THE EDUCARE (SIROHI CLASSES) TEST SERIES 2018

XII PHYSICS TEST

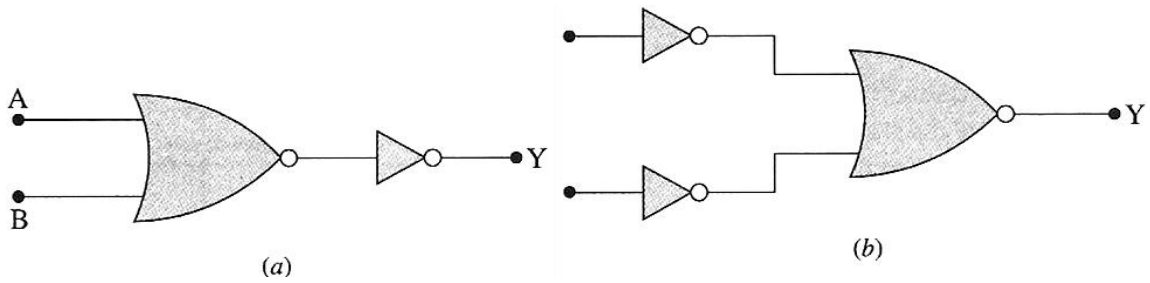
E.M. WAVE , SEMICONDUCTOR & POC

TEST

NAME-…….....… DATE-……. MM- 25 TIME-1 HR

1) What is Maxwell's displacement current ? (1)
2) Why is the transmission of signals using ground waves restricted up to a frequency of 1500 kHz? (1)
3) Why is it necessary to use satellites for long distance TV transmission ? (1)
4) In half-wave rectification, what is the output frequency if the input frequency is 50 Hz ? What is the output frequency of a full-wave rectifier for the same input frequency ? (2)
5) Electromagnetic waves with wavelength
   i) λ_1 are used to treat muscular strain
   ii) λ_2 are used by a FM radio station for broadcasting
   iii) λ_3 are used to detect fracture in bones
   iv) λ_4 are absorbed by the ozone layer of the atmosphere.

   Identify and name the part of the electromagnetic spectrum to which these radiations belong. Arrange these wavelengths in decreasing order of magnitude. (2)
6) You are given the two circuits as shown in the figure. Show that circuit (a) acts as OR gate while the circuit (b) acts as AND gate. (2)



7) Answer the following questions

(a) Long distance radio broadcasts use short-wave bands. Why ?

(b) It is necessary to use satellites for long distance TV transmission. Why ?

(c) Optical and radio telescopes are built on the ground but X-ray astronomy is possible only from satellites orbiting the earth. Why ? (3)

8) For a CE-transistor amplifier, the audio signal voltage across the collector resistance of $2\text{k}\Omega$ is 2 V.

Suppose the current amplification factor of the transistor is 100, find the input signal voltage and base current, if the base resistance is $1\ \text{k}\Omega$.

OR

Is it necessary for a transmitting antenna to be at the same height as that of the receiving antenna for line of sight communication ? A TV transmitting antenna is 81m tall. How much service area can it cover if the receiving antenna is at the ground level ? (3)

9) The ratios of number density of free electrons to holes, $\left(\frac{n_e}{n_h}\right)$ for two different materials A and B, are equal to one and less than one respectively. Name the type of semiconductor to which A and B belong Draw energy level diagrams for A and B. (2)

10) Mention the function of any two of the following used in communication system :

(i) Transducer

(ii) Repeater

(iii) Transmitter (3)

11) With the help of a labelled circuit diagram, explain how an *n-p-n* transistor can be used as an amplifier in common-emitter configuration. Explain how the input and output voltages are out of the phase by 180° for a common-emitter transistor amplifier. (5)

SOLUTIONS

1) What is Maxwell's displacement current ? (1)

SOL: Displacement current is 0.25 A. Note that the displacement current is equal to conduction current.

By Faraday's law, a changing magnetic field induces an electric .field hence, a changing electric field must be associated with a current.

Maxwell called this current as the displacement current .The displacement current exists only when the electric flux (and hence the electric field) varies with time. In a conducting medium, conduction current dominates over displacement current, whereas in an insulating , mediums, displacement current dominates over the conduction current, **"time varying electric fields" is the source of magnetic fields.**

$I_D = \varepsilon_0 \frac{d\phi_E}{dt}$ is displacement current.

2) Why is the transmission of signals using ground waves restricted up to a frequency of 1500 kHz? (1)

SOL: This is because at frequencies higher than 1500 kHz, there is an increase in the absorption of signal by the ground.

3) Why is it necessary to use satellites for long distance TV transmission ? (1)

SOL: Television signals are not properly reflected by the ionosphere. So, reflection is affected by satellites.

4) In half-wave rectification, what is the output frequency if the input frequency is 50 Hz ? What is the output frequency of a full-wave rectifier for the same input frequency ? (2)

SOL: For a half-wave rectifier, the output ripple frequency is 50 Hz. For full wave rectifier, the output frequency is 100 Hz.

5) Electromagnetic waves with wavelength

i) λ_1 **are used to treat muscular strain**

ii) λ_2 **are used by a FM radio station for broadcasting**

iii) λ_3 **are used to detect fracture in bones**

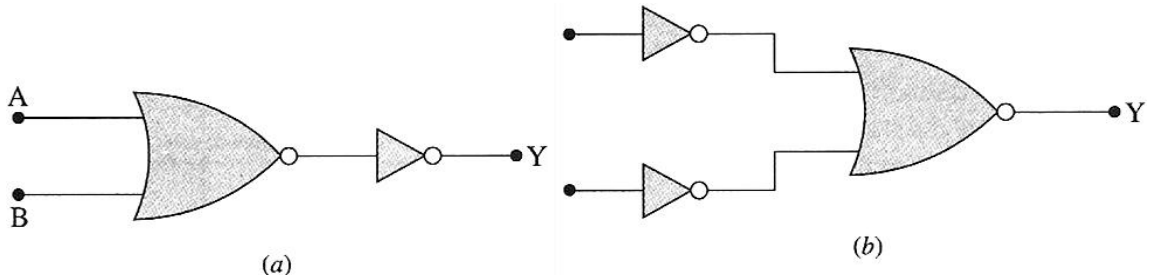
iv) λ_4 **are absorbed by the ozone layer of the atmosphere.**

Identify and name the part of the electromagnetic spectrum to which these radiations belong. Arrange these wavelengths in decreasing order of magnitude. (2)

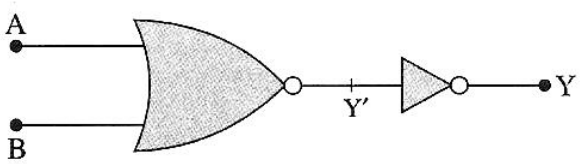
SOL: (i) λ_1 - infrared (ii) λ_2 - radiowaves

(iii) λ_3 - X-rays (iv) λ_4 - ultra-violet rays $\lambda_2 > \lambda_1 > \lambda_4 > \lambda_3$

6) You are given the two circuits as shown in the figure. Show that circuit (a) acts as OR gate while the circuit (b) acts as AND gate. (2)



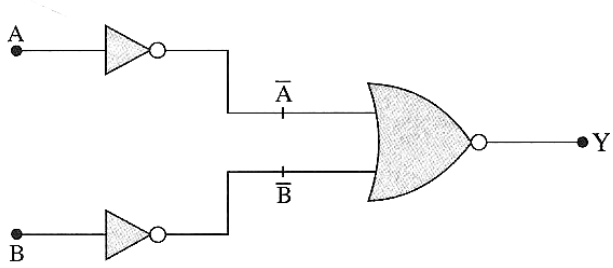
SOL: (a)



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

So, the circuit acts as an **OR** gate.

(b)



A	B	$\overline{A}$	$\overline{B}$	Y
0	0	1	1	0
0	1	1	0	0
1	0	0	1	0
1	1	0	0	1

So, the circuit acts as an **AND** gate.

7) Answer the following questions

(a) Long distance radio broadcasts use short-wave bands. Why ?

(b) It is necessary to use satellites for long distance TV transmission. Why ?

(c) Optical and radio telescopes are built on the ground but X-ray astronomy is possible only from satellites orbiting the earth. Why ? **(3)**

Ans. (a) This is because ionosphere reflects waves in these bands.

(b) It is so because television signals are not properly reflected by the ionosphere. Therefore, for reflection of signals, satellites are needed.

(c) Atmosphere absorbs X-rays, while visible and radiowaves can penetrate it. That is why optical and radio telescopes can work on earth's surface but X-ray astronomical telescopes must be used on satellites orbiting the earth.

8) For a CE-transistor amplifier, the audio signal voltage across the collector resistance of $2\text{k}\Omega$ is 2 V.

Suppose the current amplification factor of the transistor is 100, find the input signal voltage and base current, if the base resistance is $1\ \text{k}\Omega$.

SOL:

$$A_v = \beta\frac{R_C}{R_B} = 100\frac{2000}{1000} = 200$$

$$V_0 = A_v V_i$$

$$V_i = \frac{V_o}{A_v} = \frac{2}{200} = \frac{1}{100}\text{ V} = \mathbf{0.01\ V}$$

Again, $\beta = \frac{I_C}{I_B}$

or $I_B = \frac{I_C}{\beta} = \frac{V_o}{R_C} \times \frac{1}{\beta} = \frac{2}{2000 \times 100}$

$= \frac{1}{10^5}\ A = 10^{-5}\ A = 10 \times 10^{-6}\ A$

$= 10\ \mu A$

OR

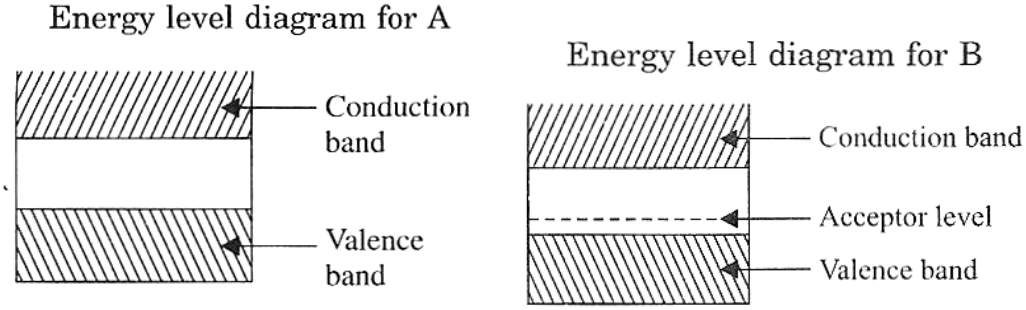
Is it necessary for a transmitting antenna to be at the same height as that of the receiving antenna for line of sight communication ? A TV transmitting antenna is 81m tall. How much service area can it cover if the receiving antenna is at the ground level ? (3)

Ans. No. Service area will be

$A = \pi d_T^2 = \frac{22}{7} \times 162 \times 6.4 \times 10^6 = \mathbf{3258\ km^2}.$

9) The ratios of number density of free electrons to holes, $\left(\frac{n_e}{n_h}\right)$ for two different materials A and B, are equal to one and less than one respectively. Name the type of semiconductor to which A and B belong Draw energy level diagrams for A and B. (2)

SOL: A is intrinsic semiconductor and B is p-type semi- conductor.



10) Mention the function of any two of the following used in communication system :

(i) Transducer

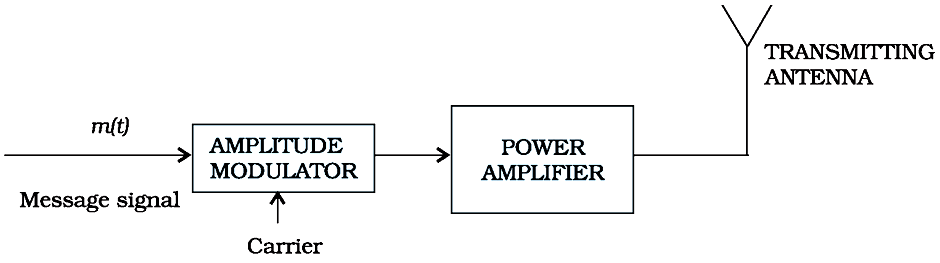
(ii) Repeater

(iii) Transmitter

SOL: (a) **Transducer** :A device which convert one form of energy into another is known as transducer, e.g., microphone, electric transducer converts pressure, temperature etc, into varying electrical signals.

(b) **Repeater**: It picks up the signal from the transmitter, amplifies it and retransmite it to the receiver. Repeater consists of transmitter and receiver.

(c)Transmitter : A transmitter processes the incoming message signal so as to make it suitable for transmission through a channel and subsequent reception.



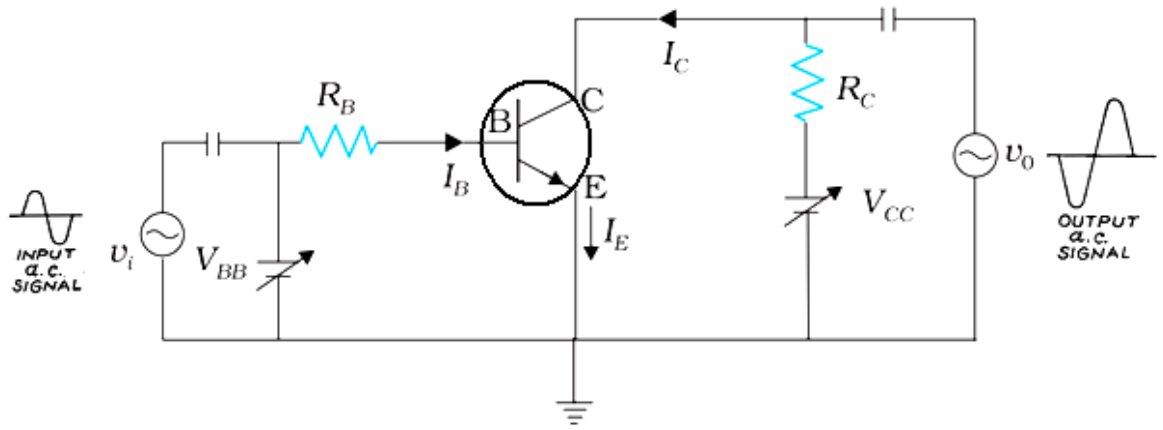
Block diagram of a transmitter.

11) With the help of a labelled circuit diagram, explain how an *n-p-n* transistor can be used as an amplifier in common-emitter configuration. Explain how the input and output voltages are out of the phase by 180° for a common-emitter transistor amplifier. (5)

SOL: Transistor as an Amplifier (CE or Grounded Emitter -configuration)

A **transistor** consisting of two *p-n* junctions, one forward-biased and the other reverse-biased, can be used for amplifying a weak signal. The forward-biased junction has a low-resistance path whereas the reverse-biased junction has a high-resistance path. The weak **input** signal is applied across the **forward-biased (low resistance) junction (BE)** and the output signal is taken across the **reverse-biased (high resistance) junction (CE).** Since the input and output currents are almost equal, the output signal appears with a much higher voltage. The transistor thus **acts as an amplifier**.

The input (base-emitter) circuit is forward-biased by a low-voltage battery $\boldsymbol{V_{BB}}$ so that the resistance of the input circuit is small. The output (collector-emitter) circuit is reverse-biased by means of a high-voltage battery V_{CC} so that the resistance of the output circuit is high. R_C is a load resistance connected in the collector-emitter output circuit. The weak input a.c. signal is applied across the base-emitter circuit and the amplified output signal is obtained across the collector-emitter circuit.



Let I_E , I_B and I_C be the emitter-current, base-current and collector-current respectively when no a.c. voltage signal is applied to the input circuit. (The arrows represent the direction of the hole current, that is, conventional current which is opposite to the direction of electron current.) By Kirchhoff s first law, we have $\boxed{I_E = I_B + I_C}$ ……(1)

Due to the collector current is (which is only slightly smaller than I_E), the voltage drop across R_C is I_C R_C Therefore, the collector-to-emitter voltage (potential difference between collector and emitter) V_{CE} would be given by

$\boxed{V_{CE} = V_{CC} - I_C R_L}$ .....(2)

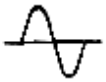
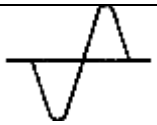
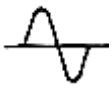
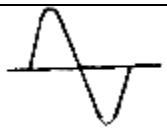
When the input a.c. voltage signal is applied across the base-emitter circuit, it changes the base-emitter voltage V_{BB} and hence the emitter-current I_E which, in turn, changes the collector current I_C Consequently, the collector-to-emitter voltage V_{CE} varies in accordance with eq. (2). This variation in V_{CE} , when the input signal is applied, appears as an amplified output.

Phase Relationship between Input and Output Voltage Signals : The first positive half-cycle of the a.c. input voltage signal supports and hence increases the forward-biasing of the base-emitter circuit. Therefore, the base current $\boldsymbol{I_B}$ and correspondingly the collector current I_C increase as $\Delta I_C = \beta \Delta I_B$. As a result, the collector voltage $\boldsymbol{V_{CE}}$ decreases in accordance to the relation $\boldsymbol{V_{CE} = V_{CC} \sim I_C R_C}$. Since the collector is connected to the positive terminal of the battery V_{CC} , a decrease in collector voltage means that the collector becomes less positive. Thus, during the **positive** half-cycle of the a-c input voltage signal, the output voltage signal at the collector undergoes a **negative half-cycle.**

The negative half-cycle of the input voltage opposes and hence reduces the forward biasing of the base-emitter circuit. Therefore, the base current I_B and correspondingly the collector current I_c decrease. As a result, the collector voltage V_{CE} increases, that is, the collector becomes more positive. Thus, during the negative half-cycle of the a-c input voltage signal, the output voltage signal at the collector undergoes a positive half-cycle.

Thus, the output voltage signal is 180 ° out of phase with the input voltage signal in the common-emitter amplifier.

Phase relationship between input voltage, input current, output voltage and output current for an amplifier in *C-E* mode is shown in table-

	INPUT	OUTPUT	PHASE DIFFERENCE
VOLTAGE			π or 180^o
CURRENT			0^0