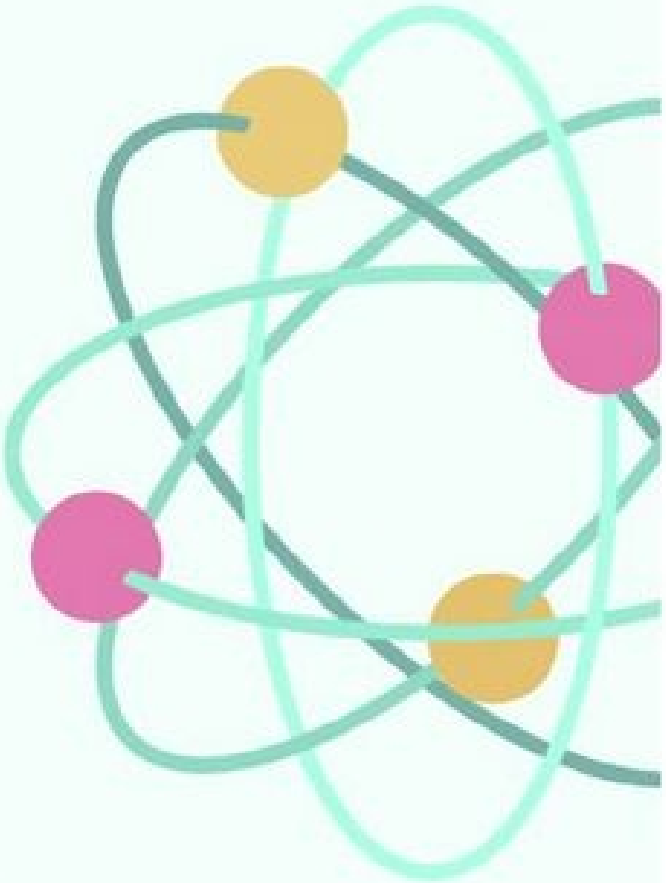


CLASS XII PHYSICS NOTES

ELECTRONIC DEVICES AND COMMUNICATION SYSTEMS

KEY NOTES AND IMPORTANT
QUESTIONS WITH ANSWERS

Unit IX & X

ELECTRONIC DEVICES AND COMMUNICATION SYSTEMS

KEY POINTS

ELECTRONIC DEVICES

1. Solids are classified on the basis of

(i) Electrical conductivity	Resistivity	Conductivity
Metals	$\rho(\Omega m)$	$\sigma(Sm^{-1})$
	$10^{-2} - 10^{-8}$	$10^{2} - 10^{8}$
Semi-conductors	$10^{-5} - 10^{6}$	$10^{-6} - 10^{5}$
Insulators	$10^{11} - 10^{19}$	$10^{-19} - 10^{-11}$

(ii) Energy Bands **(a) Metals →**

Fig. (*a*)

(b) Insulators →

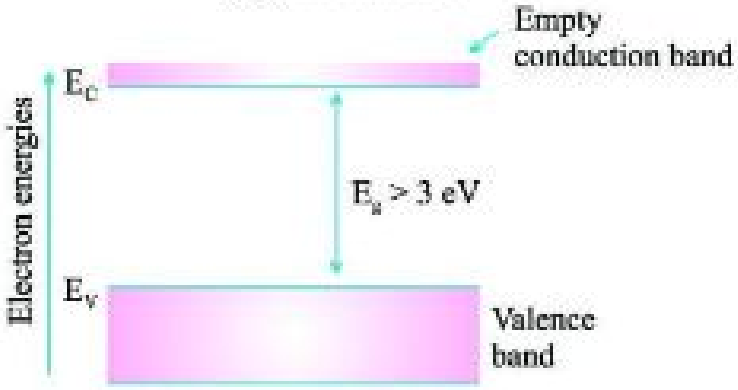


Fig (*b*)

(c) Semiconductors →

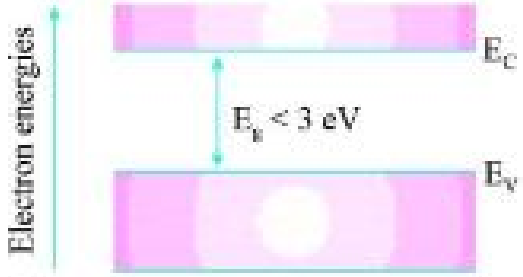
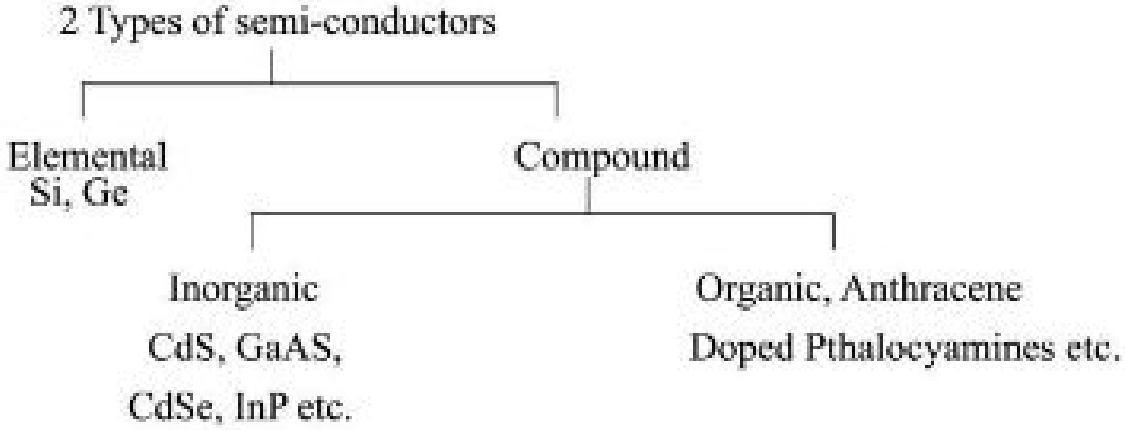


Fig (*c*)

2. Types of Semi-conductors



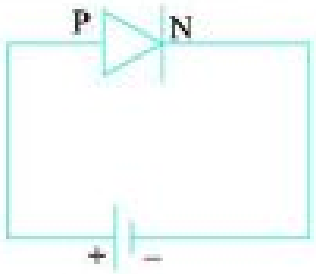
3. In intrinsic semiconductors (Pure Si, Ge) carrier (electrons and holes) are generated by breaking of bonds within the semiconductor itself. In extrinsic semiconductors carriers (*e* and *h*) are increased in numbers by 'doping'.

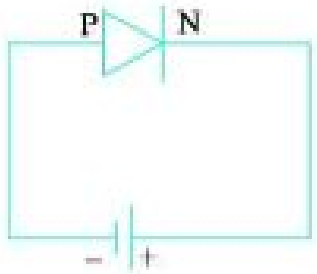
4. An intrinsic semiconductor at 0 K temperature behaves as an insulator.

5. Pentavalent (donor) atom (As, Sb, P etc) when doped to Si or Ge give *n*-type and trivalent (accestor) atom (In, Ga, Ag, etc) doped with Si or Ge give *p*-type semiconductor. In *n*-type semiconductor electrons are the majority charge carriers & in *p*-type holes are the majority charge carriers.

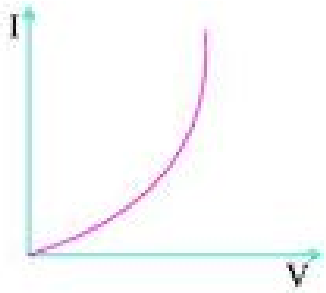
6. Net charge in *p*-type or *n*-type semiconductor remains zero.
7. Diffusion and drift are the two processes that occur during formation of *p-n* junction.
8. Diffusion current is due to concentration gradient and drift current is due to electric field.
9. In depletion region movement of electrons and holes depleted it of its free charges.
10. *p-n* Junction is the most important semiconductor device because of its different behaviours in forward biasing (as conductor for $V > V_\beta$) and reverse biasing (as insulator for $V < V_B$) a *p-n* junction can be used as Rectifier, LED, photodiode, solar cell etc.

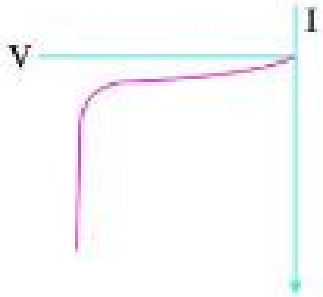
    Differences between FB and RB junction diodes :





Depletion layer is decreased	Depletion layer is increased
Lower resistance	Higher resistance
$R \rightarrow 0$ ideal diode	$R \rightarrow \infty$ ideal diods



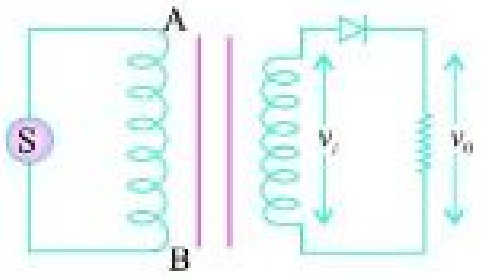


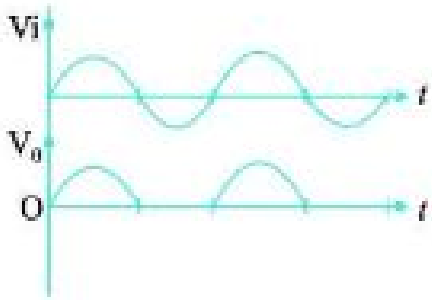
Current due to majority charge carrier.	Current due to minority charge carrier.

11. In half wave rectifier frequency output pulse is same as that of input and in full wave rectifier frequency of output is double of input.

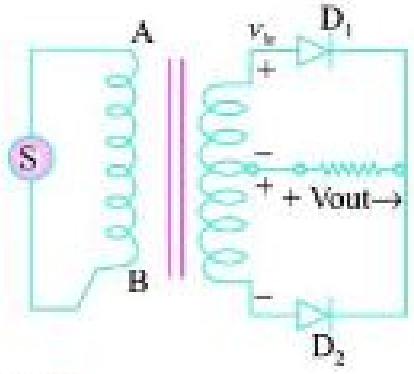
    Rectifier p-n junction diode

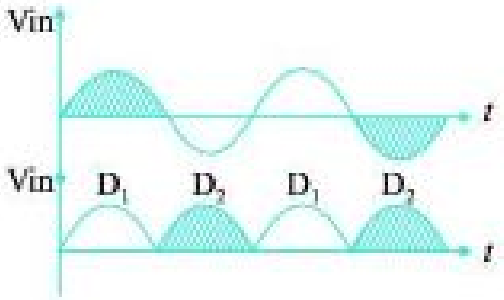
Half Wave Rectifier





Full Wave Rectifier





12. When a zener diode is reverse biased, voltage across it remains steady for a range of currents above zener breakdown. Because of this property, the diode is used as a voltage regulator.

13. Transistor is a *n-p-n* or *p-n-p* junction device. In a transistor current goes from low resistance (forward biasing) to high resistance (reverse biasing).

14. Current relationship in a transistor.

$$I_e = I_b + I_c \ (I_b \text{ is only 2\% to 8\% of } I_e)$$

15. In common emitter transistor characteristic we study

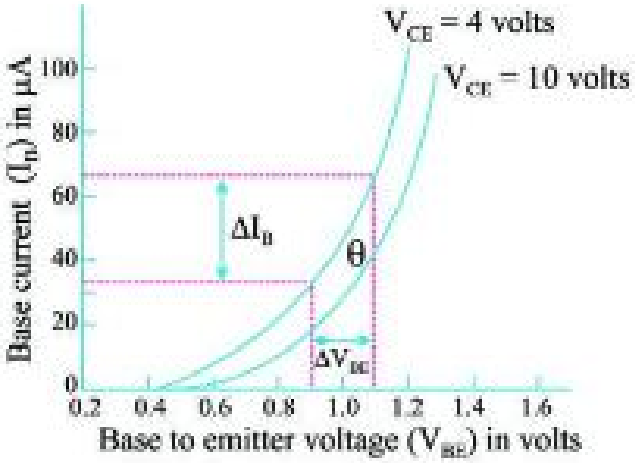
I_b versus V_{BE} at constant V_{CE} (Input characteristic)

I_c versus V_{CE} at constant I_B (output characteristic)

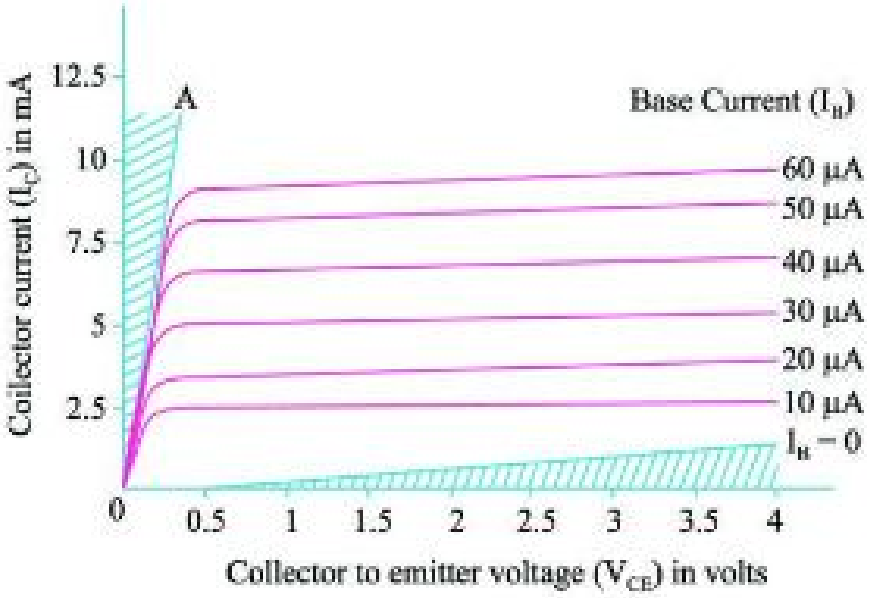
Input resistance $r_i = \left(\frac{\delta V_{BE}}{\delta I_B}\right)$ for constant V_{CE}

Output resistance $r_0 = \left(\frac{\delta V_{CE}}{\delta I_C}\right)$ for constant I_b

16.



Input characteristics of CE *n-p-n-* transistor.



Output characteristic of CE *n-p-n* transistor

$$R_{in} = \frac{\Delta V_{BE}}{\Delta I_B} = \frac{1}{\tan\theta}$$

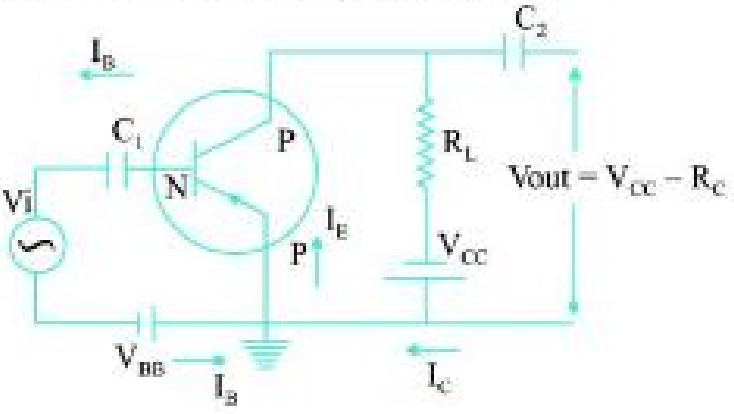
Current Amplification factor

$$\beta_{ac} = \left(\frac{\Delta I_c}{\Delta I_b}\right) \text{ keeping } V_{CE} \text{ constant}$$

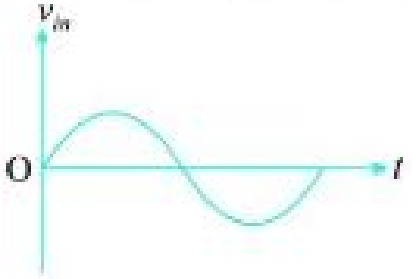
$$\beta_{dc} = I_c/I_b$$

$$\beta_{ac} = \beta_{dc}$$

17. PNP Transistor as a common emitter Amplifier



$$V_{CE} = V_{out} = V_{CC} - I_c R_c$$



18. In CE configuration, transistor as amplifier output differ in phase with input by π.

19. Gates used for performing binary logical operations in digital electronics mainly consists of diodes and transistors.

20. NAND gates along can be used to obtain NOT, AND and OR gates and similarly a NOR gates can be used to obtain AND gate, OR gate & Not gate.

COMMUNICATION SYSTEMS

- Communication is the faithful transfer of message from one place to another.
- A communication system consists of three basic elements.

- **Transmitter :** An equipment which converts the information data into electrical signal.
- A transmitter consists of
  (i) Amplifier

(ii) Modulator

(iii) Carrier Oscillator

(iv) Transmitting Antenna

(v) Transducer

- **Channel :** It is the medium through which the electrical signals from the transmitter pass to reach the receiver.
- **Receiver :** An equipment which receives and retrieves information from the electrical signals.
- A receiver section consists of
  (i) Receiver Antenna
  (ii) Amplifier.
  (iii) Demodulator
- Two important forms of communication system are **Analog** and **Digital**. In Analog communication, the information is in analog form.
- In Digital communication, the information has only discrete or quantised values.
- Modulation is a process by which any electrical signal (called input, baseband or modulating signal) of low frequency is superimposed on to another signal (carrier) of high frequency.
- Need of Modulation :
  (i) To avoid interference between different base band signals.
  (ii) To have a practical size of antenna.
  (iii) To increase power radiated by antenna.
- **Demodulation :** It is a process by which a base band signal is recovered from a modulated wave.
- **Amplitude Modulation :** In this type of modulation, the amplitude of carrier wave is varied in accordance with the information signal, keeping the frequency and phase of carrier wave constant.
- **Bandwidth :** Bandwidth is the range of frequencies over which an equipment operates.
- Space communication uses free space between transmitter and receiver for transfer of data/information.

- **Ground Wave :** These are the waves radiated by antenna that travel at zero or lower angle with respect to earth surface. They are heavily absorbed by earth surface and not suitable for long range communication.
- **Space Wave :** These are the waves that travel directly through space between transmitting and receiving antennas. The space waves are within the troposphere region of atmosphere and have two **Modes of Transmission :**
  (i) Line of sight communication
  (ii) Satellite communication

Physical Quantity	Formula	SI Unit
Power radiated by an antenna	$\alpha \frac{1}{\lambda^2}$	W
Sinusoidal carrier wave	$E = E_C \cos(\omega_c t + \varphi)$	V
The range of tower	$d = \sqrt{2Rh}$ R → radius of earth h → Height of antenna	m
The number of channels	$\frac{\text{Bandwidth}}{\text{Bandwidth per channel}}$	
The maximum range of broadcast between transmitting and receiving tower h_t and h_r → height of transmitting and receiving towers	$d_{max} = \sqrt{2Rh_t} + \sqrt{2Rh_r}$ where R → Radius of earth	

QUESTIONS

VERY SHORT ANSWER QUESTIONS

1. Write the relation between number density of holes and number density of free electrons in an intrinsic semiconductor.

Ans. $n_e = n_h$

2. Write the value of resistance offered by an ideal diode when (i) forward based (ii) reverse biased.

Ans. (i) Zero (ii) infinite

3. Write any one use of (i) photodiode (ii) LED.

Ans. (i) Use of Photodiode
- (a) In detection of optical signal
- (b) In demodulation of optical signal
- (c) In light operated switches
- (d) In electronic counters

(ii) Use of LED
- (a) Infrared LEDs are used in burglar alarm
- (b) In optical communication
- (c) LED's are used as indicator lamps in radio receivers
- (d) In remote controls

4. Write the truth table for a two input AND gate.

Ans.

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

5. At what temperature does a semiconductor behave as an insulator ?

Ans. Fermi temperature

6. Why amplitude of modulating signal is kept less than the amplitude of carrier wave ?

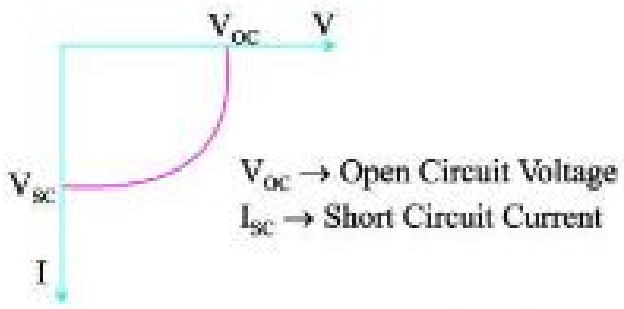
Ans. A_m must be less than A_c so that Modulation Index m become less than one to avoid distortion.

7. A semiconductor is damaged when strong current passes through it. Why ?

Ans. Because bonds break up, crystal lattice breakdown takes place and crystal lattice becomes useless.

8. Draw I–V characteristic of a solar cell.

Ans.



9. What is the phase difference between input and output waveform in the common emitter transistor amplifier ?

Ans. Phase difference between input and output wave is π or 180°.

10. What is the direction of diffusion current in a junction diode ?

Ans. The direction of diffusion current is from P to N in a semiconductor junction diode.

11. Draw a circuit diagram showing the biasing of a photodiode.

12. Name the semiconductor device that can be used to regulate an unregulated dc power supply.

Ans. Zener diode

13. Name the *p-n* junction diode which emits spontaneous radiation when forward biased.

Ans. Light emitting diode (LED)

14. Name the material used to make a light emitting diode.

Ans. GaAs and Gap

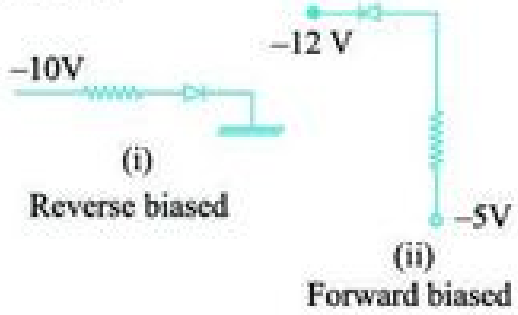
15. How does the collector current charge in a junction transistor if the base region has larger width ?

Ans. Collector current becomes small.

16. A semiconductor device is connected in a series circuit with a battery and a resistance. A current is found to pass through the circuit. When polarity of the battery is reversed, the current drops to almost zero. Name the semiconductor device.

Ans. P–N junction
(Junction Diode)

17. In the following diagram write which of the diode is forward biased and which is reverse biased ?



18. How does the energy gap in semiconductor vary, when doped, with a pentavalent impurity ?

Ans. The energy gap decreases.

19. What is the order of energy gap in a conductor, semiconductor and insulator.

Ans. Conductor–no energy gap
Semiconductor < 3 eV

Insulator > 3 eV

20. The ratio of the number of free electrons to holes n_e/n_h for two different materials A and B are 1 and < 1 respectively. Name the type of semiconductor to which A and B belong.

Ans. $\frac{n_e}{n_h} = 1 \Rightarrow n_e = n_h$ $\therefore$ Intrinsic semiconductor

$\frac{n_e}{n_h} < 1 \Rightarrow n_e < n_h$ $\therefore$ p type extrinsic semiconductor

21. What are ground waves ?

Ans. The em wave radiated from antenna which are transmitted through space along the ground. If a radiowave from the transmitting antenna reaches to the receiving antenna either directly or after reflection from the ground, it is called a ground wave.

22. What are the two basic modes of communication ?

Ans. (i) Analog, (ii) Digital.

23. On what factors does the maximum coverage range of ground wave communication depend ?

Ans. The maximum range of ground wave propagation depends upon.
(i) the frequency of transmitted wave
(ii) the power of the transmitter.

24. What is a base band signal ?

25. What is the least size of an antenna required to radiate a signal of wavelength λ ?

Ans. $\frac{\lambda}{4}$

26. Why do we use high frequencies for transmission ?

Ans. To reduce the height of antenna.

27. Why is ionisation low near the earth and high, far away from the earth ?

Ans. The U.V. radiation and other high energy radiations coming from the outer space on entering ionosphere of Earth's atmosphere, are largely absorbed by the molecules of the layer of atmosphere. Due to this molecules get ionised. The degree of ionisation varies with height. At high attitude solar intensity is high, but density of Earth's atmosphere is low. Therefore, there are few air molecules to be ionised. On the other hand, close to the earth, the density of Earth's atmosphere is high but the radiation intensity is low. Due to of ionisation is low.

28. Define the modulation index.

Ans. (i) $\mu = \frac{A_m}{A_c}$ (ii) $\frac{A_{max} - A_{min}}{A_{max} + A_{min}}$

29. What should be length of dipole antenna for a carrier wave of frequency 2×10^6 Hz ?

Ans. Length of dipole antenna : $\frac{\lambda}{2} = \frac{C}{2\upsilon}$

$$L = \frac{3 \times 10^8}{2 \times 2 \times 10^6} = 0.75 \times 10^2 m = 75m$$

30. Why is the transmission of signals using ground wave communication restricted to a frequency of 1500 kHz ?

Ans. The energy loss of a ground wave increases rapidly with the increase in frequency. Hence ground wave propagation is possible at low frequencies *i.e.,* 500 KHz to 1500 KHz

31. What is meant by transducer ? Give one example of a transducer.

Ans. Any device which converts energy from one from to another is called transducer e.g. a microphone converts sound energy (signal) into an electrical energy (signal).

32. A T.V. transmitting antenna is 80 m tall. How much service area can it cover if the receiving antenna is at ground level ?

Ans. The maximum distance upto which the signal transmitted from 80 m tall T.V. antenna can be received.

$$d = \sqrt{2hR} = \sqrt{2 \times 80 \times 6400000} = 32000m = 3.2\ km$$

Area $= \pi d^2\ m^2 = 3.2 \times 10^7\ m^2$

33. What is attenuation ?

Ans. Attenuation is the loss of strength of a signal during its propagation through the communication channel.

34. Why are repeaters used in communication ?

Ans. A repeater is a combination of a receiver, an amplifier and a transmitter. A repeater picks up the signal from the transmitter, amplifies and retransmits it to the receiver sometimes with a change in carrier frequency. Repeaters are used to increase the range of communication system.

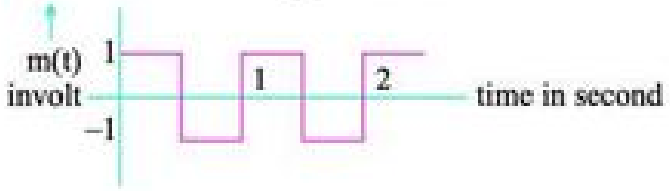
35. What is the significance of modulation index ? What is its range ?

Ans. Modulation index determines the strength and quality of the transmitted signal. High modulation index ensures better quality and better strength. Its range is 0 to 1.

36. Why are broad cast frequencies of carrier wave sufficienty spaced in Amplitude modulated wave?

Ans. To avoid mixing up of signals from different transmitters.

37. The carrier wave is given by $c(t) = 2 \sin (8\pi t)$ volt. The modulating signal is a square wave as shown in fig. Find modulation index.



Ans. $m = \frac{A_m}{A_c} = \frac{1}{2} = 0.5$

38. How are side bands produced ?

Ans. Side bands are produced by the method of amplitude modulation. It produces two new frequencies ($fc + fm$) and ($fc - fm$) around original frequency (fc) which are called side band frequencies.

39. Give one example each of 'a system' that uses the (i) sky wave (ii) space wave – mode of propagation.

Ans. (i) Short wave broadcast services.

(ii) Television broadcast (or microwave links or satellite communication)

40. Why is shortwave band used for long distance radio broadcast?

Ans. Shortwaves are not absorbed by earth is atmosphere.

SHORT ANSWER QUESTIONS (2 MARKS)

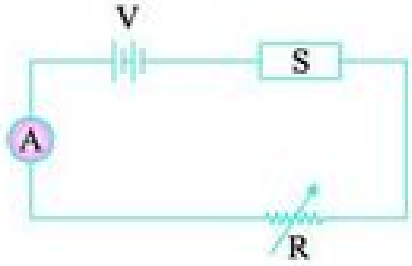
1. If the frequency of the input signal is f. What will be the frequency of the pulsating output signal in case of :

(i) half wave rectifier ? (ii) full wave rectifier ?

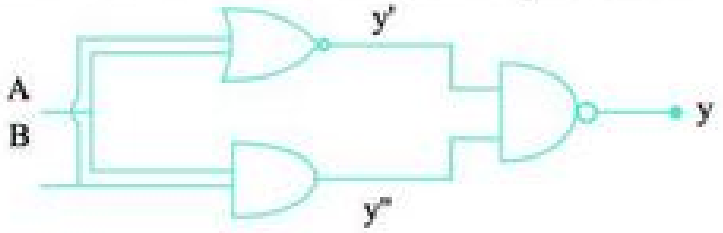
2. Find the equivalent resistance of the network shown in figure between point A and B when the p-n junction diode is ideal and :

(i) A is at higher potential (ii) B is at higher potential

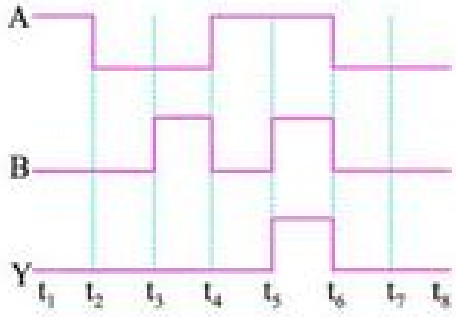
3. Potential barrier of *p-n.* junction cannot be measured by connecting a sensitive voltmeter across its terminals. Why ?
4. Diode is a non linear device. Explain it with the help of a graph.
5. A *n*-type semiconductor has a large number of free electrons but still it is electrically neutral. Explain.
6. The diagram shows a piece of pure semiconductor S in series with a variable resistor R and a source of constant voltage V. Would you increase or decrease the value of R to keep the reading of ammeter A constant, when semiconductor S is heated ? Give reason.



7. Power gain of a transistor is high. Does it mean the power is generated by the transistor itself ? Explain.
8. How can we fabricate LED's emitting light of different colours.
9. Why is a photo diode used in reverse bias ?
10. Give four advantages of LED over incandescent lamp.
11. Explain the amplifying action of a transistor.
12. Draw a labelled circuit diagram of *n-p-n* transistor amplifier in CE-configuration.
13. The output of a 2 input AND gate is fed as input to a NOT gate. Write the truth table for the final output of the combination. Name this new logic gate formed. [**Ans.** Nand Gate]
14. Write the truth table for the combination of gates shown.



15. The following figure shows the input waveform 'A' and 'B' and output wave form Y of a gate. Write its truth table and identify the gate.



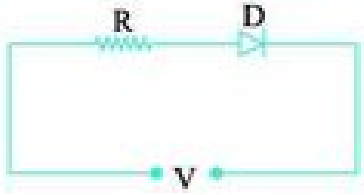
Ans. AND gate

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

16. In the given circuit, D is an ideal diode. What is the voltage across R ? When the applied voltage V makes the diode.

(a) Forward bias ?

(b) Reverse bias ?

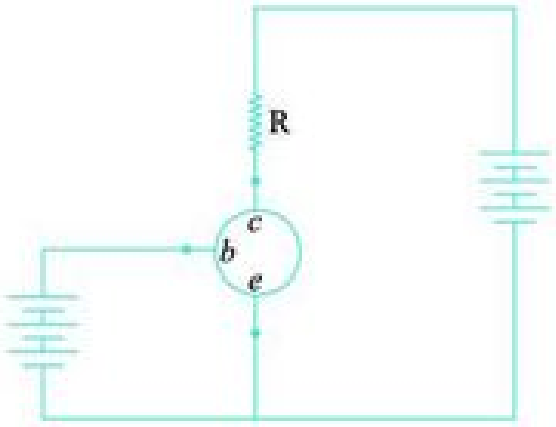


17. A transistor is a current operated device. Explain.

18. In the given circuit diagram transistor has been represented by a circle with the emitter (e), base (b) and collector (c) terminals marked clearly. Carefully look at the polarity of the voltages applied and answer the following questions.

(a) What is the type of transistor *pnp* or *npn* ?

(b) Is the transistor in saturation or cutoff ?



20. What are the characteristics to be taken care of while doping a semiconductor ? Justify your answer.

Ans. (a) The size of the dopent atom should be such that it do not distort the pure semiconductor labtice.

(b) It can easily contribute a charge carrier on forming conqlent bond with pere Si or Ge.

21. Which special type of diode can act as a voltage regulator ? Give the symbol of this diode and draw the general shape of its V-I characteristics.

22. In the working of a transistor, emitter base junction is forward biased, while the collector base junction is neverse based, why ?

23. In a transistor, base is slightly doped and is a thin layer, why ?

24. Show the donor energy level in energy band diagram of *n*-type semiconductor.

25. Show the acceptor energy level in energy band diagram of *p*-type semiconductor.

26. What is the value of knee voltage in

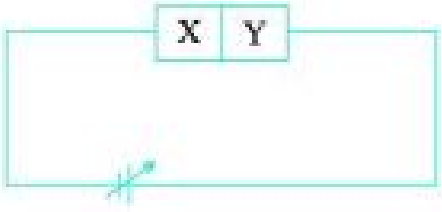
(a) Ge junction diode.

(b) Si junction diode.

27. Which of the input and output circuits of a transistor has a higher resistance and why ?

28. Describe the working principle of a solar cell. Mention three basic processes involved in the generation of emf.

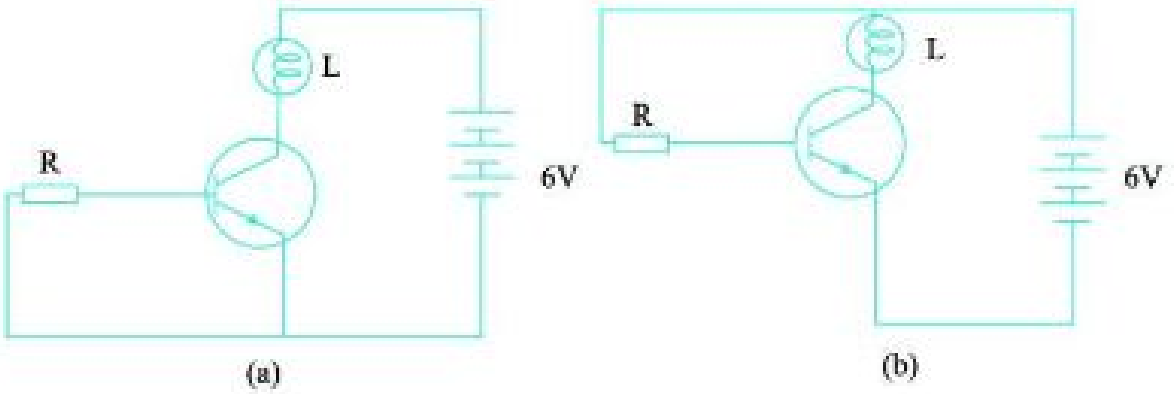
29. Two semiconductor materials X and Y shown in the given figure, are made by doping germanium crystal with indium and arsenic respectively. The two are joined at lattice level and connected to a battery as shown.



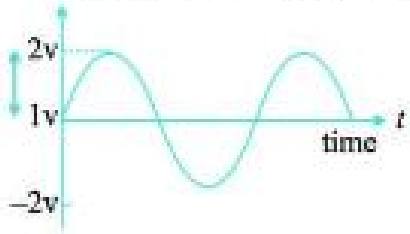
(i) Will the junction be forward biased or reversed biased ?

(ii) Sketch a V-I graph for this arrangement.

30. In only one of the circuits given below the lamp L lights. Which circuits is it ? Give reason for your answer.



31. Following voltage waveform is fed into half wave rectifier that uses a silicon diode with a threshold voltage of 0.7 V. Draw the output voltage waveform.



32. Why are Si and GaAs are preferred materials for solar cell ?

33. Write two differences between point to point communication and broadcast mode of communication. Give one example of each.

34. An audio signal of amplitude one fourth of the carrier wave, is used in amplitude modulation. What is the modulation index ? [**Ans.** = 0.25]

35. What are the essential components of a communication system ? Explain with the help of a Block diagram.

36. Explain by a diagram, how space waves are used for Television broadcast.

37. Long distance radio broadcasts use short wave bands. Why ?

Ans. The short waves are the waves of wavelength less than 200 m or frequency greater than 1.5 MHz. They are absorbed by the earth due to their high frequency. These waves are reflected from ionosphere. These waves after reflection from ionosphere reach the surface of earth only at a large distance from the place of transmission. It means attenuation is less for short waves. It is due to this reason; the short waves are used in long distance broadcasts.

38. What is modulation ? Why do we need modulation ? Give two reasons.

39. Give two reasons for using satellite for long distance T.V. transmission.

(i) As high frequency T.V. signate penetrats through ionspher so to reflect those.

(ii) It has a very wide coverage range.

40. Explain the propagation of sky wave in ionospheric layers with the help of a neat, labelled diagram.

41. Derive an expression for maximum range of an antenna of height 'h' for LOS communication.

42. Plot amplitude v/s frequency for an amplitude modulated signal.

43. Draw block diagram of simple modulator to obtain amplitude modulated signal.

44. It is necessary to use satellites for long distance TV transmission. Why ?

Ans. Yes, TV signals being of high frequency are not reflected by the ionosphere. Therefore, to reflect these signals, satellites are needed. That is why; satellites are used for long distance TV transmission.

45. What is the basic difference between an analog communication system and a digital communication system ?

Ans. An analog communication system makes use of analog signals, which vary continuously with time. A digital communication system makes use of a digital signal, which has only two values of voltage either high or low.

46. What is ground wave ? Why short wave communication over long distance is not possible via ground waves ?

Ans. The amplitude modulated radiowaves having frequency 1500 kHz to 40 MHz (or wavelength between 7.5 m to 200 m) which are travelling directly following the surface of earth are known as ground waves. The short wave communication over long distance is not possible via ground because the bending of these waves become severe round the corners of the objects on earth and hence, their intensity falls with distance. Moreover the ground wave transmission becomes weaker as frequency increases.

SHORT ANSWER QUESTIONS (3 MARKS)

1. What is depletion region in p-n junction diode. Explain its formation with the help of a suitable diagram.

2. Explain the working of *npn* transistor as an amplifier and find an expression for its voltage gain.
3. What is rectification ? With the help of labelled circuit diagram explain half wave rectification using a junction diode.
4. With the help of a circuit diagram explain the V–I graph of a *p-n* junction in forward and reverse biasing.
5. With the help of a circuit diagram, explain the input and output characteristic of a transistor in common emitter configuration.
6. What is *p-n* junction ? How is *p-n* junction made ? How is potential barrier developed in a *p-n* junction.
7. What is a transistor ? Draw symbols of *npn* transistor. Explain action of transistor.
8. Give three differences between forward bias and reverse bias.
9. Show the biasing of a photodiode with the help of a circuit diagram. Draw graphs to show variations in reverse bias currents for different illumination intensities.
10. Write three differences between *n*-type semiconductor and *p*-type semiconductor.
11. Construct AND gate using NAND gate and give its truth table.
12. Construct NOT gate using NAND gate and give its truth table.
13. With the help of Block Diagram show how an amplitude modulated wave can be demodulated.
14. Draw the block diagram ofa communication system. What is the function of transducer and communication channel.
15. What is amplitude modulation ? Derive the equation of an amplitude modulated wave.
16. What are the different ways of propagation of radiowaves ? Explain briefly.
17. Draw block diagram for a :
    (a) Transmitter
    (b) Receiver

18. Write the band width of the following :

(1) Telephonic communication

(2) Video signal

(3) TV signal

19. Explain the following terms :

(1) Ground waves

(2) Space waves

(3) Sky waves

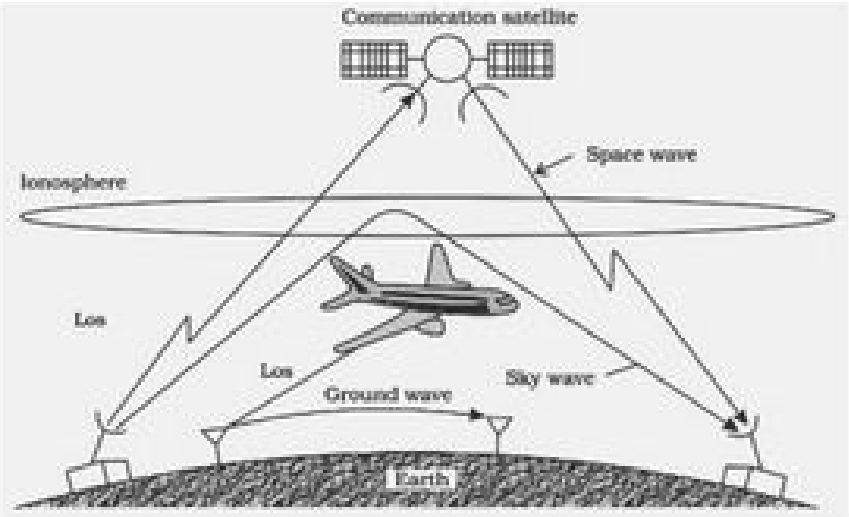
Ans. (i) At low frequencies ($v < 2$MHz), radio-waves radiated by antenna travel directly following the surface of earth and are known as ground waves.

(ii) Frequencies ranging from 100-200 Mhz penetrate ionosphere and hence can only be transmitted by using line-of-sight antenna or satellites, are known as space wave propagation.

(iii) Frequencies between 2-20 MHz are reflected by the ionosphere and known as sky waves (or ionospheric propagation)

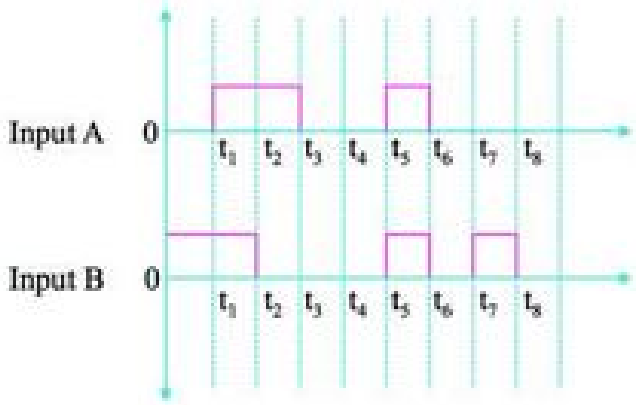
20. What does 'LOS communication' mean ? Name the types of waves that are used for this communication. Give typical examples, with the help of suitable figure, of communication systems that use space mode propagation.

Ans. Mode of radiowave propagation by space waves, in which the wave travels in a straight line from transmitting antenna to the receiving antenna, is called *line-of-sight* (LOS) communication. Two types of waves that are used for LOS communication are : Space wave and Ground wave.



LONG ANSWER QUESTIONS (5 MARKS)

1. Draw the circuit arrangement for studying the input and output characteristics of an npn transistor in CE Configuration.
   Draw these characterstics graphically. With the help of these characteristics define (i) input resistance (ii) Current amplification factor.
2. What is the function of base region of a transistor ? Why is this region made thin and lightly doped ? Explain with the help of a circuit diagram the working of npn transistor as a common emitter amplifier.
3. What is *p-n* junction diode ? Define the term dynamic resistance for the junction. With the help of labelled diagram, explain the working of *p-n* junction as a full wave rectifier.
4. What are logic gates ? Why are they so called ? Draw the logic symbol and write truth table for AND, OR and NOT gate.
5. Describe (i) NAND gate (ii) NOR gate.
   Why these gates are called universal gates? Explain.
6. Two signals A, B as given below are applied as input to (i) AND (ii) NOR and (iii) NAND gates. Draw the output waveform in each case.



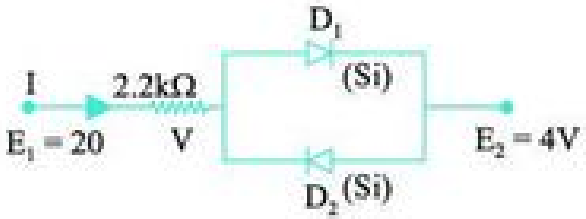
NUMERICALS

1. In a *p-n* junction, width of depletion region is 300 nm and electric field of 7×10^5 V/m exists in it.
   (i) Find the height of potential barrier.
   (ii) What should be the minimum kinetic energy of a conduction electron which can diffuse from the *n*-side to the *p*-side ?

2. In an *npn* transistor circuit, the collector current is 10 mA. If 90% of the electrons emitted reach the collector, find the base current and emitter current.

3. An LED is constructed from a *p-n* junction of a certain semiconducting material whose energy gap is 1.9eV. What is the wavelength of light emitted by this LED ? [**Ans.** $\lambda = 2.18 \times 10^{-7}$ m]

4. Determine the current I for the network. (Barrier voltage for Si diode is 0.7 volt).



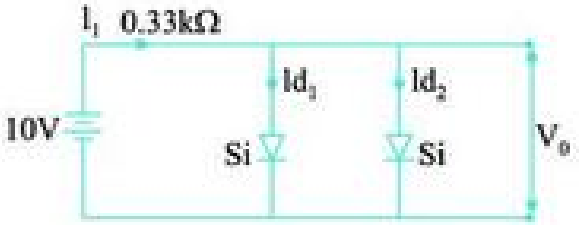
5. Determine V_0 and I_d for the network.

6. A *p-n* junction is fabricated from a semiconductor with a band gap of 2.8 eV. Can it detect a wavelength of 600 nm ? Justify your answer.

Ans. Eneryg of photon of wavelength 600 *n m* = 2.07 eV ..... working condition of photodiode $hv \leq$ Eg but Eg > hv so photodio can not detecthe given wavelength

7. Determine V_0, I_{d1} and I_{d2} for the given network. Where D_1 and D_2 are made of silicon.

$$\left(I_{d_1} = I_{d_2} = \frac{I_1}{2} = 14.09 \text{ mA}\right)$$



Ans. $V_0 = V_{si} = 0.7V$

$$I_1 = \frac{10 - 0.7}{.33 \times 10^3}$$

$$= 28.18 \text{ mA}$$

14. An amplitude modulator consist of L–C circuit having a coil of inductance 8mH and capacitance of 5pF. If an audio signal of frequency 10kHz is modulated by the carrier wave generated by the L–C circuit, find the frequency of upper and lower side bands.

[**Ans.** $f_c = 7.96 \times 10^5$ Hz; Lower side band = 786 kHz;
= 796 kHz Upper side band = 806 kHz]

15. A T.V. Tower has height of 70 m.

(i) How much population is covered by the T.V. broadcast if the average population density around the tower is 1000 km^{-2} ? Radius of earth is 6.4×10^6 m.

(ii) By how much should the height of the tower be increased to double the coverage area ?

[**Ans.** Population covered = 28.16 lacs; Change in height = 70m]

16. A communication system is operating at wavelength $\lambda = 750$ nm. If only 1% of the frequency is used as channel bandwidth for optical communication then find the number of channels that can be accommodated for transmission of

(i) an Audio signal requiring a bandwidth of 8 kHz.

(ii) a Video T.V. signal requiring a bandwidth of 4.5 kHz.

Ans. Optical signal frequency $\nu = \frac{C}{\lambda} = \frac{3\times10^8}{750\times10^{-9}} = 4\times10^{14}$ Hz

(i) No. of channels for audio signal = $\frac{4\times10^{12}}{8\times10^3} = 5\times10^8$

(ii) No. of channels for video signal = $\frac{4\times10^{12}}{4.5\times10^3} = 8.88 \times 10^8$

17. Calculate the percentage increase in the range of signal reception, if the height of TV tower is increased by 44%. [**Ans.** 20% increase]

18. A transmitting antenna at the top of a tower has a height 32 m and the height of the receiving antenna is 50 m. What is the maximum distance between them for satisfactory communication in LOS mode ? Given radius of earth 6.4×10^6 m.

$$d_m = \sqrt{2\times64\times10^5\times32} + \sqrt{2\times64\times10^5\times50\text{ m}}$$

Sol. :

$$= 64\times10^2\times\sqrt{10} + 8\times10^3\times\sqrt{10}\text{ m}$$

$$= 144\times10^2\times\sqrt{10}\text{ m} = 45.5\text{ km}$$

19. A message signal of frequency 10 kHz and peak voltage of 10 volts is used to modulate a carrier of frequency 1 MHz and peak voltage of 20 volts. Determine (a) modulation index, (b) the side bands produced.

Sol. (a) Modulation index = 10/20 = 0.5 = $\frac{A_m}{A_c}$

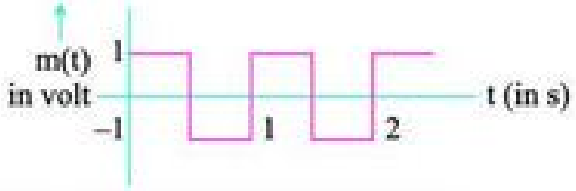
(b) The side bands are at (1000 + 10) kHz
= 1010 kHz and (1000 – 10) kHz
= 990 kHz.

20. A carrier wave of peak voltage 12 v is used to transmit a message signal. What should be the peak voltage of the modulating signal in order to have a modulation index of 75% ?

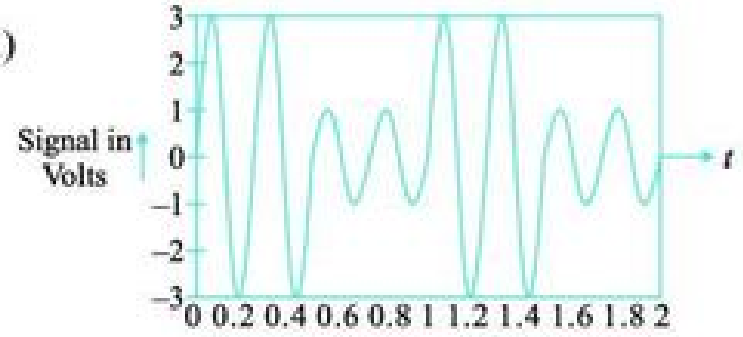
Sol. $\mu = 0.75 = \frac{A_m}{A_c}$

Hence, $A_m = 0.75\ A_c = 0.75 \times 12\ V = 9\ V$

21. A modulating signal is a square wave, as shown in figure.
The carrier wave is given by $c(t) = 2 \sin (8 \pi t)$ volts.
(i) Sketch the amplitude modulated waveform
(ii) What is the modulation index ?



Sol. (i)



(ii) $\mu = 0.5$

22. For an amplitude modulated wave, the maximum amplitude is found to be 10 V while the minimum amplitude is found to be 2 V. Determine the modulation index, μ.
What would be the value of μ if the minimum amplitude is zero volt ?

Sol. The AM wave is given by $(A_c + A_m + \sin \omega_m t) \cos \omega_c t$,

The maximum amplitude is $M_1 = A_c + A_m$ while the minimum amplitude is

$$M_2 = A_c - A_m$$

Hence the modulation index is

$$\mu = \frac{A_m}{A_c} = \frac{M_1 - M_2}{M_1 + M_2} = \frac{8}{12} = \frac{2}{3}.$$

SHORT ANSWER QUESTIONS (2 MARKS)

1. Frequency of output in half wave rectifier is f and in full have rectifier is $2f$.
2. Equivalent resistance is

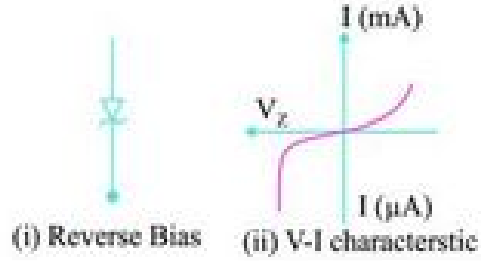
   (i) 10Ω, As diode is forward biased

   (ii) 20Ω, diode is reverse biased
3. Because there is no free charge carrier in depletion region.
6. On heating S, resistance of semiconductors S is decreased so to compensate the value of resistance in the circuit R is increased.
10. In this case diode is sensitive and it is easier to observe fractional change in current with change in intensity.
15. Nand gate

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

17. (a) V (b) Zero
18. Change in I_c is related to I_b and not to the base voltage change (δV_{be}).
19. (a) *npn* (ii) saturation

21. Zener diode



(i) Reverse Bias (ii) V-I characterstic

22. To make transistor to act as an amplifier.

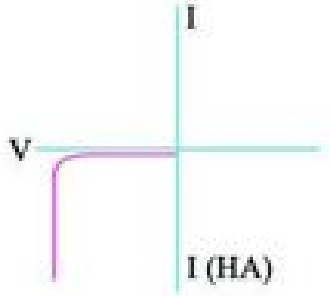
26. Ge ~ 0.3 V

Si ~ 0.7 V

27. Output circuit is reverse biasd which has large resistance.

29. (i) Reverse bias

(ii)



30. (b) In circuit (b) emitter base junction is forward biased through 'L' while in (a) emitter base junction is not biased.

31. Output waveform is :

NUMERICALS

1. (i) $V = Ed = 7 \times 10^5 \times 300 \times 10^{-9} = 0.21$ V

(ii) Kinetic energy = eV = 0.21 eV

2. Emitter current $I_e = \frac{10}{90} \times 100 = 11.11$ mA

Base current $I_b = I_e - I_c = 1.11$ mA

4. $I = \dfrac{E_1 - E_2 - V_d}{R} = \dfrac{20 - 4 - 0.7}{2.2 \times 10^3} = 6.95 \text{ mA}$

5. $V_0 = E - V_{si} - V_{Ge} = 12 - 0.7 - 1.1 = 12 - 1.8 = 10.2 \text{ V}$

$I_d = \dfrac{V_0}{R} = \dfrac{10.2}{5.6 \times 10^3} = 1.82 \text{ mA}.$ $V_0 = 12 - 0.7 - 0.3 = 11 \text{ V}$

$I_d = \dfrac{11}{5.6 \times 10^3} = 1.96 \text{ mA}$