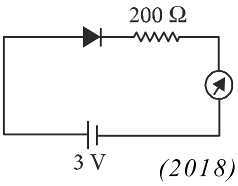
CHAPTER

19 Electronic Devices

1. 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 *(2018)*

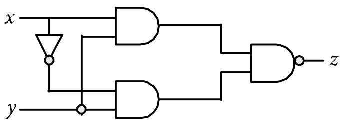
2. In a common emitter configuration with suitable bias, it is given that R_L is the load resistance and R_{BE} is small signal dynamic resistance (input side). Then, voltage gain, current gain and power gain are given, respectively, by (β is current gain, I_B, I_C and I_E are respectively base, collector and emitter currents.)

(a) $\beta\frac{R_L}{R_{BE}}, \frac{\Delta I_E}{\Delta I_B}, \beta^2\frac{R_L}{R_{BE}}$ (b) $\beta\frac{R_L}{R_{BE}}, \frac{\Delta I_C}{\Delta I_B}, \beta^2\frac{R_L}{R_{BE}}$

(c) $\beta^2\frac{R_L}{R_{BE}}, \frac{\Delta I_C}{\Delta I_E}, \beta^2\frac{R_L}{R_{BE}}$ (d) $\beta^2\frac{R_L}{R_{BE}}, \frac{\Delta I_C}{\Delta I_B}, \beta\frac{R_L}{R_{BE}}$

(Online 2018)

3. Truth table for the following digital circuit will be



(a)

x	y	z
0	0	1
0	1	1
1	0	1
1	1	1

(b)

x	y	z
0	0	0
0	1	0
1	0	0
1	1	1

(c)

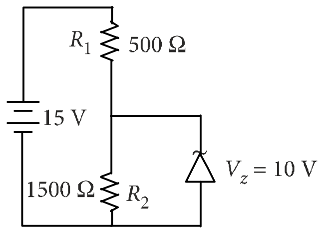
x	y	z
0	0	0
0	1	1
1	0	1
1	1	1

(d)

x	y	z
0	0	1
0	1	1
1	0	1
1	1	0

(Online 2018)

4. In the given circuit, the current through zener diode is



(a) 6.7 mA (b) 3.3 mA
(c) 2.5 mA (d) 5.5 mA

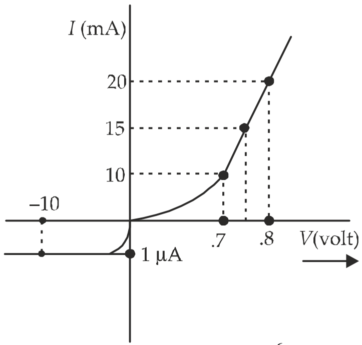
(Online 2018)

5. In a common emitter amplifier circuit using an *n-p-n* transistor, the phase difference between the input and the output voltages will be

(a) 45° (b) 90° (c) 135° (d) 180°

(2017)

6. The *V-I* characteristic of a diode is shown in the figure. The ratio of forward to reverse bias resistance is



(a) 100 (b) 10^6
(c) 10 (d) 10^{-6}

(Online 2017)

7. What is the conductivity of a semiconductor sample having electron concentration of 5×10^{18} m^{-3}, hole concentration of 5×10^{19} m^{-3}, electron mobility of 2.0 m^2 V^{-1} s^{-1} and hole mobility of 0.01 m^2 V^{-1} s^{-1}?
(Take charge of electron as 1.6×10^{-19} C)

(a) 1.83 (Ω-m)$^{-1}$ (b) 1.68 (Ω-m)$^{-1}$
(c) 1.20 (Ω-m)$^{-1}$ (d) 0.59 (Ω-m)$^{-1}$

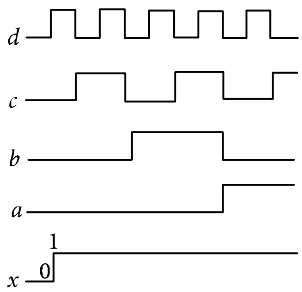
(Online 2017)

8. The current gain of a common emitter amplifier is 69. If the emitter current is 7.0 mA, collector current is

(a) 0.69 mA (b) 6.9 mA
(c) 69 mA (d) 9.6 mA

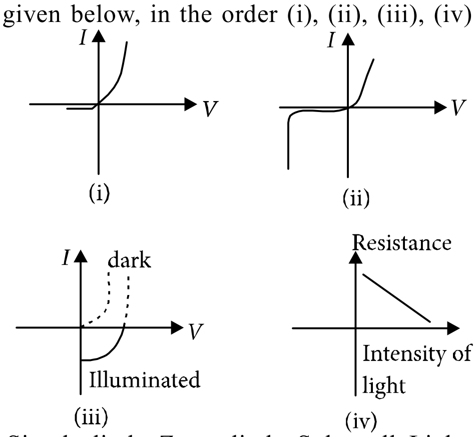
(Online 2017)

9. If *a, b, c, d* are inputs to a gate and *x* is its output, then, as per the following time graph, the gate is



(a) NOT (b) AND
(c) OR (d) NAND *(2016)*

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



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

(2016)

11. For a common emitter configuration, if α and β have their usual meanings, the incorrect relationship between α and β is

(a) $\frac{6}{\alpha}=\frac{6}{\beta}+6$ (b) $\alpha=\frac{\beta}{6-\beta}$

(c) $\alpha=\frac{\beta}{6+\beta}$ (d) $\alpha=\frac{\beta^7}{6+\beta^7}$ *(2016)*

12. An unknown transistor needs to be identified as a *npn* or *pnp* type. A multimeter, with +ve and –ve terminals, is used to measure resistance between different terminals of transistor. If terminal 2 is the base of the transistor then which of the following is correct for a *pnp* transistor?
(a) + ve terminal 2, –ve terminal 3, resistance low
(b) +ve terminal 2, –ve terminal 1, resistance high
(c) +ve terminal 1, –ve terminal 2, resistance high
(d) +ve terminal 3, –ve terminal 2, resistance high

(Online 2016)

13. An experiment is performed to determine the *I-V* characteristics of a Zener diode, which has a protective resistance of $R = 100\ \Omega$, and a maximum power of dissipation rating of 1 W. The minimum voltage range of the *DC* source in the circuit is
(a) 0 – 5V (b) 0 – 24V
(c) 0 – 12V (d) 0 – 8V *(Online 2016)*

14. The truth table given in figure represents

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

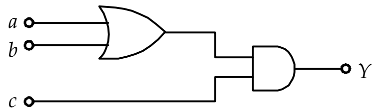
(a) OR - Gate (b) NAND - Gate
(c) AND - Gate (d) NOR - Gate

(Online 2016)

15. The ratio (*R*) of output resistance r_0, and the input resistance r_i in measurements of input and output characteristics of a transistor is typically in the range
(a) $R \sim 10^2 - 10^3$ (b) $R \sim 1 - 10$
(c) $R \sim 0.1 - 1.0$ (d) $R \sim 0.1 - 0.01$

(Online 2016)

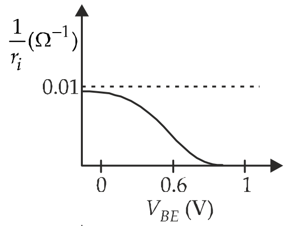
16. To get an output of 1 from the circuit shown in figure the input must be

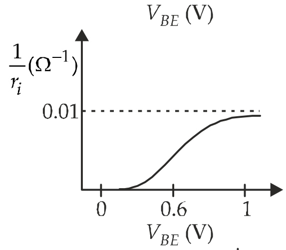


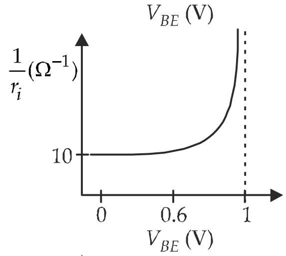
(a) $a = 0, b = 0, c = 1$ (b) $a = 1, b = 0, c = 0$
(c) $a = 1, b = 0, c = 1$ (d) $a = 0, b = 1, c = 0$

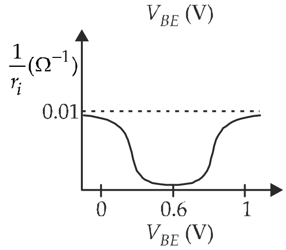
(Online 2016)

17. A realistic graph depicting the variation of the reciprocal of input resistance in an input characteristics measurement in a common emitter transistor configuration is

(a)


(b)


(c)


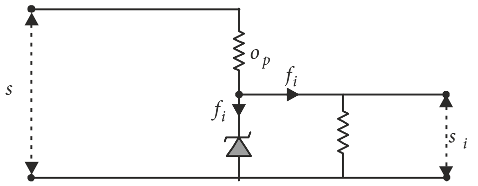
(d)


(Online 2016)

18. In an unbiased *n-p* junction electrons diffuse from *n*-region to *p*-region because
(a) holes in *p*-region attract them
(b) electrons travel across the junction due to potential difference

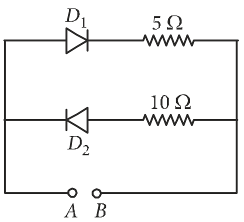
(c) electron concentration in n-region is more as compared to that in p-region
(d) only electrons move from n to p region and not the vice-versa.
(Online 2015)

19. The value of the resistor, R_S, needed in the dc voltage regulator circuit shown here, equals



(a) $(V_i - V_L)/n\ I_L$ (b) $(V_i + V_L)/n\ I_L$
(c) $(V_i - V_L)/(n + 1)\ I_L$ (d) $(V_i + V_L)/(n + 1)\ I_L$
(Online 2015)

20. A 2 V battery is connected across AB as shown in the figure. The value of the current supplied by the battery when in one case battery's positive terminal is connected to A and in other case when positive terminal of battery is connected to B will respectively be

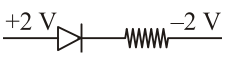


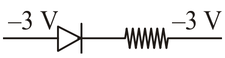
(a) 0.2 A and 0.1 A (b) 0.4 A and 0.2 A
(c) 0.1 A and 0.2 A (d) 0.2 A and 0.4 A
(Online 2015)

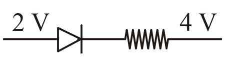
21. The current voltage relation of diode is given by $I = (e^{1000\ V/T} - 1)$ mA, where the applied voltage V is in volts and the temperature T is in degree Kelvin. If a student makes an error measuring ± 0.01 V while measuring the current of 5 mA at 300 K, what will be the error in the value of current in mA?
(a) 0.05 mA (b) 0.2 mA
(c) 0.02 mA (d) 0.5 mA *(2014)*

22. The forward biased diode connection is

(a) 

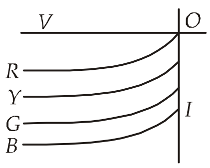
(b) 

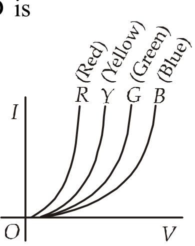
(c) 

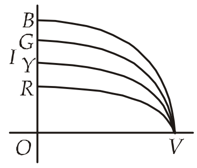
(d) 

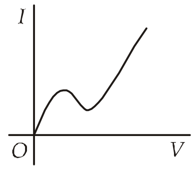
(2014)

23. The I-V characteristic of an LED is

(a) 

(b) 

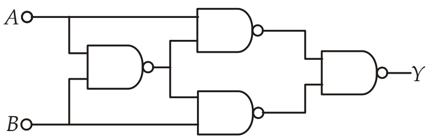
(c) 

(d) 

(2013)

24. A diode detector is used to detect an amplitude modulated wave of 60% modulation by using a condenser of capacity 250 pico farad in parallel with a load resistance 100 kilo ohm. Find the maximum modulated frequency which could be detected by it.
(a) 5.31 kHz (b) 10.62 MHz
(c) 10.62 kHz (d) 5.31 MHz *(2013)*

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



(a)

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

(b)

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

(c)

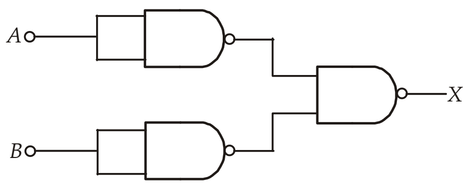
A	B	Y
0	0	1
0	1	0
1	0	0
1	1	1

(d)

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

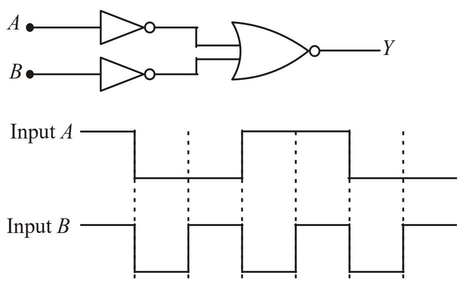
(2012)

26. The combination of gates shown below yields

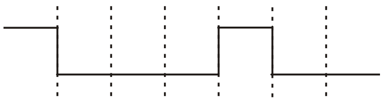


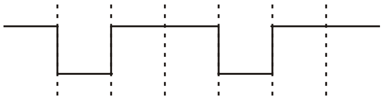
(a) NAND gate (b) OR gate
(c) NOT gate (d) XOR gate *(2010)*

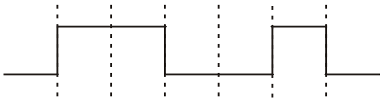
27. The logic circuit shown below has the input waveforms 'A' and 'B' as shown. Pick out the correct output waveform.

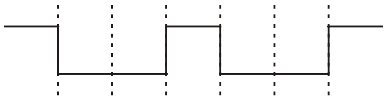


Output is

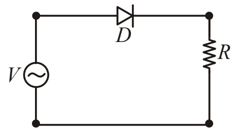
(a) 

(b) 

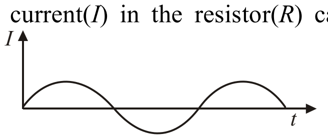
(c) 

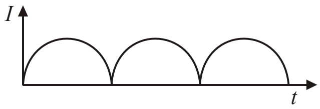
(d)  *(2009)*

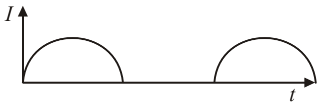
28. A *p-n* junction (*D*) shown in the figure can act as a rectifier.

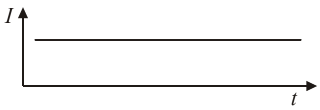


An alternating current source (V) is connected in the circuit. The current(I) in the resistor(R) can be shown by

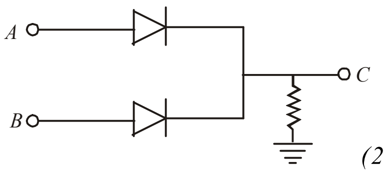
(a) 

(b) 

(c) 

(d)  *(2009)*

29. In the circuit below, A and B represent two inputs and C represents the output. The circuit represents

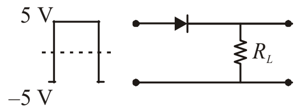


(a) OR gate
(b) NOR gate
(c) AND gate
(d) NAND gate *(2008)*

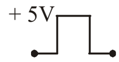
30. A working transistor with its three legs marked P, Q and R is tested using a multimeter. No conduction is found between P and Q. By connecting the common (negative) terminal of the multimeter to R and the other (positive) terminal to P or Q, some resistance is seen on the multimeter. Which of the following is true for the transistor?
(a) It is an *npn* transistor with R as collector.
(b) It is an *npn* transistor with R as base.
(c) It is a *pnp* transistor with R as collector.
(d) It is a *pnp* transistor with R as emitter. *(2008)*

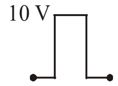
31. Carbon, silicon and germanium have four valence electrons each. At room temperature which one of the following statements is most appropriate ?
(a) The number of free electrons for conduction is significant only in Si and Ge but small in C.
(b) The number of free conduction electrons is significant in C but small in Si and Ge.
(c) The number of free conduction electrons is negligibly small in all the three.
(d) The number of free electrons for conduction is significant in all the three. *(2007)*

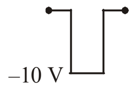
32. If in a p - n junction diode, a square input signal of 10 V is applied as shown



Then the output signal across R_L will be

(a) 

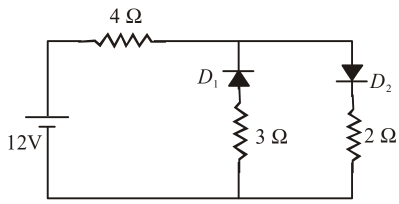
(b) 

(c) 

(d) 

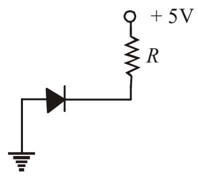
(2007)

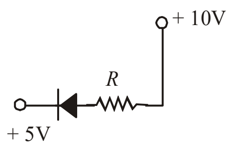
33. The circuit has two oppositely connect ideal diodes in parallel. What is the current following in the circuit?

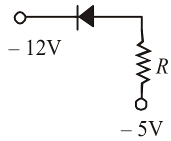


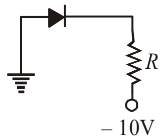
(a) 1.33 A (b) 1.71 A
(c) 2.00 A (d) 2.31 A *(2006)*

34. In the following, which one of the diodes is reverse biased?

(a) 

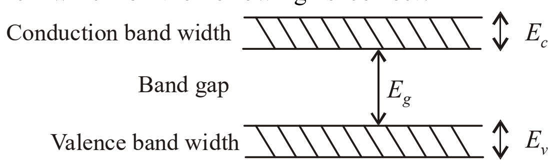
(b) 

(c) 

(d) 

(2006)

35. If the lattice constant of this semiconductor is decreased, then which of the following is correct?



(a) all E_c, E_g, E_v decrease
(b) all E_c, E_g, E_v increase
(c) E_c, and E_v increase, but E_g decreases
(d) E_c, and E_v decrease, but E_g increases. *(2006)*

36. In common base mode of a transistor, the collector current is 5.488 mA for an emitter current of 5.60 mA. The value of the base current amplification factor (β) will be
(a) 48 (b) 49 (c) 50 (d) 51 *(2006)*

37. In the ratio of the concentration of electrons that of holes in a semiconductor is 7/5 and the ratio of currents is 7/4 then what is the ratio of their drift velocities?
(a) 4/7 (b) 5/8 (c) 4/5 (d) 5/4 *(2006)*

38. A solid which is transparent to visible light and whose conductivity increases with temperature is formed by
(a) metallic bonding (b) ionic bonding
(c) covalent bonding (d) van der Waals bonding *(2006)*

39. In a full wave rectifier circuit operating from 50 Hz mains frequency, the fundamental frequency in the ripple would be
(a) 100 Hz (b) 70.7 Hz (c) 50 Hz (d) 25 Hz *(2005)*

40. In a common base amplifier, the phase difference between the input signal voltage and output voltage is
(a) 0 (b) $\pi/2$ (c) $\pi/4$ (d) π *(2005)*

41. 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) 0.5 eV (b) 0.7 eV
(c) 1.1 eV (d) 2.5 eV *(2005)*

42. When *p-n* junction diode is forward biased, then
(a) the depletion region is reduced and barrier height is increased
(b) the depletion region is widened and barrier height is reduced
(c) both the depletion region and barrier height are reduced
(d) both the depletion region and barrier height are increased. *(2004)*

43. The manifestation of band structure in solids is due to
(a) Heisenberg's uncertainty principle
(b) Pauli's exclusion principle
(c) Bohr's correspondence principle
(d) Boltzmann's law *(2004)*

44. A piece of copper and another of germanium are cooled from room temperature to 77 K, the resistance of
(a) each of them increases
(b) each of them decreases
(c) copper decreases and germanium increases
(d) copper increases and germanium decreases. *(2004)*

45. For a transistor amplifier in common emitter configuration for load impedance of 1 kΩ (h_{fe} = 50 and h_{oe} = 25) the current gain is
(a) –5.2 (b) –15.7
(c) – 24.8 (d) – 48.78 *(2004)*

46. When *npn* transistor is used as an amplifier
(a) electrons move from base to collector
(b) holes move from emitter to base
(c) electrons move from collector to base
(d) holes move from base to emitter. *(2004)*

47. 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. *(2003)*

48. 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 structure
(b) variation of the number of charge carriers with temperature
(c) type of bonding
(d) variation of scattering mechanism with temperature. *(2003)*

49. A strip of copper and another 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 these increases. *(2003)*

50. Formation of covalent bonds in compounds exhibits
(a) wave nature of electron
(b) particle nature of electron
(c) both wave and particle nature of electron
(d) none of these. *(2002)*

51. The part of a transistor which is most heavily doped to produce large number of majority carriers is
(a) emitter
(b) base
(c) collector
(d) can be any of the above three. *(2002)*

52. The energy band gap is maximum in
(a) metals (b) superconductors
(c) insulators (d) semiconductors *(2002)*

53. By increasing the temperature, the specific resistance of a conductor and a semiconductor
(a) increases for both (b) decreases for both
(c) increases, decreases (d) decreases, increases. *(2002)*

54. At absolute zero, Si acts as
(a) non-metal (b) metal
(c) insulator (d) none of these. *(2002)*

ANSWER KEY

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

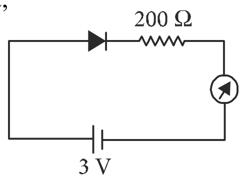
Explanations

1. (c) : Current in the circuit,

$$I = \frac{V - V_{\text{diode}}}{R}$$

$$= \frac{3-0.7}{200} = \frac{2.3}{200}\text{A}$$

$$= \frac{2300}{200}\text{mA} = 11.5 \text{ mA}$$

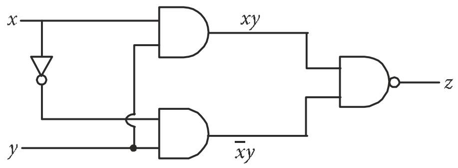


2. (b) : Current gain $\beta = \frac{\Delta I_C}{\Delta I_B}$

Voltage gain $A_V = \frac{\Delta V_{CE}}{R_{BE} \Delta I_B} = \beta \frac{R_L}{R_{BE}}$

Power gain $A_P = \beta A_V = \beta^2 \frac{R_L}{R_{BE}}$

3. (a) :



Output, $z = \overline{(xy)\,(\overline{x}y)} = \overline{0y} = \overline{0} = 1$ $\quad (\because x\overline{x} = 0 \text{ and } yy = y)$

Whatever be the inputs to the given digital circuit, output will be one.

4. (b) : Current in R_1, $I_1 = \frac{5}{500} = 10 \times 10^{-3}\text{A} = 10 \text{ mA}$

Current in R_2, $I_2 = \frac{10}{1500}\text{A} = \frac{20}{3}$ mA

Current in zener diode

$= I_1 - I_2 = \left(10 - \frac{20}{3}\right)\text{mA} = \frac{10}{3}\text{ mA} \approx 3.3\text{mA}$

5. (d)

6. (d) : Forward bias resistance,

$$R_1 = \frac{\Delta V}{\Delta I_{\text{for}}} = \frac{0.8-0.7}{(20-10)\times 10^{-3}} = \frac{0.1}{10\times 10^{-3}} = 10$$

Reverse bias resistance, $R_2 = \frac{10}{1\times 10^{-6}} = 10^7$

then, the ratio of forward to reverse bias resistance,

$$\frac{R_1}{R_2} = \frac{10}{10^7} = 10^{-6}$$

7. (b) : Given; $n_e = 5 \times 10^{18}$ m^{-3}, $n_h = 5 \times 10^{19}$ m^{-3}, $\mu_e = 2$ m^2 V^{-1} s^{-1}, $\mu_h = 0.01$ m^2 V^{-1}s^{-1} then conductivity,

$\sigma = e\,(n_e\mu_e + n_h\mu_h)$

Putting values, we get

$\sigma = 1.6 \times 10^{-19}(5 \times 10^{18} \times 2 + 5 \times 10^{19} \times 0.01)$

$\quad = 1.6 \times 10^{-19}(10^{19} + 0.05 \times 10^{19}) = 1.68\ (\Omega\text{-m})^{-1}$

8. (b) : Here, $\beta = 69$, $I_e = 7$ mA, $I_c = ?$

$$\alpha = \frac{\beta}{1+\beta} = \frac{69}{70}$$

Also, $\alpha = \frac{I_c}{I_e}$ or $\frac{69}{70} = \frac{I_c}{7} \Rightarrow I_c = \frac{69}{70} \times 7 = 6.9$ mA

. (c) : Output (x) is high when atleast one of the inputs is high. Hence, x is the output of OR gate.

10. (a)

11. (b, d) : We know $\alpha = \frac{f}{f} 1\beta = \frac{f}{f}$

$$\alpha = \frac{\beta f}{f \ \ + f} = \frac{\beta}{6+f \ \ 4f} = \frac{\beta}{6+\beta} \ \{\sim \frac{6}{\alpha} = \frac{6}{\beta} + 6$$

Hence options (b) and (d) are incorrect.

12. (b) : p-n-p transistor

$E(p)$	$B(n)$	$C(p)$
1	2	3

Positive at terminal 2 and negative at terminal 1 implies p-n junction is reverse biased and hence offers high resistance.

13. (b) : Potential drop across Zener diode

$V_Z = V - IR = V - 100\ I$

$\therefore$ Power, $P = V_Z I_Z$

$\quad = (V - 100\ I)\ I$

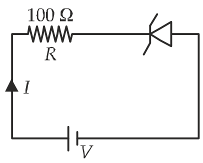
But $P = 1$ W (given)

$\therefore \quad (V - 100\ I)\ I = 1$

or $\quad 100\ I^2 - VI + 1 = 0$

For I to be real, $V^2 - 4 \times 100 \times 1 \geq 0$

or $\quad V \geq 20$ V



14. (a) : The given truth table represents OR gate.

15. (b) : $R = \frac{\text{Output resistance } (r_0)}{\text{Input resistance } (r_i)} \equiv 1 - 10$

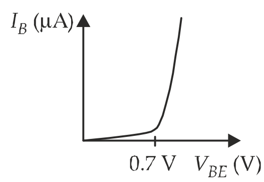
16. (c) : Output $Y = (a + b) \cdot c$

$Y = 1$ if $c = 1$ and $a = 0$, $b = 1$ or $a = 1$, $b = 0$

17. (c) : For common emitter configuration, the input characteristic

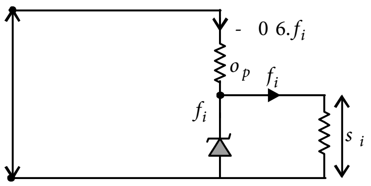
$$r_i = \frac{\Delta V_{BE}}{\Delta I_B}$$

$\frac{1}{r_i} = \frac{dI_B}{dV_{BE}}$ = Slope of ($I_B - V_{BE}$) curve



Slope of the input characteristic is almost constant upto knee voltage (0.7 V). Then it increases sharply. Hence option (c) is the correct choice.

18. (c) : Electron concentration in n-region is more as compared to that in p-region. So electrons diffuse from n-side to p-side.

19. (c) : 

Voltage drop across Zener diode is V_L, so voltage drop across R_S is, $V_{RS} = V_i - V_L = (n + 1)I_L R_S$

$$\therefore\ o_p = \frac{s - s_i}{- + 6 f_i}$$

20. (b) : When positive terminal of battery is connected to A, current passes through diode D_1.

∴ J ×~qz µ−×| | xuqp = 7 b / : Ω = 539 H

When positive terminal is connected to B current passes through D_2.

∴ J ×~qz µ−×| | xuqp = 7 b / 65 Ω = 537 H

21. (b) : As, $I = (e^{1000\,V/T} - 1)$ mA ...(i)

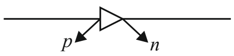
Here, $I = 5$ mA at $T = 300$ K

$dV = 0.01$ V

$\therefore\quad 5 = (e^{1000\,V/T} - 1) \quad\Rightarrow\quad e^{(1000\,V/T)} = 6$ mA

Differentiating eqn. (i), we get

$$dI = \left(\frac{1000}{T}\right)e^{(1000\,V/T)}dV = \frac{1000}{300}(6)(0.01) = 0.2 \text{ mA}$$

22. (b) : 

In forward bias, p-side of diode is at higher potential with respect to the potential of n-side.

23. (b) : The I-V characteristics of a LED is similar to that of a Si junction diode. But the threshold voltages are much higher and slightly different for each colour.
Hence, the option (b) represents the correct graph.

24. (c) : The maximum frequency which can be detected is

$$\upsilon = \frac{1}{2\pi m_a \tau}\text{; where, } \tau = CR$$

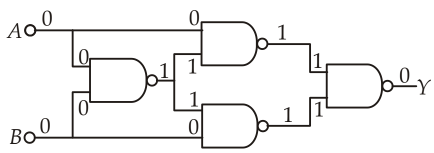
Here, $C = 250$ pico farad $= 250 \times 10^{-12}$ farad

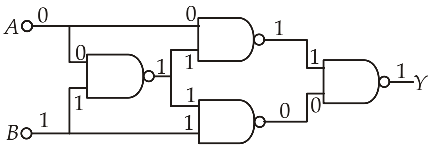
$R = 100$ kilo ohm $= 100 \times 10^3$ ohm

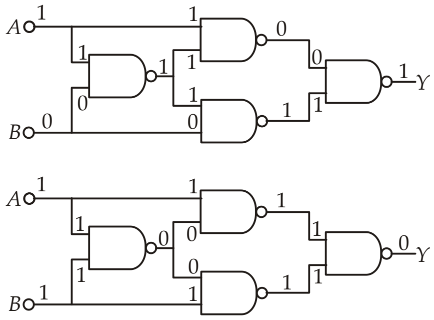
$m_a = 0.6$

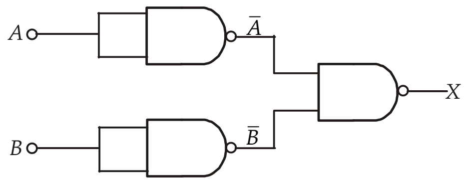
$$\therefore\quad \upsilon = \frac{1}{2\pi \times 0.6 \times 250 \times 10^{-12} \times 100 \times 10^3}$$

$= 10.61 \times 10^3$ Hz $= 10.61$ kHz

25. (d) : 





26. (b) : 

The Boolean expression of the given circuit is

$X = \overline{\overline{A} \cdot \overline{B}}$

$= \overline{\overline{A}} + \overline{\overline{B}}$ (Using De Morgan's theorem)

$= A + B$ (Using Boolean identity)

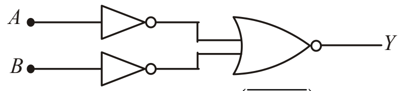
This is same as the Boolean expression of OR gate.

Alternative method

The truth table of the given circuit is as shown in the table

A	B	$\overline{A}$	$\overline{B}$	$\overline{A} \cdot \overline{B}$	$X = \overline{\overline{A} \cdot \overline{B}}$
0	0	1	1	1	0
0	1	1	0	0	1
1	0	0	1	0	1
1	1	0	0	0	1

This is same as that of OR gate.

27. (a) : 

By de Morgan's theorem, $(\overline{\overline{A} + \overline{B}}) = A \cdot B$

A	B	$\overline{A}$	$\overline{B}$	$\overline{A} + \overline{B}$	$\overline{\overline{A} + \overline{B}}$	Verify $A \cdot B$
1	1	0	0	0	1	1
0	0	1	1	1	0	0
0	1	1	0	1	0	0
1	0	0	1	1	0	0

This is the same as AND Gate of A and B.

28. (c) : (a) is original wave, (b) is a full-wave rectified, (c) is the correct choice. The negative waves are cut off when the diode is connected in reverse bias, (d) is not the diagram for alternating current.

29. (a) : It is OR gate. When either of them conducts, the gate conducts.

30. (a) : It is *npn* transistor with R as collector. If it is connected to base, it will be in forward bias.

31. (a) : C, Si and Ge have the same lattice structure and their valence electrons are 4. For C, these electrons are in the second orbit, for Si it is third and for germanium it is the fourth orbit. In solid state, higher the orbit, greater the possibility of overlapping of energy bands. Ionization energies are also less therefore Ge has more conductivity compared to Si. Both are semiconductors.Carbon is an insulator.

32. **(a) :** The current will flow through R_L when diode is forward biased.

33. **(c) :** Since diode D_1 is reverse biased, therefore it will act like an open circuit.
Effective resistance of the circuit is $R = 4 + 2 = 6\ \Omega$
Current in the circuit is $I = E/R = 12/6 = 2$ A

34. **(a) :** Figure (a) represent a reverse biased diode.

35. **(d) :** E_c and E_v decrease but E_g increases if the lattice constant of the semiconductor is decreased.

36. **(b) :** $\beta = \frac{I_c}{I_b} = \frac{I_c}{I_e - I_c} = \frac{5.488}{5.60 - 5.488} = \frac{5.488}{0.112} = 49$

37. **(d) :** Drift velocity $v_d = \frac{I}{nAe}$

$$\frac{(v_d)_{\text{electron}}}{(v_d)_{\text{hole}}} = \left(\frac{I_e}{I_h}\right)\left(\frac{n_h}{n_e}\right) = \frac{7}{4} \times \frac{5}{7} = \frac{5}{4}$$

38. **(c) :** Covalent bonding.

39. **(a) :** Frequency of full wave rectifier
= 2 × input frequency = 2 × 50 = 100 Hz

40. **(a) :** In a common base amplifier, the phase difference between the input signal and output voltage is zero.

41. **(a) :** Band gap = Energy of photon of $\lambda = 2480$ nm

$\therefore$ Energy $= \frac{hc}{\lambda}$ J $= \frac{hc}{\lambda e}$ eV

$\therefore$ Band gap $= \frac{(6.63\times10^{-34})\times(3\times10^{8})}{(2480\times10^{-9})\times(1.6\times10^{-19})}$ eV $= 0.5$ eV

42. **(c) :** When *p-n* junction diode is forward biased, both the depletion region and barrier height are reduced.

43. **(b) :** Pauli's exclusion principle explains band structure of solids.

44. **(c) :** Copper is a conductor.
Germanium is a semiconductor.
When cooled, the resistance of copper decreases and that of germanium increases.

45. **(d) :** In common emitter configuration, current gain is

$$A_i = \frac{-(h_{fe})}{1+(h_{oe})(R_L)} = \frac{-50}{1+(25\times10^{-6})\times(1\times10^{3})}$$

$$= -\frac{50}{1+0.025} = \frac{-50}{1.025} = -48.78$$

46. **(a) :** Electrons of *n*-type emitter move from emitter to base and then base to collector when *npn* transistor is used as an amplifier.

47. **(a) :** Electric field is zero in the middle of the depletion layer of a reverse baised *p-n* junction.

48. **(b) :** Variation of number of charge carriers with temperature is responsible for variation of resistance in a metal and a semiconductor.

49. **(c) :** Copper is conductor and germanium is semiconductor. When cooled, the resistance of copper strip decreases and that of germanium increases.

50. **(a) :** Wave nature of electron and covalent bonds are correlated.

51. **(a) :** The emitter is most heavily doped.

52. **(c) :** The energy band gap is maximum in insulators.

53. **(c) :** For conductor, ρ increases as temperature rises. For semiconductor, ρ decreases as temperature rises.

54. **(c) :** Semiconductors, like Si, Ge, act as insulators at low temperature.