symbol always shows the direction of hole flow in the emitter region

42 **(d)**

Conductor has positive temperature coefficient of resistance but semiconductor has negative temperature coefficient of resistance

43 **(b)**

In transistor, base is least doped

44 **(c)**

Germanium is semiconductor, whereas copper is conductor.

For conductors, $R \propto \Delta t$

For semiconductors$R \propto \frac{1}{\Delta t}$

Hence, when both are cooled, then resistance of copper decreases whereas that of germanium increases.

45 **(c)**

Boolean expression for OR gate is $Y = A + B$

46 **(c)**

Peak value of rectified output voltage

= peak value of input voltage – barrier voltage

= 2 – 0.7 = 1.3 V

47 **(c)**

As RC time constant of the capacitor is quite large ($\tau = RC = 10 \times 10^3 \times 10 \times 10^{-6} = 0.1\ s$), it will not discharge appreciably. Hence voltage remains nearly constant

48 **(b)**

Formation of energy bands in solids are due to Pauli's exclusion principle

49 **(c)**

A diode is used as a rectifier to convert ac to dc

50 **(a)**

The reverse bias potential that results in this sudden change in characteristics is called the zener potential and is given by the symbol V_Z. When the voltage across diode is increased in the reverse bias region, the minority carriers gain velocity and associated kinetic energy. These minority carriers are responsible for the reverse saturation current. The collisions of these minority carriers with atomic structure will result in an ionisation process and a very high current is established. This current is called avalanche current and the region in which this current is established is called avalanche breakdown region. The magnitude of zener potential may be decreased by increasing doping levels in the p and n-type materials. When the V_Z decreases to a very low level, there is a strong electric field in the region of the junction that can break the bonds with C in the atom and generate charge carriers. This mechanism is called zener breakdown.

51 **(a)**

For N-type semiconductor, the impurity should be pentavalent

52 **(b)**

The ripple factor for full wave rectifier is 0.482 which is 48.2%.

53 **(c)**

$$R_a = \frac{\mu}{g_m} = \frac{50}{2 \times 10^{-3}} = 25 \times 10^3 \Omega;$$

$$A_v = \frac{\mu R_L}{R_a + R_L} = \frac{50 \times 25 \times 10^3}{25 \times 10^3 + 25 \times 10^3} = 25$$

54 **(d)**

After saturation plate current can be increased by increasing the temperature of filament. It can be done by increasing the filament current

55 **(c)**

Antimony is pentavalent

57 **(c)**

Intensity $\propto$ Number of electrons

59 **(a)**

The probability of electrons to be found in the conduction band of an intrinsic semiconductor

$P(E) = \frac{1}{1+e^{\frac{(E-E_F)}{kT}}}$; where k = Boltzmann's constant

Hence, at a finite temperature, the probability decreases exponentially with increasing band gap

60 **(d)**

The conditions for a circuit to oscillate are (i) the feedback is positive (ii) the fraction of the output voltage feedback $ie, \beta = \frac{1}{A}$ ie, the reciprocal of the voltage gain without feedback.

61 **(a)**

First diode is in reverse biasing it acts as open circuit, hence no current flows

62 **(d)**

$$V_{g_2} = V_{g_1}\left(\frac{V_{p_2}}{V_{p_1}}\right) = -5\left(\frac{200}{150}\right) = -6.66 \text{ V}$$

63 **(a)**

For $Ge, E_g = 0.7\ eV = 0.7 \times 1.6 \times 10^{-19} J = 1.12 \times 10^{-19} J$

64 **(b)**

In half wave rectifier $V_{dc} = \frac{V_0}{\pi} = \frac{10}{\pi}$

65 **(c)**

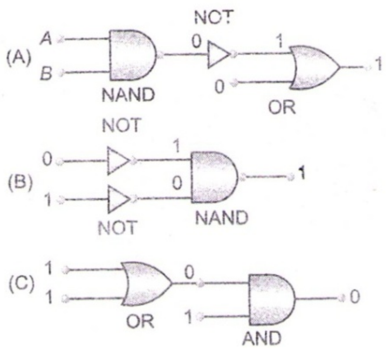
When a $p-n$ junction is formed, n-side attains positive potential and p-side attains negative. When ends of p and n of a $p-n$ junction are joined by a wire, there will be a steady conventional current from n-side to p-side through the wire and p-side to n-side through the $p-n$ junction.

66 **(c)**

$$R_p = \frac{V_p}{i_p} = \frac{50}{150 \times 10^{-3}} = 333.3\ \Omega$$

68 **(a)**

The output gate circuit will be as shown below.



Hence, outputs of A, B and C are 1, 1, and 0 respectively.

69 **(b)**

Amplification with negative feedback is $A' = \frac{A}{1+\beta A}$

Where β = fraction of output feedback to input

$\because \beta = \frac{9}{100} = 0.09$ and $A' = 10$

$$\Rightarrow 10 = \frac{A}{1+0.09A} \Rightarrow A = 100$$

70 **(c)**

$^{6}C = 1S^2, 2S^2\ 2P^2$

$^{14}Si = 1S^2, 2S^2\ 2p^6, 3S^2\ 3P^2$

71 **(b)**

In figure 2, 4 and 5 P-crystals are more positive as compared to N-crystals

73 **(a)**

The first data gives value of plate resistance

$$r_p = \frac{\Delta V_p}{\Delta i_p} = \frac{10}{0.8 \times 10^{-3}} = \frac{10^5}{8}\Omega$$

Also $g_m = \frac{\Delta i_p}{\Delta V_g}$ and $g_m = \frac{\mu}{r_p}$

$$\Rightarrow \Delta V_g = \frac{\Delta i_p \times r_p}{\mu} = \frac{4 \times 10^{-3} \times 10^5/8}{8} = 6.25\ V$$

74 **(c)**

Forward biased resistance $= \frac{\Delta V}{\Delta I} = \frac{0.7-0.6}{(15-5)\times 10^{-3}}$

$$= \frac{0.1}{10 \times 10^{-3}} = 10\ \Omega$$

75 **(c)**

$(11010.101) = 1 \times 2^4 + 1 \times 2^3 + 0 \times 2^2 +$
$1 \times 2^1 + 0 \times 2^0 + 1 \times 2^{-1} +$
$0 \times 2^{-2} + 1 \times 2^{-3}$

$= 16 + 8 + 0 + 2 + 0 + \frac{1}{2} + 0 + \frac{1}{8} = 26 + \frac{1}{2} + \frac{1}{8}$

$= 26\frac{5}{8} = 26.625$

76 **(d)**

In an intrinsic semiconductor, $n_e = n_h$

77 **(d)**

GaAs ($Eg = 1.5\ eV$) is used for making infrared LED

78 **(d)**

When reverse bias is increased the electron field across the junction also increases. At some stage the electric field becomes so high that it breaks the covalent bonds creating electron-hole pairs. This mechanism is known as zener breakdown. In breakdown region for a long range of load (R_L) the voltage remains the same though the current may be large.

79 **(c)**

Electric conduction in semi-conductor takes place due to both electrons and holes.

80 **(a)**

If $A = 1, B = 1$ and $Y = 0$, the gate can be NOR gate, NAND gate or exclusive NOR gate (*ie*, XOR gate).

81 **(a)**

For forward biasing of $p - n$ junction, the positive terminal of external battery is to be connected to p-semiconductor and negative terminal of battery to the n-semiconductor.

82 **(c)**

$A_v = -\frac{V_o}{V_i}$

or $V_o = -A_V \times V_i = -30 \sin 100\pi t$.

83 **(c)**

Vander Waal's force is weak dipole-dipole interaction

84 **(c)**

For any fixed value of the grid bias, the plate current increases as the plate voltage is increased, because more of electrons are drawn towards the anode. Also, for any fixed value of the plate voltage, more plate current flows when the grid is positive. As grid is made more and more negative, electrons are repelled back and very few reach the anode, when the grid becomes highly negative no electrons reach the plate. Thus, for a fixed plate voltage, it is possible to cut out anode current completely by making the grid suitably negative. This is called the cut-off voltage, hence, plate current is reduced.

85 **(c)**

$\alpha = \frac{I_c}{I_e} < 1$ or $I_c < I_e$.

86 **(c)**

The junction diode I will provide output when forward biased. It will be so during negative half cycle of input AC voltage applied.

87 **(c)**

$E_g = h\nu = \frac{hc}{\lambda} = \left(\frac{6.63\times10^{-34}\times3\times10^{8}}{2480\times10^{-9}\times1.6\times10^{-19}}\right) = 0.5 \text{ eV}$

88 **(b)**

In common emitter amplifier

Voltage gain = current gain × resistance gain

Or $A_V = \beta \times \frac{R_o}{R_i}$

Or $\frac{V_o}{V_i} = \beta \frac{R_o}{R_i}$

Or $\frac{3}{0.01} = 100 \times \frac{R_o}{1\times10^3}$

Or $R_o = \frac{3}{0.01} = 3 \text{ k}\Omega$

89 **(b)**

It is the symbol of 'NOR' gate

90 **(a)**

The potential of P-side is more negative that of N-side, hence diode is in reverse biasing. In reverse biasing it acts as open circuit, hence no current flows

91 **(b)**

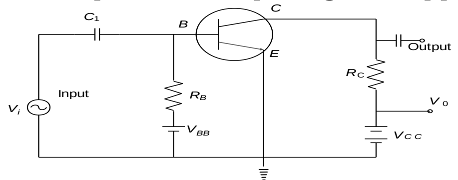
Maximum load current $I_m = \frac{V_m}{r_f + R_L} = \frac{50\sqrt{2}\text{V}}{(20+980)\Omega}$

$= 70.7 \text{ mA}$

∴ Mean load current. $I_{DC} = \frac{2I_m}{\pi} = \frac{2\times70.7}{\pi} = 45 \text{ mA}$

92 **(d)**

In CE amplifier, the input signal is applied across base-emitter junction as shown in the figure below.



93 **(b)**

In circuit the upper diode junction is forward biased and the lower diode junction is reverse biased. Thus there will be no conduction across lower diode junction. Now the total resistance of circuit= $100 + 150 + 50 = 300\Omega$

Current in $100\Omega = \frac{6}{300} = 0.02$ A.

94 **(d)**

5 *volt* is low signal (0) and 10 *volt* is high signal (1) and taking 5 μ-s as 1 unit, in a negative logic, low signal (0) gives high output (1) and high signal (1) gives low output (0). The output is therefore 1010010111

95 **(b)**

Due to forward bias at the emitter-base junction, the majority charge carrier electrons of emitter get repelled from the negative terminal and move towards base. Some of these electrons combine with the majority charge carrier holes present in the base and most of the electrons reach the collector, crossing the collector-base junction. This implies that collector current is always less than the emitter current due to the reason (b).

96 **(d)**

For tetragonal, cubic and orthorhombic system $\alpha = \beta = \gamma = 90°$

98 **(d)**

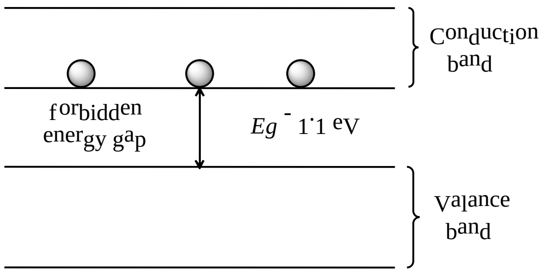
$\beta = \frac{I_c}{I_b} > 1$ or $I_c > I_b$.

99 **(b)**

$\beta = \frac{\alpha}{1-\alpha} = \frac{0.96}{1-0.96} = 24$

100 **(a)**

The energy band scheme of semiconductors is shown here.



In semiconductors, valence band and conduction band are separated by an energy gap called the forbidden energy gap. It is very small. At room temperature some electrons in valence band acquire thermal energy. This energy is more than forbidden energy gap E_g, thus they jump into the conduction band and leaves their vacancy in the valence band which act as holes. Hence, at room temperature valence band is partially empty and conduction band is partially filled.

101 **(b)**

Ga has a valancy of 3

102 **(c)**

$\Delta I_c = \alpha \Delta I_e = 0.98 \times 5.00 = 4.90$ mA.

103 **(a)**

$\beta = \frac{\alpha}{1-\alpha} = \frac{0.995}{1-0.995} = 199 \approx 200$

104 **(d)**

Temperature co-efficient of semiconductor is negative

105 **(b)**

In half wave rectifier, we get the output only in one half cycle of input AC therefore, the frequency of the ripple of the output is same as that of input AC *ie*, 50 Hz.

106 **(c)**

For 'XNOR' gate $Y = \bar{A}\,\bar{B} + AB$

$i.e., \bar{0}.\bar{0} + 0.0 = 1.1 + 0.0 = 1 + 0 = 1$

$\bar{0}.\bar{1} + 0.1 = 1.0 + 0.1 = 0 + 0 = 0$

$\bar{1}.\bar{0} + 1.0 = 0.1 + 1.0 = 0 + 0 = 0$

$\bar{1}.\bar{1} + 1.1 = 0.0 = 1.1 = 0 + 1 = 1$

107 **(d)**

When a free electron is produced, simultaneously a hole is also produced

108 **(a)**

In conductors valence band and conduction band overlaps

109 **(b)**

When a strong current passes through the semiconductor it heats up the crystal and covalent bonds are broken. Hence because of excess number of free electrons it behaves like a conductor

110 **(b)**

The charge on hole is positive

111 **(b)**

In 'NOR' gate $Y = \overline{A + B}$

$i.e., \overline{0+0} = \overline{0} = 1, \overline{1+0} = \overline{1} = 0$

$\overline{0+1} = \overline{1} = 0, \overline{1+1} = \overline{1} = 0$

112 **(c)**

The given circuit is full wave rectifier

113 **(c)**

AC power gain $= \frac{\text{Change in output power}}{\text{Change in input power}}$

$= \frac{\Delta V_c \times \Delta i_c}{\Delta V_i \times \Delta i_b} = \left(\frac{\Delta V_c}{\Delta V_i}\right) \times \left(\frac{\Delta i_c}{\Delta i_b}\right) = A_V \times \beta_{\text{AC}}$

where A_V is voltage gain and $(\beta)_{\text{AC}}$ is AC current gain.

Also,

$A_V = \beta_{\text{AC}} \times \text{resistance gain} \left(= \frac{R_o}{R_i}\right)$

Given, $A_V = 50, R_o = 200\ \Omega, R_i = 100\ \Omega$

Hence, $50 = \beta_{\text{AC}} \times \frac{200}{100}$

$\therefore \beta_{\text{AC}} = 25$

Now, AC power gain $= A_V \times \beta_{\text{AC}} = 50 \times 25 = 1250$

114 **(b)**

Due to the large concentration of electrons in N-side and holes in P-side, they diffuses from their own side to other side. Hence depletion region produces

115 **(a)**

Electrical conductivity of a semiconductor increases with rise in temperature because more covalent bonds will be broken with rise in temperature. Due to which more number of electrons and holes will be available for the conduction of electricity in a semiconductor.

116 **(b)**

In reverse bias of $p-n$ junction when high voltage is applied, electric break down of junction takes place, resulting large increase in reverse current. This high voltage applied is called zener voltage.

117 **(a)**

Current gain $\beta = \frac{\Delta i_c}{\Delta i_b} \Rightarrow \Delta i_c = \beta \times \Delta i_b = 80 \times 250\ \mu A$

118 **(b)**

$\alpha = \frac{\beta}{1+\beta} = \frac{99}{1+99} = 0.99$

119 **(d)**

Given $i_c = \frac{80}{100} \times i_e \Rightarrow 24 = \frac{80}{100} \times i_e \Rightarrow i_e = 30\ mA$

By using $i_e = i_b + i_c \Rightarrow i_b = 30 - 24 = 6\ mA$

120 **(d)**

The collector current

$I_C = \beta I_b = \frac{2}{2 \times 10^3}$

$I_C = 1 \times 10^{-3}$ A

The base current

$$I_b = \frac{10^{-3}}{200}$$
$$I_b = 5 \times 10^{-6}\text{ A}$$
$$I_b = 5\mu\text{A}$$

121 **(b)**

For full wave rectifier, ripple frequency

$= 2\times$ input frequency

$= 2 \times 50 = 100$ Hz

122 **(b)**

$V = V_{CE} + I_C R_L$

$\Rightarrow 15 = 7 + I_C \times 2 \times 10^3 \Rightarrow i_C = 4\, mA$

$\because\ \beta = \frac{i_C}{i_B} \Rightarrow i_B = \frac{4}{100} = 0.04\, mA$

123 **(a)**

$$h_{fe} = \left(\frac{\Delta i_c}{\Delta i_b}\right)_{V_{ce}} = \frac{8.2}{8.3 - 8.2} = 82$$

124 **(b)**

Number of holes in base region increases hence recombination of electron and hole are also increases in this region. As result base current increases which in turn decreases the collector current

126 **(d)**

Number density of atoms in silicon specimen

$= 5 \times 10^{28}$ atoms-m^{-3} $= 5 \times 10^{22}$ atoms cm^{-3}.

Since, 1 atom of indium is doped in 5×10^7 silicon atoms, so total number of indium atoms doped per cm^3 of silicon will be

$n = \frac{5\times10^{22}}{5\times10^7} = 10^{15}$ atom-cm^{-3}.

127 **(d)**

Also know that in an N-type semiconductor the donor energy level lies just below the conduction band

128 **(b)**

Antimony and phosphorus both are pentavalent

130 **(d)**

The dynamic plate resistance is $r_p = \frac{\Delta V_p}{\Delta i_p}$

Now for a vacuum diode $i_p = KV_p^{3/2} \Rightarrow V_p = \left(\frac{i_p}{K}\right)^{2/3}$

$\Rightarrow \frac{\Delta V_p}{\Delta i_p} = \frac{2}{3K^{2/3}} i_p^{\left(\frac{2}{3}-1\right)}$

$\Rightarrow r_p = (\text{constant}) i_p^{-1/3} \Rightarrow r_p \propto \frac{1}{I_p^{1/3}}$

133 **(d)**

Current in junction, V is positive; In reverse bias V is negative. Then $I_r = I_0$

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

134 **(b)**

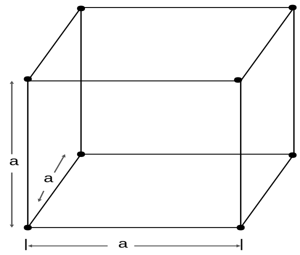
Across the $P - N$ junction, a barrier potential is developed whose direction is from N region to P region

135 **(a)**

Input characteristics of transistor in CE mode is the curve between base current I_B and base-emitter voltage V_{BE} at constant collector-emitter voltage V_{CE}.

136 **(d)**

In cubic crystals, the crystal axes are perpendicular to one another ($\alpha = \beta = \gamma = 90^0$) and the repetitive interval is the same along the three axes ($a = b = c$).



137 **(d)**

In a common-emitter configuration, the voltage gain is defined as the ratio of change in the output voltage to the change in the input voltage.

$A_V = \beta \times$ resistance gain ...(i)

Also, power gain is defined as the ratio of the change in the output power to the change in input power.

$A_p = \beta^2 \times$ resistance gain ...(ii)

Dividing Eq. (ii) by Eq. (i), we get

$$\frac{A_p}{A_V} = \beta$$

138 **(a)**

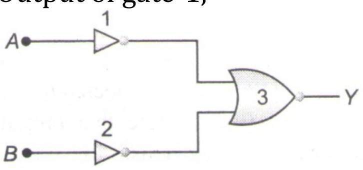
$V - d$ curve near the junction will be as shown by curve (a).

140 **(c)**

In case of a N-P junction diode, width of the depletion region decreases as the forward bias voltage decreases

142 **(c)**

Output of gate-1,



Output of gate-2,

Output of gate 3 $Y_1 = \bar{A}$

$Y_2 = \bar{B}$

$Y = \overline{Y_1 + Y_2} = \overline{\bar{A} + \bar{B}} = \overline{\overline{AB}} = AB$

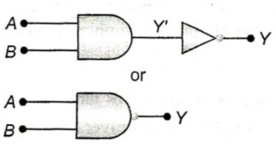
which is the output of AND gate.

143 **(c)**

Calcite, quartz and tourmaline are uniaxial crystals

144 **(a)**

If we connect the output Y' of AND gate to the input of a NOT gate as shown in figure, the gate so obtained is called NAND gate. The truth table of NAND gate can be obtained by logically using the truth table of AND and NOT gates as shown in figure.



Truth Table

A	B	Y
0	0	1
1	0	1
0	1	1
1	1	0

Assertion - Reasoning Type

This section contain(s) 34 questions numbered 1 to 34. Each question contains STATEMENT 1(Assertion) and STATEMENT 2(Reason). Each question has the 4 choices (a), (b), (c) and (d) out of which **ONLY ONE** is correct.

a) Statement 1 is True, Statement 2 is True; Statement 2 **is** correct explanation for Statement 1

b) Statement 1 is True, Statement 2 is True; Statement 2 **is not** correct explanation for Statement 1

c) Statement 1 is True, Statement 2 is False

d) Statement 1 is False, Statement 2 is True

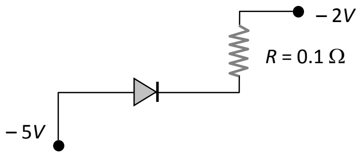
1 **Statement 1:**NAND or NOR gates are called digital building blocks.

Statement 2: The repeated use of NAND or NOR gates can produce all the basics or completed gates.

2 **Statement 1:**A P-N photodiode is made from a semiconductor for which $E_g = 2.8\ eV$. This photo diode will not detect the wavelength of 6000 nm

Statement 2:A PN photodiode detects wavelength λ if $\frac{hc}{\lambda} > E_g$

3 **Statement 1:**In the following circuit the potential drop across the resistance is zero



Statement 2: The given resistance has low value

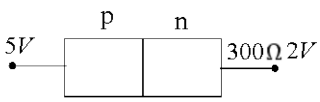
4 **Statement 1:** Silicon is preferred over germanium for making semiconductor devices

Statement 2: The energy gap germanium is more than the energy gap of silicon

5 **Statement 1:** NOT gate is also called invertor.

Statement 2: NOT gate inverts the input signals.

6 **Statement 1:** The value of current through $p - n$ junction in the adjoining figure will be 10 mA.



Statement 2: In the above figure, p-side at higher potential than n-side.

7 **Statement 1:** Electron has higher mobility than hole in a semiconductor

Statement 2: Mass of electron is less than the mass of hole

8 **Statement 1:** We can measure the potential barrier of a PN junction by putting a sensitive voltmeter across its terminals

Statement 2: The current through the PN junction is not same in forward and reversed bias

9 **Statement 1:** The energy gap between the valence band and conduction band is greater in silicon than in germanium

Statement 2: Thermal energy produces fewer minority carriers in silicon than in germanium

10 **Statement 1:** In transistor common emitter mode as an amplifier is preferred over common base mode

Statement 2: In common emitter mode the input signal is connected in series with the voltage applied to the base emitter junction

11 **Statement 1:** In a common base circuit, current gain is 0.95. If base current is 60 μA, then emitter current is 1200 μA.

Statement 2: Current gain in common base circuit is $\alpha = \frac{I_c}{I_E}$.

12 **Statement 1:** If forward current changed by 1.5 mA when forward voltage in semiconductor triode is changed from 0.5 V to 2V, the forward resistance of diode will be 1Ω.

Statement 2: The forward resistance is given by

$$R_f = \frac{\Delta V_f}{\Delta I_f}.$$

13 **Statement 1:** The current gain in common base circuit is always less than one
Statement 2: At constant collector voltage the change in collector current is more than the change in emitter current

14 **Statement 1:** In vacuum tubes (valves) vacuum is necessary for the movement of electrons between electrodes otherwise electrons collide with air particle and lose their energy
Statement 2: In semiconductors devices, external heating or vacuum is not required

15 **Statement 1:** The dominant mechanism for motion of charge carriers in forward and reverse biased silicon P-N junction are drift in both forward and reverse bias
Statement 2: In reverse biasing, no current flows through the junction

16 **Statement 1:** The temperature coefficient of resistance is positive for metals and negative for P-type semiconductor
Statement 2: The effective charge carriers in metals are negatively charged whereas in P-type semiconductor they are positively charged

17 **Statement 1:** A p-n junction with reverse bias can be used as a photo-diode to measure light intensity
Statement 2: In a reverse bias condition the current is small but it is more sensitive to changes in incident light intensity

18 **Statement 1:** The co-ordination number of face centred crystal is 8.
Statement 2: The co-ordination number is number of the closest neighbouring atoms in a crystal structure.

19 **Statement 1:** Two P-N junction diodes placed back to back, will work as a NPN transistor
Statement 2: The P-region of two PN junction diodes back to back will form the base of NPN transistor

20 **Statement 1:** In a common emitter transistor amplifier the input current is much less than the output current
Statement 2: The common emitter transistor amplifier has very high input impedance

21 **Statement 1:** In common base configuration, the current gain of the transistor is less than unity
Statement 2: The collector terminal is reverse biased for amplification

22 **Statement 1:** The resistivity of a semiconductor increases with temperature.
Statement 2: The atoms of a semiconductor vibrate with larger amplitude at higher temperature thereby increasing its resistivity.

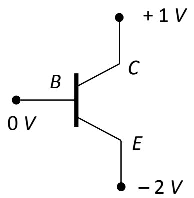
23 **Statement 1:** An N-type semiconductor has a large number of electrons but still it is electrically neutral
Statement 2: An N-type semiconductor is obtained by doping an intrinsic semiconductor with a pentavalent impurity

24 **Statement 1:** Thickness of depletion layer is fixed in all semiconductor devices.
Statement 2: No free charge carriers are available in depletion layer.

25 **Statement 1:** The logic gates NOT can be built using diode.
Statement 2: The output voltage and the input voltage of the diode have 180° phase difference.

26 **Statement 1:** V-i characteristic of P-N junction diode is same as that of any other conductor
Statement 2: P-N junction diode behaves as conductor at room temperature

27 **Statement 1:** When PN-junction is forward biased then motion of charge carriers at junction is due to diffusion. In reverse biasing the cause of motion of charge is drifting
Statement 2: In the following circuit emitter is reverse biased and collector is forward biased



28 **Statement 1:** Zener diode works on a principle of breakdown voltage

Statement 2: Current increases suddenly after breakdown voltage

29 **Statement 1:** A transistor amplifier in common emitter configuration has a low input impendence

Statement 2: The base to emitter region is forward biased

30 **Statement 1:** Light emitting diode (LED) emits spontaneous radiation

Statement 2: LED are forward biased $p-n$ junction

31 **Statement 1:** 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

Statement 2: It is due to law of mass action.

32 **Statement 1:** When base region has larger width, the collector current increases.

Statement 2: Electron hole combination in base results in increase of base current

33 **Statement 1:** If the temperature of a semiconductor is increased then it's resistance decreases

Statement 2: The energy gap between conduction band and valence band is very small

34 **Statement 1:** The resistivity of a semiconductor increases in temperature.

Statement 2: In a conducting solid, the rate of collisions between free electrons and ions increases with increase of temperature.

: ANSWER KEY :

1)	a	2)	a	3)	b	4)	c	5)	a	6)	b	7)	a	8)	d
9)	b	10)	b	11)	b	12)	a	13)	c	14)	b	15)	d	16)	b
17)	a	18)	c	19)	d	20)	c	21)	b	22)	d	23)	b	24)	d
25)	d	26)	d	27)	b	28)	a	29)	a	30)	a	31)	a	32)	c
33)	a	34)	d												

: HINTS AND SOLUTIONS :

1 **(a)**

NAND or NOR gates are called universal (digital) building blocks because using repeated order of these two types of gates we can produce all the basic gates namely OR, AND or complex gates.

2 **(a)**

For detection of a particular wavelength (λ) by a PN photo diode, energy of incident light

$> E_g \Rightarrow \frac{hc}{E_g} > \lambda$

For $E_g = 2.8\ eV, \frac{hc}{E_g} = \frac{6.6\times10^{-34}\times3\times10^{8}}{2.8\times1.6\times10^{-19}} = 441.9\ nm$

$i.e., \frac{hc}{E_g} < 6000\ nm$, so diode will not detect the wavelength of 6000Å

3 **(b)**

Potential difference across the resistance is zero, because diode is in reverse biasing hence no current flows

4 **(c)**

The energy gap for germanium is less $(0.72\ eV)$ than the energy gap of silicon $(1.1 eV)$. Therefore, silicon is preferred over germanium for making semiconductor devices

5 **(a)**

NOT gate inverts the input signal ie, if input is 1 then output will be zero or $vice-versa$. Therefore, it is called as invertor. NOT gate inverts the input order means that for low input, it gives high output or for high input, it gives low output.

6 **(b)**

The p-side of $p-n$ junction is taken at higher potential than n-side so, $p-n$ junction is forward biased. Taking its resistance to be zero and applying Ohm's law.

$$\frac{V}{R} = \frac{5-2}{300} = 10^{-2}\text{A}$$

$$= 10^{-2} \times 10^{3}\ \text{mA}$$

$$= 10\ \text{mA}$$

7 **(a)**

The ratio of the velocity to the applied field is called the mobility. Since electrons are lighter than holes, they move faster in applied field than holes

8 **(d)**

We cannot measure the potential barrier of a PN-junction by connecting a sensitive voltmeter across its terminals because in the depletion region, there are no free electrons and holes and in the absence of forward biasing, PN-junction offers infinite resistance

9 **(b)**

The energy gap between valence band and conduction band in germanium is 0.76 eV and the energy gap between valence band and conduction band in silicon is 1.1 eV. Also, it is true that thermal energy produces fewer minority carriers in silicon than in germanium

10 **(b)**

Common emitter is preferred over common base because all the current, voltage and power gain of common emitter amplifier is much more than the gains of common base amplifier

11 **(b)**

In a common base configuration

$\alpha = \frac{I_C}{I_E} = \frac{I_E - I_B}{I_E} = 1 - \frac{I_B}{I_E}$

or $\frac{I_B}{I_E} = 1 - \alpha = 1 - 0.95 = 0.05$

So, $I_E = \frac{I_B}{0.05}\,\mu A = 1200\ \mu A.$

12 **(a)**

$R_f = \frac{\Delta V_f}{\Delta I_f} = \frac{(2-0.5)V}{1.5\times10^{-3}A}$

$= 10^3 \Omega$

$= 1\ k\Omega$

13 **(c)**

The current gain in common base circuit $\alpha = \left(\frac{\Delta I_C}{\Delta I_E}\right)_{V_C}$

The change in collector current is always less than the change in emitter current $\Delta I_C < \Delta I_E$. Therefore, $\alpha < 1$

14 **(b)**

In vacuum tubes, vacuum is necessary and the working of semiconductor devices is independent of heating or vacuum

15 **(d)**

In PN-junction, the diffusion of majority carriers takes place when junction is forward biased and drifting of minority carriers takes place across the function, when reverse biased. The reverse bias opposes the majority carriers but makes the minority carriers to cross the PN-junction. Thus the small current in μA flows during reverse bias

18 **(c)**

The coordination number of face centred crystal is 12. It is the number of the closest neighbouring atom in a crystal structure.

19 **(d)**

Two PN-junctions placed back to back cannot work as NPN transistor because in transistor the width and concentration of doping of P-semiconductor is less as compared to width doping of N-type semiconductor type

20 **(c)**

In common emitter transistor amplifier current gain $\beta > 1$, so output current > input current, hence assertion is correct.

Also, input circuit has low resistance due to forward biasing to emitter base junction, hence reason is false

21 **(b)**

Current gain is less because $i_c < i_e$

22 **(d)**

Assertion is not true as resistivity of a semiconductor decreases with increase of temperature.

The atoms of a semiconductor vibrate with large amplitude at higher temperatures thereby increasing its conductivity not its resistivity.

24 **(d)**

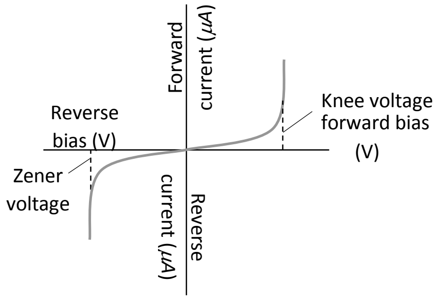
Depletion layer of semiconductor is affected by various factors *eg*, biasing, temperature condition etc. So, it cannot be a fixed layer. In depletion layer, negatively and positively immobile ions are present. Therefore, no free charge carriers are available in such layer.

25 **(d)**

NOT gate inverts the signal applied to it. But in diode, the input and output are in same phase. Thus, NOT gate cannot be built by a diode

26 **(d)**

The V-i characteristic of PN-diode depends whether the junction is forward biased or reverse biased. This can be shown by graph between voltage and current



27 **(b)**

In forward biasing of PN junction current flows due to diffusion of majority charge carriers. While in reverse biasing current flows due to drifting of minority charge carriers. The circuit given in the reason is a PNP transistor having emitter more negative $w.r.t.$ base so it is reverse biased and collector is more positive $w.r.t.$ base so it is forward biased

28 **(a)**

When the reverse voltage across the zener diode is equal to or more than the breakdown voltage, the reverse current increases sharply

29 **(a)**

Input impedance of common emitter configuration

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

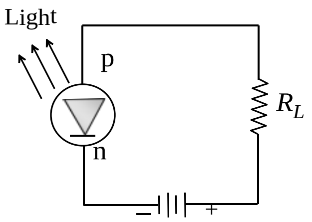
Where ΔV_{BE} = voltage across base and emitter (base emitter region is forward biased)

Δi_B = base current which is order of few microampere.

Thus input impedance of common emitter is low

30 **(a)**

When a junction diode is forward biased as shown in figure, energy is released at the junction due to recombination of electrons and holes. In the junction diode made of gallium arsenide or indium phosphide, the energy is released in visible region. Such a junction diode is called light emitting diode or LED. The radiated energy emitted by LED is equal or less than the band gap of semiconductor



31 **(a)**

According to law of mass action, $n_i^2 = n_e n_h$. In intrinsic semiconductors $n_i = n_e = n_h$ and for P-type semiconductor n_e would be less than n_i, since n_h is necessarily more than n_i

32 **(c)**

When base region has large width, electron hole combination increases the base current. The output collector current decreases from $I_e + I_b + I_c$ =constant

33 **(a)**

In semiconductors the energy gap between conduction band and valence band is small $(\approx 1\ eV)$. 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

34 **(d)**

Resistivity of semiconductors decreases with temperature. The atoms of a semiconductor vibrate with larger amplitudes at higher temperatures there by increasing it's conductivity not resistivity