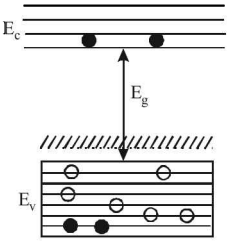
28 Semiconductor Electronics : Materials, Devices and Simple Circuits

Conceptual MCQs

1. In order to prepare a p-type semiconductor, pure silicon can be doped with
(a) Phosphorus (b) Aluminium
(c) Antimony (d) Germanium

2. In the energy band diagram of a material shown below, the open circles and filled circles denote holes and electrons respectively. The material is



(a) an insulator
(b) a metal
(c) an n-type semiconductor
(d) a p-type semiconductor

3. 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

4. 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

5. 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 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

6. The difference in the variation of resistance with temperature in a metal and a semiconductor arises essentially due to the difference in the
(a) crystal sturcture
(b) variation of the number of charge carriers with temperature
(c) type of bonding
(d) variation of scattering mechanism with temperature

7. Application of a forward bias to a p–n junction
(a) widens the depletion zone.
(b) increases the potential difference across the depletion zone
(c) increases the number of donors on the n side.
(d) increases the electric field in the depletion zone.

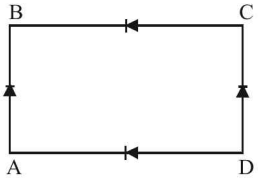
8. At absolute zero, Si acts as
(a) non-metal (b) metal
(c) insulator (d) None of these

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

10. 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

11. For a transistor, $I_C = 25$ mA and $I_B = 1$ mA. The value of current gain α is
(a) $\frac{25}{26}$ (b) $\frac{26}{25}$ (c) $\frac{24}{25}$ (d) $\frac{25}{24}$

12. In figure, the input is across the terminals A and C and the output is across B and D. Then the output is
(a) zero
(b) same as the input
(c) half wave rectified
(d) full wave rectified



13. The charge carriers in a p – type semiconductor are
(a) electrons only
(b) holes only
(c) holes in larger number and electrons in smaller numbers
(d) holes and electrons in equal numbers

14. 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) 1000 (b) 1250 (c) 100 (d) 500

15. NAND gate is a combination of
(a) AND gate and NOT gate
(b) AND gate and OR gate
(c) NOT gate and OR gate
(d) NOT gate and NOR gate

Application Based MCQs

16. 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?

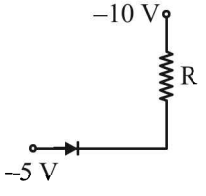
(a) $\frac{5}{8}$ (b) $\frac{4}{5}$ (c) $\frac{5}{4}$ (d) $\frac{4}{7}$

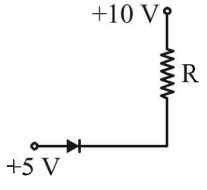
17. A potential barrier of 0.50 V exists across a p-n junction. If the depletion region is 5.0×10^{-7} m wide, the intensity of the electric field in this region is

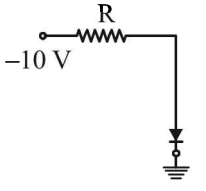
(a) 1.0×10^{6} V/m (b) 1.0×10^{5} V/m

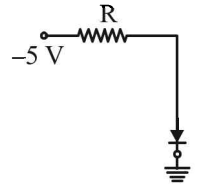
(c) 2.0×10^{5} V/m (d) 2.0×10^{6} V/m

18. Which of the junction diodes shown below are forward biased?

(a) 

(b) 

(c) 

(d) 

19. 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 200 μA produces a change in the collector current from 5 mA to 10 mA. The current gain is

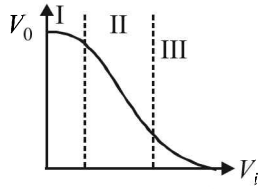
(a) 100 (b) 150 (c) 50 (d) 75

20. The device that can act as a complete electronic circuit is

(a) junction diode (b) integrated circuit

(c) junction transistor (d) zener diode

21. Transfer characteristics [output voltage (V_0) vs input voltage (V_1)] for a base biased transistor in CE configuration is as shown in the figure. For using transistor as a switch, it is used



(a) in region (III) (b) both in region (I) and (III)

(c) in region (II) (d) in region (I)

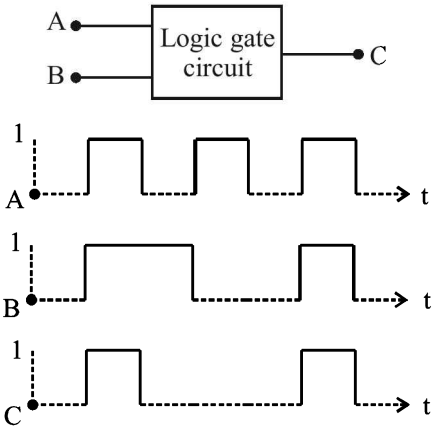
22. The electrical conductivity of a semiconductor increases when electromagnetic radiation of wavelength shorter than 2480nm is incident on it. The band gap in (eV) for the semiconductor is

(a) 2.5 eV (b) 1.1 eV (c) 0.7 eV (d) 0.5 eV

23. In an experiment with nPn transistor amplifier in common emitter configuration, the current gain of the transistor is 100. If the collector current changes by 1mA, what will be the change in emitter current?

(a) 1.1 mA (b) 1.01 mA (c) 0.01 mA (d) 10 mA

24. The following figure shows a logic gate circuit with two inputs A and B and the output C. The voltage waveforms of A, B and C are as shown below



The logic gate is

(a) NAND gate (b) NOR gate

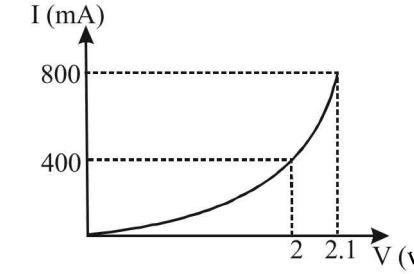
(c) OR gate (d) AND gate

25. A zener diode of voltage V_Z (= 6V) is used to maintain a constant voltage across a load resistance R_L (= 1000 Ω) by using a series resistance R_s (= 100Ω). If the e.m.f. of source is E (= 9 V), what is the power being dissipated in Zener diode ?

(a) 0.144 watt (b) 0.324 watt

(c) 0.244 watt (d) 0.544 watt

26. The I-V characteristic of a P-N junction diode is shown below. The approximate dynamic resistance of the p-n junction when a forward bias of 2 volt is applied is



(a) 1 Ω (b) 0.25 Ω (c) 0.5 Ω (d) 5 Ω

27. The current gain in the common emitter mode of a transistor is 10. The input impedance is 20 kΩ and output impedance is 100 kΩ. The power gain is

(a) 300 (b) 500 (c) 200 (d) 100

28. A silicon diode has a threshold voltage of 0.7 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) 2V (b) 1.4V (c) 1.3V (d) 0.7V

29. A working transistor with its three legs marked *P*, *Q* and *R* is tested using a multimeter. No conduction is found between *P* and *Q*. By connecting the common (negative) terminal of the multimeter to *R* and the other (positive) terminal to *P* or *Q*, some resistance is seen on the multimeter. Which of the following is true for the transistor?

(a) It is an npn transistor with *R* as base
(b) It is a pnp transistor with *R* as collector
(c) It is a pnp transistor with *R* as emitter
(d) None of these

30. When germanium is doped 1 part in a million with indium, its conductivity increases by a factor of about

(a) 10 (b) 10^3 (c) 10^5 (d) 10^6

31. 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

32. A change of 8.0 mA in the emitter current bring a change of 7.9 mA in the collector current. The values of α and β are

(a) 0.99,90 (b) 0.96,79 (c) 0.97,99 (d) 0.99,79

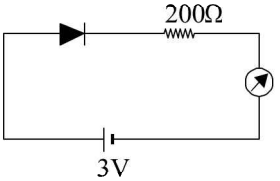
33. The current gain α of transistor in common base mode is 0.995. Its current gain β in the common emitter mode is

(a) 199 (b) 90.5 (c) 100 (d) 1.005

34. When a p-n junction diode is reverse biased the flow of current across the junction is mainly due to

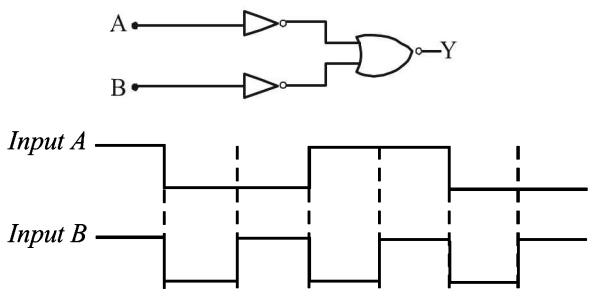
(a) diffusion of charges
(b) drift of charges
(c) depends on the nature of material
(d) both drift and diffusion of charges.

35. The reading of the ammeter for a silicon diode in the given circuit is :

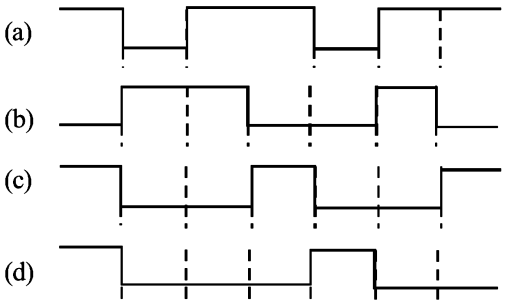


(a) 0
(b) 15 mA
(c) 11.5 mA
(d) 13.5 mA

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



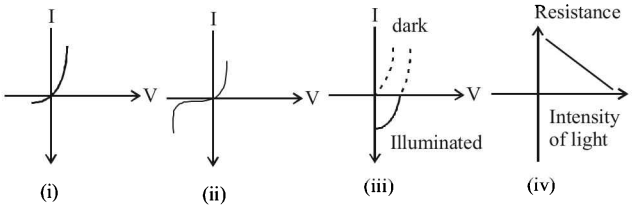
Output is



37. In a transistor the base is

(a) an insulator
(b) a conductor of low resistance
(c) a conductor of high resistance
(d) an extrinsic semiconductor

38. Identify the semiconductor devices whose characteristics are given below, in the order (i), (ii), (iii), (iv) :

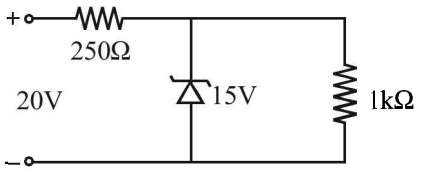


(a) Solar cell, Light dependent resistance, Zener diode, simple diode
(b) Zener diode, Solar cell, simple diode, Light dependent resistance
(c) Simple diode, Zener diode, Solar cell, Light dependent resistance
(d) Zener diode, Simple diode, Light dependent resistance, Solar cell

39. Pure Si at 500K has equal number of electron (n_e) and hole (n_h) concentrations of 1.5×10^{16} m^{-3}. Doping by indium increases n_h to 4.5×10^{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}

40. 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) 10mA (b) 15mA (c) 20mA (d) 5mA

41. Transistor working as an amplifier operates in its active region of characteristics only when

(a) the emitter junction is forward biased and the collector junction is reverse biased

(b) the emitter junction is reverse biased

(c) the collector junction is forward biased

(d) the emitter junction is reverse biased and the collector junction is forward biased

42. The input resistance of a silicon transistor is 100 Ω. Base current is changed by 40 μA 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

43. 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

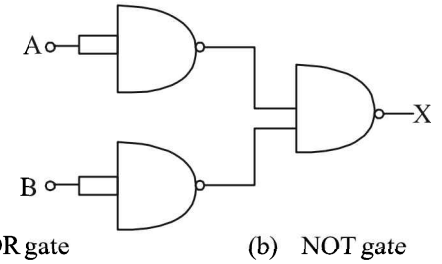
(c) there will be more free electrons than holes in the semiconductor

(d) its resistance is increased

44. 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) 0.1V (b) 1.0V (c) 1mV (d) 10 mV

45. The combination of gates shown below yields



(a) OR gate (b) NOT gate

(c) XOR gate (d) NAND gate

46. Which one of the following statement is false ?

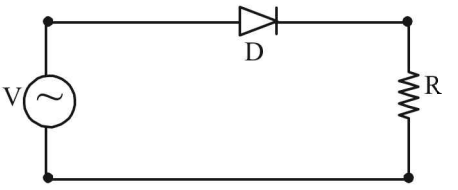
(a) Pure Si doped with trivalent impurities gives a p-type semiconductor

(b) Majority carriers in a n-type semiconductor are holes

(c) Minority carriers in a p-type semiconductor are electrons

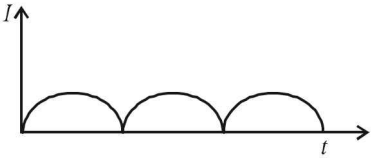
(d) The resistance of intrinsic semiconductor decreases with increase of temperature

47. A *p-n* junction (*D*) shown in the figure can act as a rectifier. An alternating current source (*V*) is connected in the circuit.

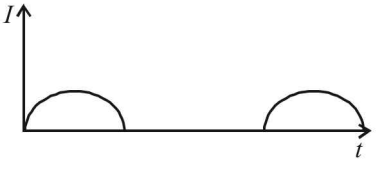


The current (*I*) in the resistor (*R*) can be shown by :

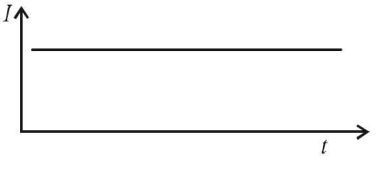
(a)



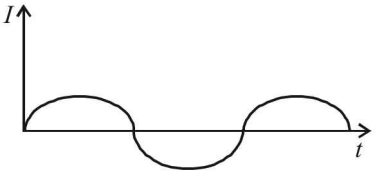
(b)



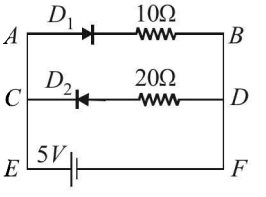
(c)



(d)



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



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

49. The barrier potential of a p-n junction depends on:

(A) type of semi conductor material

(B) amount of doping

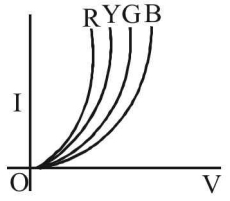
(C) temperature

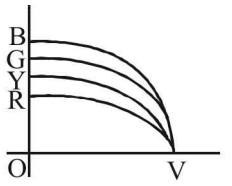
Which one of the following is correct ?

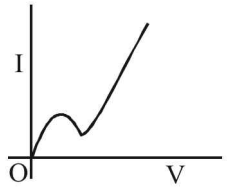
(a) (A) and (B) only (b) (B) only

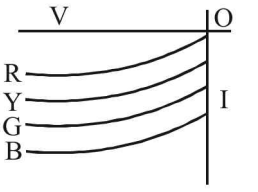
(c) (B) and (C) only (d) (A), (B) and (C)

50. The I-V characteristic of an LED is

(a) 

(b) 

(c) 

(d) 

Skill Based MCQs

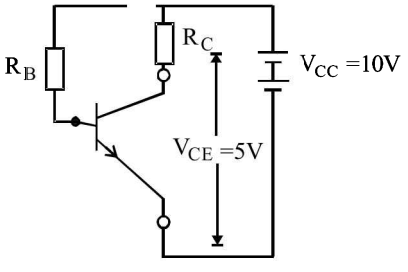
51. The concentration of hole - electron pairs in pure silicon at T = 300 K is 7×10^{15} per cubic meter. Antimony is doped into silicon in a proportion of 1 atom in 10^7 Si atoms. Assuming that half of the impurity atoms contribute electron in the conduction band, calculate the factor by which the number of charge carriers increases due to doping. The number of silicon atoms per cubic meter is 5×10^{28}

(a) 2.8×10^5 (b) 3.1×10^2
(c) 4.2×10^5 (d) 1.8×10^5

52. A sinusoidal voltage of amplitude 25 volt and frequency 50Hz is applied to a half wave rectifier using P-n junction diode. No filter is used and the load resistor is 1000Ω. The forward resistance R_f of ideal diode is 10Ω. The percentage rectifier efficiency is

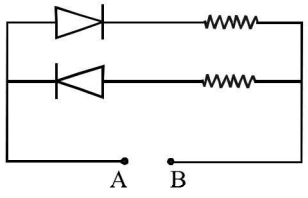
(a) 40% (b) 20% (c) 30% (d) 15%

53. A transistor connected in common emitter configuration has input resistance R_B = 2 kΩ and load resistance of 5 kΩ. If β = 60 and an input signal 12 mV is applied, calculate the voltage gain, the power gain and the value of output voltage



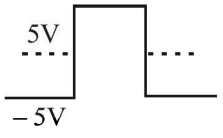
(a) $A_v = 150$, $V_{out} = 1.8$V, and power gain = 9000
(b) $A_v = 20$, $V_{out} = 1$V, and power gain = 2000
(c) $A_v = 150$, $V_{out} = 1.5$V, and power gain = 8500
(d) $A_v = 20$, $V_{out} = 1.5$V, and power gain = 2000

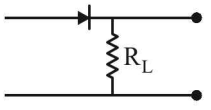
54. A 2 V battery is connected across the points A and B as shown in the figure given below. Assuming that the resistance of each diode is zero in forward bias, and infinity in reverse bias, the current supplied by the battery when its positive terminal is connected to A, is



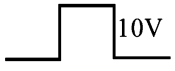
(a) 0.2 A (b) 0.4 A (c) zero (d) 0.1 A

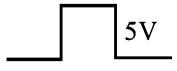
55. In a *p-n* junction diode, a square input signal of 10 V is applied as shown in fig.

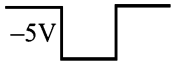




The output signal across R_L will be

(a) 

(b) 

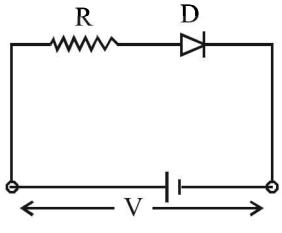
(c) 

(d) 

56. Within depletion region of p-n junction diode

(a) p-side is positive and n-side is negative
(b) p-side is negative and n-side is positive
(c) both sides are positive or both negative
(d) both sides are neutral

57. 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



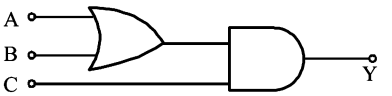
(a) 2V when diode is forward biased
(b) Zero when diode is forward biased
(c) V when diode is reverse biased
(d) V when diode is forward biased

58. The input signal given to a CE amplifier having a voltage gain of 150 is $V_i = 2\cos\left(15t+\frac{\pi}{3}\right)$. The corresponding output signal will be :

(a) $75\cos\left(15t+\frac{2\pi}{3}\right)$ (b) $2\cos\left(15t+\frac{5\pi}{6}\right)$

(c) $300\cos\left(15t+\frac{4\pi}{3}\right)$ (d) $300\cos\left(15t+\frac{\pi}{3}\right)$

59. To get output 1 for the following circuit, the correct choice for the input is



(a) A = 0, B = 1, C = 0 (b) A = 1, B = 0, C = 0

(c) A = 1, B = 1, C = 0 (d) A = 1, B = 0, C = 1

60. A npn transistor is connected in common emitter configuration in a given amplifier. A load resistance of 800 Ω is connected in the collector circuit and the voltage drop across it is 0.8 V. If the current amplification factor is 0.96 and the input resistance of the circuit is 192Ω, the voltage gain and the power gain of the amplifier will respectively be

(a) 4, 3.84 (b) 3.69, 3.84 (c) 4, 4 (d) 4, 3.69

ANSWER KEY

Conceptual MCQs																		
1	(b)	**3**	(d)	**5**	(a)	**7**	(c)	**9**	(a)	**11**	(a)	**13**	(c)	**15**	(a)			
2	(d)	**4**	(c)	**6**	(b)	**8**	(c)	**10**	(d)	**12**	(d)	**14**	(b)					
Application Based MCQs																		
16	(c)	**20**	(b)	**24**	(d)	**28**	(c)	**32**	(d)	**36**	(d)	**40**	(d)	**44**	(d)	**48**	(d)	
17	(a)	**21**	(b)	**25**	(a)	**29**	(d)	**33**	(a)	**37**	(d)	**41**	(a)	**45**	(a)	**49**	(d)	
18	(a)	**22**	(d)	**26**	(b)	**30**	(d)	**34**	(b)	**38**	(c)	**42**	(a)	**46**	(b)	**50**	(a)	
19	(c)	**23**	(b)	**27**	(b)	**31**	(b)	**35**	(c)	**39**	(d)	**43**	(c)	**47**	(b)			
Skill Based MCQs																		
51	(d)	**52**	(a)	**53**	(a)	**54**	(a)	**55**	(b)	**56**	(b)	**57**	(b)	**58**	(c)	**59**	(d)	**60**	(a)