SOLVED EXAMPLES

Example 1. A p-type semiconductor has acceptor levels 57 meV above the valence bond. Find the maximum wavelength of light which can create a hole.

(1) 2.18×10^{-5} m (2) 1.18×10^{-5} m

(3) 2.10×10^{-5} m (4) 0.18×10^{-5} m

Solution : (1) To create a hole, an electron from the valence band should be given sufficient energy to go into one of the acceptor levels. Since the acceptor levels are 57 meV above the valence band, at least 57 meV is needed to create a hole. If λ be the wavelength of light, its photon will have an energy hc/λ. To create a hole.

$$\frac{hc}{\lambda} \geq 57\,\text{meV} \qquad \text{or, } \lambda \leq \frac{hc}{57\,\text{meV}} = \frac{1242\text{nm}}{57 \times 10^{-3}\text{eV}} = 2.18 \times 10^{-5}\,\text{m}$$

Example 2. The reverse-biased current of a particular *p-n* junction diode increases when it is exposed to light of wavelength less than or equal to 600 nm. Assume that the increase in carrier concentration takes place due to the creation of new hole-electron pairs by the light. Find the band gap.

(1) 2.17 eV (2) 3.07 eV

(3) 2.27 eV (4) 2.07 eV

Solution : **(4)** The reverse-biased current is caused mainly due to the drift current. The drift current in a *p-n* junction is caused by the, formation of new hole-electron pairs and their subsequent motions in the depletion layer. When the junction is exposed to light, it may absorb energy from the light photons. If this energy supplied by a photon is greater than (or equal to) the band gap, a hole-electron pair may be formed. Thus, the reverse-biased current will increase if the light photons have energy greater than (or equal to) the band gap. Hence the band gap is equal to the energy of a photon of 600 nm light which is

$$\frac{hc}{\lambda} = \frac{1242\text{ eV}}{600} = 2.07\text{ eV}.$$

Example 3. A transistor is used in common-emitter mode in an amplifier circuit. When a signal of 20 mV is added to the base-emitter voltage, the base current changes by 20 μA and the collector current changes by 2 mA. The load resistance is 5 kΩ. Calculate (a) the factor β, (b) the input resistance R_{BE}, (c) the transconductance and (d) the voltage gain.

Solution :

(a) $\beta = \dfrac{\Delta I_C}{\Delta I_B} = \dfrac{2\,\text{mA}}{20\,\mu\text{A}} = 100.$

(b) The input resistance $R_{BE} = \dfrac{\Delta V_{BE}}{\Delta I_B} = \dfrac{20\,\text{mV}}{20\,\mu\text{A}} = 1\text{k}\Omega.$

(c) Transconductance = $\dfrac{\Delta I_C}{\Delta V_{BE}} = \dfrac{2\,mA}{20\,mV} = 0.1\,mho.$

(d) The change in output voltage is $R_L \Delta I_C = (5\,k\Omega)(2\,mA) = 10\,V.$

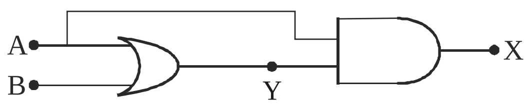
The applied signal voltage = 20 mV.

Thus, the voltage gain is,

$$\frac{10\,V}{20\,mV} = 500.$$

Example 4.

Construct the truth table for the function X of A and B represented by figure.



Solution :

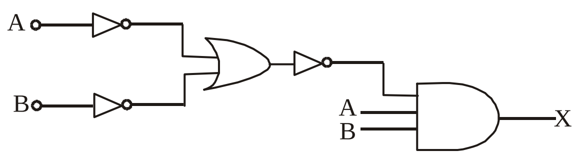
Here an AND gate and on OR gate are used. Let the output of the OR gate be Y. Clearly, Y = A + B. The AND gate receives A and A + B as input. The output of this gate is X. So X = A(A + B). The following table evaluates X for all combinations of A and B. The last three columns give the truth table.

A	**B**	**Y = A + B**	**X = A(A + B)**	**A**	**B**	**X**
0	0	0	0	0	0	0
0	1	1	0	0	1	0
1	0	1	1	1	0	1
1	1	1	1	1	1	1

Example 5.

Find the output A of the following circuit if the inputs are

A = 0, B = 0; A = 0, B = 1; A = 1, B =0; A = 1, B = 1



(1) 1 (2) 2 (3) 3 (4) 4

Solution :

(1) The equation for given circuit is

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

$$\overline{(\overline{0} + \overline{0})}\ 0.0 = 0 \qquad \overline{(\overline{0} + \overline{1})}\ 0.1 = 0$$

$$\overline{(\overline{1} + \overline{0})}\ 0.1 = 0$$

$$\overline{(\overline{1} + \overline{1})}\ 1.1 = \overline{(\overline{0} + \overline{0})}\ 1.1 = (\overline{0})\ 1.1 = 1.1.1 = 1$$

MULTIPLE CHOICE QUESTIONS

LEVEL – 1

1. A hole diffuses from the *p*-side to the n-side in a p-n junction. This means that
   (1) A bond is broken on the *n*-side and the electron freed from the bond jumps to the conduction band
   (2) A conduction electron on the *p*-side jumps to a broken bond to complete it
   (3) A bond is broken on the *n*-side and the electron freed from the bond jumps to a broken bond on the *p*-side to compete it
   (4) A bond is broken on the *p*-side and the electron freed from the bond jumps to a broken bond on the *n*-side to complete it

2. A PN junction diode cannot be used
   (1) As rectifier
   (2) For converting light energy to electrical energy
   (3) For getting light radiation
   (4) For increasing the amplitude of an ac signal

3. A solid which is transparent to visible light and whose conductivity increases with temperature is formed by
   (1) metalic binding
   (2) ionic binding
   (3) Covalent
   (4) Vander Waal's binding

4. A semiconductor is known to have an electron concentration of 8×10^{13} /cm^3 and hole concentration of 5×10^{12}/cm^3. The semiconductor is
   (1) N-type (2) P-type
   (3) Intrinsic (4) Insulator

5. Diffusion current in a *p*-*n* junction is greater than the drift current in magnitude
   (1) If the junction is forward-biased
   (2) If the junction is reverse-biased
   (3) If the junction is unbiased
   (4) In no case

6. The depletion layer in the p-n junction region is caused by
   (1) Diffusion of carriers
   (2) Drift of electrons
   (3) Drift of holes
   (4) Migration of impurity ions

7. If A = 1 and B = 0, then $A \cdot (A + B)$ in the Boolean expression is equal to
   (1) B (2) $A \cdot B$
   (3) A (4) $B \cdot B$

8. A p-n junction diode when forward biased has a potential drop of 0.5 V, which is assumed to be independent of current. If the current through the diode exceeds 10 mA, Joule heating damage the diode. If one wants to use a 1.5 V battery to forward bias the diode, what should be the value of resistor used in series with the diode so that the maximum current does not exceed 5 mA ?
   (1) 200 Ω (2) 400 Ω
   (3) 300 Ω (4) 100 Ω

9. An input resistance of a silicon transistor is 665 Ω. Its base current is changed by 15μA, which results in the change in collector current by 2mA. This transistor is used as a common emitter amplifier with a load resistance of 5kΩ. What is the voltage gain of the amplifier?
   (1) –3000 (2) 2000
   (3) –1000 (4) 4000

10. What is the change in the collector current, in a transistor of a current gain 150, for a 100 μA change in its base current ?
    (1) 1.015 A. (2) 0.005 A.
    (3) 0.015 A (4) 2.015 A.

11. Carbon silicon & germanium have four valence electron each. At room temperature which one of the following statements, is most appropriate

(1) the number of free electron for conduction is significant only in Si and Ge but small in C

(2) the number of free conduction electron is significant in C but small is Si & Ge

(3) the number of free conduction electron is negligibly small in all the three.

(4) The number of free electrons for conduction is sigficant in all the three.

12. The energy gap of silicon is 1.14 eV. The maximum wavelength at which silicon will begin absorbing energy is

(1) 10855 Å (2) 1088.8 Å

(3) 108.88 Å (4) 10.888 Å

13. A common emitter amplifier is designed with n-p-n transistor ($\alpha = 0.99$). The input impedence is 1 kΩ and load is 10 KΩ. The voltage gain will be

(1) 9.9 (2) 99

(3) 990 (4) 9900

14. In a n-p-n transistor circuit, the collector current is 9 mA. If 90% of the electrons emitted reach the collector, then the emitter current is

(1) 10 mA (2) 9 mA

(3) 8 mA (4) 8.1 mA

15. A transistor has an $\alpha = 0.95$. It has change in emitter current of 100 milli ampere. The change in the collector current is

(1) 100 mA (2) 100.95 mA

(3) 99.05 mA (4) 95 mA

16. Application of a forward bias to a p-n junction

(1) Increases the number of donors on the n side

(2) Widens the depletion zone

(3) Increases the potential difference across the depletion zone

(4) Increases the electric field in the depletion zone

17. Carbon, Silicon and Germanium atoms have four valence electrons each. Their valence and conduction bands are separated by energy band gaps represented by $(E_g)_C$, $(E_g)_{Si}$ and $(E_g)_{Ge}$ respectively. Which one of the following relationships is true in their case ?

(1) $(E_g)_C < (E_g)_{Ge}$ (2) $(E_g)_C < (E_g)_{Si}$

(3) $(E_g)_C = (E_g)_{Si}$ (4) $(E_g)_C > (E_g)_{Si}$

18. Zener diode is used for

(1) Amplification

(2) Producing oscillations in an oscillator

(3) Stabilisation

(4) Rectification

19. Choose the only false statement from the following

(1) Substances with energy gap of the order of 10 eV are insulators

(2) The conductivity of a semiconductor increases with increase in temperature

(3) In conductors the valence and conduction bands may over lap

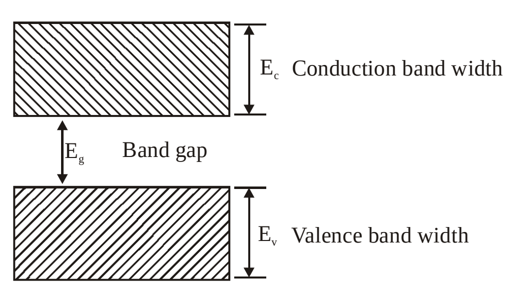
(4) The resistivity of a semiconductor increases with increases in temperature.

20. For a transistor $\Delta I_c = 2.4\text{mA}$, $\Delta I_B = 2.4\mu\text{A}$. The value of α of the transistor is

(1) 0.96 (2) 0.8

(3) 1.04 (4) 0.9

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



(1) All E_c, E_g and E_v decreases

(2) All E_c, E_g and E_v

(3) E_c and E_v increase, but E_g decreases

(4) E_c and E_v decrease, but E_g increases

22. The difference in the variation of resistance with temperature in a metal and a semi conductor arises essentially due to the difference in.
(1) type of bonding
(2) crystal structure
(3) scattering mechanism with temperature
(4) number of charge carriers with temperature

23. In the middle of the depletion layer of a reverse biased p-n junction the
(1) potential is zero
(2) electric field is zero
(3) potential is maximum
(4) electric is maximum

24. When p-n junction diode is forward biased then
(1) the depletion region is reduced and barrier height is increased
(2) the depletion is widened and barrier height is reduced
(3) both the depletion region and barrier height are reduced
(4) both the depletion region and barrier height are increased.

25. When n-p-n transistor is used as an amplifier then
(1) electrons move from base to collector
(2) electrons move from base to emitter
(3) electrons move from collector to base
(4) holes move from base to emitter

LEVEL - II

1. When transistor is in action; (emitter base junction is J_1 base collector junction is J_2)
(1) J_1 is forward biased , J_2 is reverse biased
(2) J_1 and J_2 are reverse biased
(3) J_1 and J_2 are forward biased
(4) J_1 is reverse biased , J_2 is forward biased

2. The radius of Germanium (Ge) nuclide measured to be twice the radius of ${}^{9}_{4}Be$, the number of nucleons in Ge are
(1) 72 (2) 73
(3) 74 (4) 75

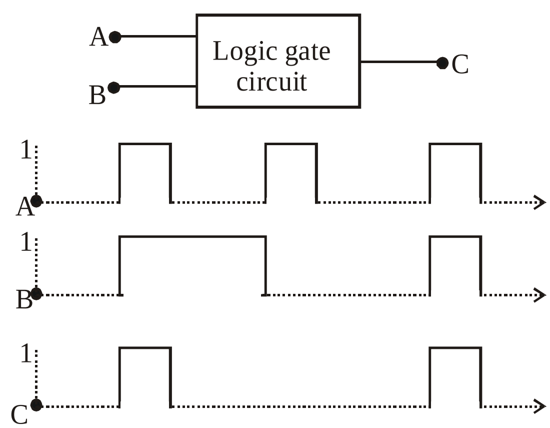
3. A transistor-oscillator using a resonant with an inductor L (of negligible resistance) a capacitor C in series produce oscillation frequency f. If L is doubled and C is changed to 4 C, the frequency will be
(1) f/2 (2) f/4
(3) 8f (4) $f/2\sqrt{2}$

4. Forward biased diode is
(1) 

(2) 

(3) 

(4) 

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


The logic circuit gate is
(1) OR gate (2) AND gate
(3) NAND gate (4) NOR gate

6. A transistor is operated in common emitter configuration at constant collector voltage V_c

= 1.5 V such that a change in the base current from 100 μA to 150 μA produces a change in the collector current from 5mA to 10mA. The current gain (β) is

(1) 50 (2) 67

(3) 75 (4) 100

7. When a p-n diode is reverse biased, then :

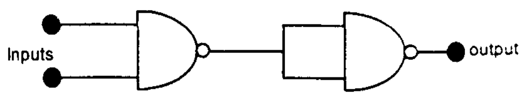
(1) No current flows

(2) The depletion region is increased

(3) The depletion region is reduced

(4) The height of the potential barrier is reduced

8. The circuit given below represents which of logic operations:



(1) AND (2) NOT

(3) OR (4) NOR

9. A light emitting diode (LED) has a voltage drop of 2 volt across it and passes a current of 10 mA. When it operates with a 6 volt battery through a limiting resistor R. The value of R is:

(1) 40 kΩ (2) 4 kΩ

(3) 200 kΩ (4) 400 Ω

10. The minimum potential difference between the base and emitter required to switch a silicon transistor 'ON' is approximately:

(1) 1 V (2) 3 V

(3) 5 V (4) 4.2 V

11. The potential in the depletion layer is due to

(1) Electrons (2) Holes

(3) Ions (4) Forbidden band

12. The cut off voltage for silicon diode is approximately

(1) 0.2 V (2) 0.7 V

(3) 1.1 V (4) Any value

13. A fullwave *p-n* diode rectifier uses a load resistance of 480 Ω. If the internal resistance of each diode is 20 Ω, its efficiency is

(1) 78% (2) 88%

(3) 50% (4) 100%

14. The width of forbidden gap in silicon crystal is 1.1 eV. When the crystal is converted into a n-type semiconductor the distance of Fermi level from conduction band is

(1) Greater than 0.55 eV

(2) Equal to 0.55 eV

(3) Lesser than 0.55 eV

(4) Equal to 1.1 eV

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

(1) 0.9 (2) 0.7

(3) 0.5 (4) 1.1

16. If the collector current changes from 2mA to 3mA in a transistor when collector emitter voltage is increased from 2V to 10V, the output resistance is

(1) 2kΩ (2) 4kΩ

(3) 6kΩ (4) 8kΩ

17. In a *p-n-p* transistor, circuit, the collector current is 10 mA. If 90% of holes emitted reach the collector.

(1) The emitter current will be 9 mA

(2) The emitter current will be 11 mA

(3) The base current is 9 mA

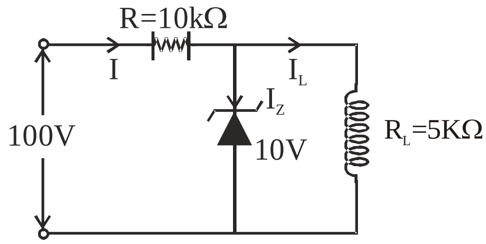
(4) The base current is –1 mA

18. In common emitter amplifier, the current gain in 62. The collector resistance and input resistance are 5kΩ respectively. If the input voltage is 0.01V, the output voltage is

(1) 0.62V (2) 6.2V

(3) 62V (4) 620V

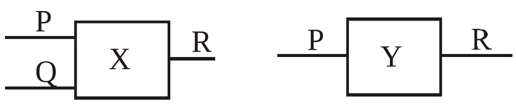
19. In the following circuit, the zener current is



(1) 5 mA (2) 7 mA

(3) 10 mA (4) 20 mA

20. Logic gates X and Y have the truth tables shown below



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

P	R
0	1
1	0

When the output of X is connected to the input of Y, the resulting combination is equivalent to a single

(1) NOT gate (2) OR gate

(3) NOR gate (4) NAND gate

21. In common base mode of a transistor, the collector current is 5.488 mA, for an emitter of 5.60 mA. The value of the base current amplication factor (β) will be

(1) 48 (2) 49

(3) 50 (4) 51

22. For a transistor amplifier in common emitter configuration for load impedance of $1k\Omega$ (h_{fe}=50 and h_{oe}=25×10^{-6}) the current gain is

(1) -5.2 (2) -15.7

(3) -24.8 (4) -48.78

23. In a full wave rectifier circuit operating from 50 Hz mains frequency, the fundamental frequency in the ripple is

(1) 25 Hz (2) 50 Hz

(3) 70 Hz. (4) 100 Hz

24. If the ratio of concentration of electrons to that of holes in a semiconductor is 7/5 and the ratio of current is 7/4, then what is the ratio of their drift velocities?

(1) 4/7 (2) 5/8

(3) 4/5 (4) 5/4

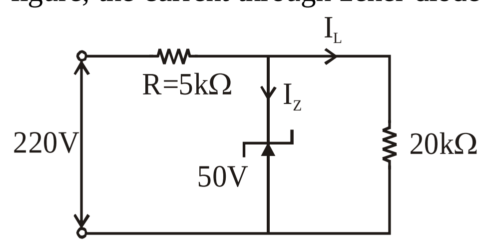
LEVEL - III

1. In half wave rectifier a p–n diode with internal resistance 20 Ω is used. If the load resistance of 2kΩ is used in the circuit, then find the efficiency of this half wave rectifier.

(1) 80 % (2) 20 %

(3) 40.2 % (4) 42 %

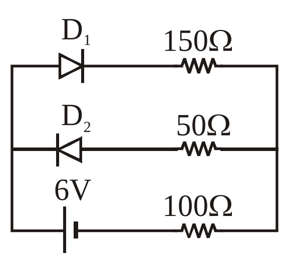
2. From the zener diode circuit shown in the figure, the current through zener diode is



(1) 34 mA (2) 30 mA

(3) 33 mA (4) 31.5 mA

3. If each diode forward resistance is 50 Ω then find current through the 100 Ω resistor in the given circuit.



(1) 2 A (2) 0.02 A

(3) 0.2 A (4) 0.002 A

4. Find the current produced at room temperature in a pure germanium plate of

area 2×10^{-4} m^2 and of thickness 1.2×10^{-3} m when a potential of 5V is applied across the faces. Concentration of carriers in germanium at room temperature is 1.6×10^6 per cubic meter. The mobilities of electrons and holes are 0.4 m^2 V^{-1} s^{-1} and 0.2 m^{2}V^{-1}s^{-1} respectively. How much heat is generated in the plate in 100 seconds.

(1) 6.4×10^{-11} J (2) 64×10^{-11} J

(3) 3.2×10^{-11} J (4) 32×10^{-11} J

5. Calculate the change in base current from transistor characteristics when current amplification factor $\beta = 100$; with change in collector current as 1mA.

(1) 1 mA (2) 0.1 mA

(3) 0.01 mA (4) 10 mA

6. If the collector current changes from 12 mA to 13 mA in a transistor when collector emitter voltage is increased from 12V to 20 V what is the output resistance?

(1) 8 kΩ (2) 80 kΩ

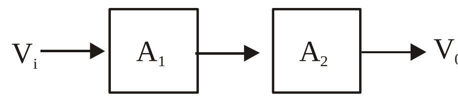
(3) 0.8 kΩ (4) 4 kΩ

7. In a CE amplifier, using a transistor of current gain $\beta = 50$, the voltage gain is 200. A change of 0.5 V in input voltage produces a change of 50 μA in base current. What is load resistance ?

(1) 10 V (2) 20 V

(3) 40 V (4) 30 V

8. Two amplifiers are connected as shown in figure. Find V_0, if $A_1 = 20$, $A_2 = 10$ and V_i = 50 mV.



(1) 20 V (2) 10 V

(3) 30 V (4) 40 V

9. A change of 8.0 mA in the emitter current brings a change of 7.9 mA in the collector current. Find the value of α

(1) 0.96 (2) 0.98

(3) 0.99 (4) 0.97

10. Calculate the change in base current from transistor characteristics when current amplification factor $\beta = 100$; with change in collector current as 1mA.

(1) 0.01 mA (2) 1 mA

(3) 0.1 mA (4) 10 mA

ANSWERS (ELECTRONIC DEVICES)

LEVEL - I

1. (3)	6. (1)	11. (1)	16. (1)	21. (4)
2. (4)	7. (3)	12. (1)	17. (4)	22. (4)
3. (3)	8. (1)	13. (3)	18. (3)	23. (1)
4. (1)	9. (3)	14. (1)	19. (4)	24. (3)
5. (1)	10. (3)	15. (4)	20. (1)	25. (1)

LEVEL - II

1. (1)	6. (4)	11. (3)	16. (4)	21. (2)
2. (1)	7. (2)	12. (3)	17. (2)	22. (4)
3. (4)	8. (1)	13. (1)	18. (2)	23. (4)
4. (1)	9. (4)	14. (3)	19. (2)	24. (4)
5. (2)	10. (1)	15. (3)	20. (4)	

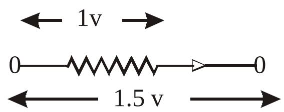
LEVEL - III

1. (3)	3. (2)	5. (3)	7. (1)	9. (3)
2. (4)	4. (1)	6. (1)	8. (2)	10. (1)

SOLUTIONS (LEVEL - I)

4. N type semi conductor, electrons are majority carriers.

7. A. (A+B) $\Rightarrow$ 1. (1+0) $\Rightarrow$ 1.1 $\Rightarrow$ 1=A

8. 

$R \times 5 \times 10^{-3} = 1$

$R = \frac{1000}{5} = 200\Omega$

9.

$$\beta = \frac{I_c}{I_b} = \frac{2\times10^{-3}}{15\times10^{-6}} = \frac{2000}{15}$$

$$Voltage\ gain = \beta\frac{R_L}{R_I} = \frac{2000\times5000}{15\times665} = 1000$$

10.

$$Current\ gain = \frac{\Delta I_C}{\Delta I_b}$$

$$150 = \frac{\Delta I_c}{\Delta I_b} = \frac{\Delta I_c}{100\times10^{-16}}$$

$$\Delta I_c = 150\times100\times10^{-6} = 0.0150A$$

11. C, Si and Ge have same lattice structure and their valence electron are 4. For C, these electron are in second orbit. For Si it is third and germanium it is 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 semi conductor. Carbon is an insulator.

12.

$$1.14\times1.6\times10^{-19}$$

$$= \frac{hc}{\lambda}$$

$$= \frac{6.67\times10^{-34}\times3\times10^{8}}{\lambda}$$

$$\lambda = 10855\overset{0}{A}$$

13.

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

$$V = \beta\frac{R_L}{R_I} = \frac{99\times10\times1000}{1\times1000} = 990$$

14. I_c = 90% of I_e

9×10^{-3} = 90% of I_e

$$I_e = \frac{9\times10^{-3}\times100}{90} = 10mA$$

15.

$$\alpha = \frac{\Delta I_c}{I_e}$$

$$0.95 = \frac{\Delta I_c}{100\times10^{-3}}$$

$$\Delta I_c = 0.95\times100\times10^{-3}$$

$$= 95mA$$

17. Band gap of carbon is 5.5ev while that of silicon is 1.1ev. Therefore $(Eg)_c > (Eg)_{Si}$

20. ΔI_B =2.4 mA= 2.4×10^{-3} mA = 0.0024 mA

ΔI_c=2.4mA

ΔI_e= 2.4mA+0.0024mA = 2.4024 mA

$$\alpha = \frac{2.4mA}{2.4024mA} = 0.96$$

24. In forward biasing, the applied potential difference opposes the potential barrier present across p-n juction diode. So, answer (3) is correct.

SOLUTIONS (LEVEL - II)

2. $R_{Ge} = 2R_{Be}$

$V_{Ge} \propto R_{Ge}^{3}$

$V_{Ge} \propto 8\ R_{Be}^{3}$

$V_{Ge} \propto 8\ V_{Be}$

No. of nucleon in Ge=8(9)=72

3.

$$f = \frac{1}{2\pi\sqrt{lc}}$$

$$f^1 = \frac{1}{2\pi\sqrt{2l \times 4c}}$$

$$therefore\ f^1 = \frac{f}{2\sqrt{2}}$$

4. 

$V_a - V_d - V_R = V_b$
$V_a - V_b = V_d + V_R$
$V_a > V_b$
So option 1 is will be correct

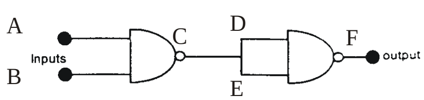
5. The truth table corresponding to wave form is given by

A	B	C
1	1	1
0	1	0
1	0	0
0	0	0

The given logic gate is AND gate

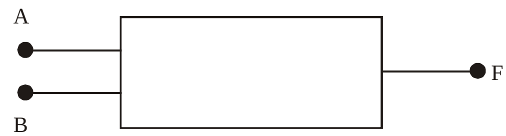
6. $V_c = 1.5V$

$$\beta = \frac{\Delta I_c}{\Delta I_B} = \frac{5 \times 10^{-3}}{50 \times 10^{-6}} = \frac{5 \times 10^3}{50} = 100$$

8. 

A	B	C	D	E	F
0	0	1	1	1	0
1	0	1	1	1	0
0	1	1	1	1	0
1	1	0	0	0	1

A	B	F
0	0	0
1	0	0
0	1	0
1	1	1



AND gate

9. As LED is connected to a battery through resistance in series hence current flowing is 10 mA.

The voltage drop across LED = 2V

As the battery has 6v, the potential difference across R = 4V

$$\therefore IR = 4volt\ or\ R = \frac{4}{10 \times 10^{-3}} = 400\Omega$$

$$R_d = \frac{2}{10mA} = 200\Omega$$

$(R+200)\ 10 \times 10^{-3} = 6$

$R = 400\,\Omega$

13. $$y = \frac{0.816R_L}{R_L + rf} = \frac{0.816 \times 480}{500} = 78\%$$

15. Band gap is given by

$$Eg = \frac{h_c}{\lambda} = \frac{6.6 \times 10^{-34} \times 3 \times 10^8}{248 \times 10^{-8}}$$

$$= 7.984 \times 10^{-20} J$$

$$= \frac{7.984 \times 10^{-20}}{1.6 \times 10^{-19}} ev = 0.5ev$$

16. Output resistance

$$\frac{(10-2)v}{(3-2)mA} = \frac{8v}{10^{-3} A} = 8k\Omega$$

17.

$$I_b = \left(10 \times \frac{10}{100}\right) mA = 1mA$$

$$I_e = I_b + I_e$$

$$= (10+1)mA = 11mA$$

18.

$$\frac{V_o}{V_{in}}=\frac{R_0}{R_{in}}\times\beta=\frac{5\times10^3\times62}{500}=10\times62=620$$

$V_0=620\times V_{in}=620\times0.01=6.2V$

19. R= $10\times10^3\,\Omega$
input voltage =100 V
load resistance = $5\times10^3\,\Omega$
zener voltage V_z=10V
Voltage across the load = V_Z = 10 V

$$load\ current\ I_L=\frac{V_z}{R_L}=\frac{10}{5\times10^3}=2\times10^{-3}A$$

Current through R

$$I=\frac{voltage\ drop\ across\ R}{R}$$

$$=\frac{90}{10\times10^3}=9\times10^{-3}A$$

According to Kirchoff's law
$I=I_L+I_Z$
zener current=$I-I_L$
$9\times10^{-3}-2\times10^{-3}$
$=7\times10^{-3}$A=7mA

20. AND + NOT = NAND GATE

21.

$$\beta=\frac{I_c}{I_b}$$

$$Since, I_e=I_b+I_c$$

$$I_b=I_e-I_c=5.60-5.488$$

$$=0.112mA$$

$$\beta=\frac{5.488}{0.112}=49$$

22. In CE configuration

$$A=\frac{-h_{fe}}{1+h_{oe}R_L}$$

$$=\frac{-50}{1+25\times10^{-6}\times1\times10^3}$$

$$=-48.78$$

23. The fundamental frequency in the ripple
= 2×50Hz =100Hz

24. Drift velocity,

$$v_d=\frac{1}{nAe}$$

$$\therefore v_d\propto\frac{1}{n}$$

$$Given:\frac{n_e}{n_n}=\frac{7}{5}\ and\ \frac{I_e}{I_n}=\frac{7}{4}$$

$$\therefore\frac{(v_d)_e}{(v_d)_n}=\left(\frac{I_e}{I_n}\right)\times\frac{n_n}{n_e}=\frac{7}{4}\times\frac{5}{7}=\frac{5}{4}$$

Solutions (Level - III)

1. r_f = 20 Ω

R_L = 2kΩ = 2000 Ω

$\therefore$ Rectifier efficiency (η) $=\dfrac{0.406R_L}{R_L+r_f}$

$$=\frac{0.406\times2000}{2000+20}=\frac{812}{2020}=0.402$$

$\therefore$ Efficiency = 40.2%

2. From the figure

R = 5kΩ = 5 × 10^3 Ω
Input voltage = 220V
Load resistance R_L = 20kΩ = 20 × 10^3 Ω
Zener voltage, V_z = 50V

$$\text{Load current, } I_L=\frac{V_z}{R_L}=\frac{50}{20\times10^3}\ 2.5\times10^{-3}\text{A}$$

Current through R,

$$I=\frac{\text{Voltage drop across R}}{\text{R}}=\frac{170}{5\times10^3}$$

= 34 × 10^{-3}A

According to Kirchoff's first law $I = I_L + I_Z$

$\therefore$ Zener current, $I_Z = I - I_L$
= 34 × 10^{-3} – 2.5 × 10^{-3}
= 31.5 × 10^{-3}A = 31.5 mA

3. The diode D_1 is forward biased but diode D_2 is reverse biased. So no current pass through

the diode D_2.

$\therefore$ Current passes through 100 Ω resistor

$$=\frac{6}{50+150+100}=0.02\text{A}$$

4. The conductivity of a semiconductor is given by

$$\sigma = n_e e\mu_e + n_h e\mu_h$$

Since in the problem semiconductor is pure germanium (intrinsic semiconductor)

$\therefore$ $n_e = n_h = n_i$

$\therefore$ $\sigma = n_i e(\mu_e + \mu_h)$

As per given data,

$n_i = 1.6 \times 10^6$ per cubic meter

$\mu_e = 0.4\, m^2 V^{-1} s^{-1}$

$\mu_h = 0.2\, m^2 V^{-1} s^{-1}$

$\therefore$ $\sigma = 1.6\times10^6 \times 1.6\times10^{-19}(0.4+0.2)$

$= 1.6 \times 1.6 \times 0.6 \times 10^{-13}$

Current proudced in germanium plate

$$\text{I = JA} = \sigma\,\text{E.A} = \sigma\left(\frac{V}{d}\right)A$$

$$=1.6\times1.6\times0.6\times10^{-13}\times\left(\frac{5}{1.2\times10^{-3}}\right)\times2\times10^{-4}$$

$\therefore$ I = 1.28×10^{-13} ampere

Heat generated in the plate

H = V × I × t = $5 \times 1.28 \times 10^{-13} \times 100$

$= 6.4 \times 10^{-11}$ Joule.

5. Change in collector current

$$\Delta I_c = 1m\text{A} = 10^{-3}\,\text{A}$$

Change in base current $\Delta I_B = ?$

$$\because \quad \beta = \frac{\Delta I_C}{\Delta I_B}$$

$$\therefore \quad \Delta I_B = \frac{\Delta I_C}{\beta} = \frac{10^{-3}}{100} = 10^{-5}\,\text{A} = 10\,\mu\text{A}$$

=0.01 mA.

6. Change in collector curent

$$\Delta I_C = 3-2 = 1mA = 10^{-3}A$$

Change in collector – emitter voltage

$$\Delta V_{CE} = 10-2 = 8V$$

$\therefore$ Output resistance $R_0 = \dfrac{\Delta V_{CE}}{\Delta I_C}$

$$=\frac{8}{10^{-3}} = 8\times10^{+3}\Omega = 8k\Omega$$

7. Total amplification A, obtained by connecting the two amplifiers is

$$A = A_1 \times A_2\ ; = 20\times10 = 200$$

Now, $A = \dfrac{V_0}{V_i}\,l \quad \therefore \quad V_0 = A\times V_i$

$= 200 \times 50 \times 10^{-3}$ V $= 10^4 \times 10^{-3}$ V = 10 V

8. Total amplification A, obtained by connecting the two amplifier is

$$A = A_1 \times A_2\ ; = 20\times10 = 200$$

Now, $A = \dfrac{V_0}{V_i}\ ; \quad \therefore \quad V_0 = A\times V_i$

$=200 \times 50 \times 10^{-3}$ V $= 10^4 \times 10^{-3}$ V = 10 V.

9. We have,

$$I_E = I_B + I_C$$

or, $\Delta I_E = \Delta I_B + \Delta I_C$.

From the question, when

$\Delta I_E = 8.0$ mA, $\Delta I_C = 7.9$ mA.

Thus,

$\Delta I_B = 8.0\text{ mA} - 7.9\text{ mA} = 0.1\text{ mA}.$

So a change of 0.1 mA in the base current is required to have a change of 7.9 mA in the collector current.

$$\alpha = \frac{I_C}{I_E} = \frac{\Delta I_C}{\Delta I_E}$$

$$=\frac{7.9\,\text{mA}}{8.0\,\text{mA}} \approx 0.99.$$

10. Change in collector current

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

Change in base current $\Delta I_B = ?$

$$\because \quad \beta = \frac{\Delta I_C}{\Delta I_B}$$

$$\therefore \quad \Delta I_B = \frac{\Delta I_C}{\beta} = \frac{10^{-3}}{100} = 10^{-5}A$$

$$= 10\mu A = 0.01 mA.$$