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SFI GEC PALAKKAD

Course Code: EST 130

Course Name: BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING

PART I: BASIC ELECTRICAL ENGINEERING

(2019 Scheme)

Max. Marks: 50 Duration: 90 min

PART A

Answer all questions, each carries 4 marks.

1 What are statically and dynamically induced emfs? Explain.

2 Derive the expression for average value of a sinusoidal wave form.

3 Derive an expression for the energy stored in an inductor.

4 Prove that in a purely capacitive circuit the current leads the applied voltage by 90 degrees and the power consumed is zero.

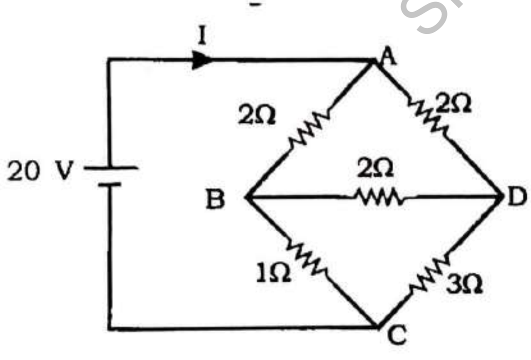
5 Derive the relation between line and phase currents in a 3 phase delta connected system. (5x4=20)

PART B

Answer one full question from each module, each question carries 10 marks

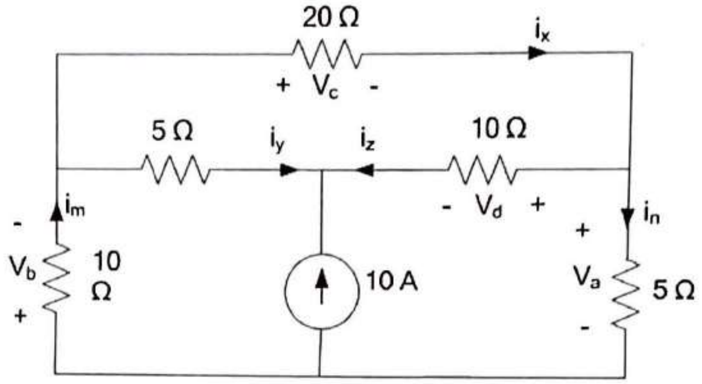
Module-I

6 Find the source current I in the below figure using star-delta transformation. (10)



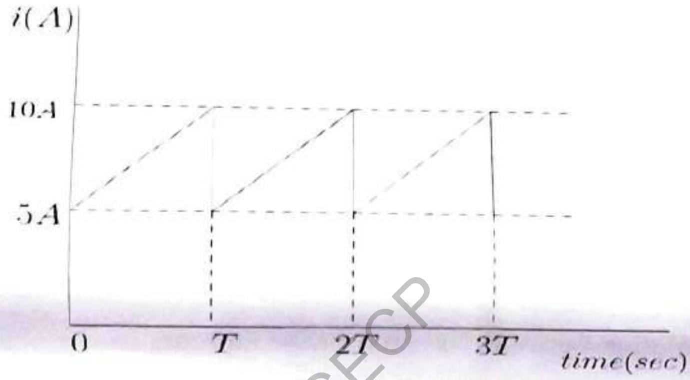
OR

7 Use the nodal analysis to find voltages Va , Vb , Vc , Vd . (10)



Module-II

8 Determine the average value and rms value of the current waveform shown in figure below. (10)



OR

9 a) A coil of 50 Ω resistance is placed in a magnetic field of 1mWb. The coil has 50 turns and a galvanometer of 400 Ω resistance is connected in series with it. Find the average induced emf and the resulting current if the coil is moved in 0.1 second from the given field to another field of 0.2mWb. (6)

b) Define rms value and average value of a time varying wave form. (4)

Module-III

10 A resistor of 50Ω, an inductor of 0.1H and a capacitor of 40μF are connected in series and the combination is connected across 220V, 50 Hz supply. Calculate (i) the circuit impedance (ii) resulting current (iii) power factor (iv) phase angle and (v) power consumed by the circuit. (10)

OR

11 Three inductive coils, each with a resistance of 22 Ω and an inductance of 0.05 H are connected in first in star and then in delta, to a 3 phase 415 V, 50 Hz supply. Calculate for both star and delta connections, (i) phase current and line current and (ii) total power absorbed. (10)

PART II: BASIC ELECTRONICS ENGINEERING
(2019 Scheme)

Max. Marks:50 Duration: 90 min

PART A

Answer all questions, each carries 4 marks.

12 Distinguish between active and passive electronic components with examples for each.

13 Explain Avalanche breakdown?

14 Write a note on potential divider biasing.

15 Describe gain and bandwidth of an RC coupled amplifier.

16 Distinguish between AM and FM. *(5x4=20)*

PART B

Answer one full question from each module, each question carries 10 marks

Module-IV

17 a) What are the specifications of a resistor? Define any three (5)

b) What do you understand by depletion region? (5)

OR

18 a) Describe the colour coding of a resistor. (4)

b) Explain the VI characteristics of a diode with relevant sketches. (6)

Module-V

19 a) Explain the working of a full wave bridge rectifier with capacitor filter. (7)

b) With a neat sketch explain the block diagram of an instrumentation system. (3)

OR

20 a) Define line regulation and load regulation. (4)

b) Draw the circuit diagram of a CE amplifier and discuss the role of each component used in it. (6)

Module-VI

21 a) With a neat sketch explain the basic block diagram of a GSM system. (7)

b) Explain the principle of an antenna. (3)

OR

22 a) Write the expression for an AM wave and comment on the bandwidth requirement and modulation index. (5)

b) Explain the concept of cellular communication systems. (5)

****

1. what are statically and dynamically induced emfs ? explain.

Ans. The change in flux lines with respect to coil can be achieved without physically moving the coil or the magnet such induced emf in a coil which is without physical movement of coil or a magnet is called statically induced emf. To have an induced emf there must be change in flux associated with a coil, such a change in flux can be achieved without any physical movement by increasing and decreasing the current producing the flux rapidly with time. Due to alternating flux linkage with the coil itself, the emf gets induced in that coil itself which carries an alternating current.

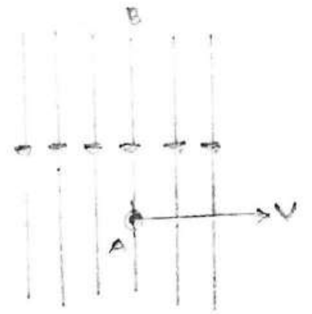
The statically induced emf is further classified as,

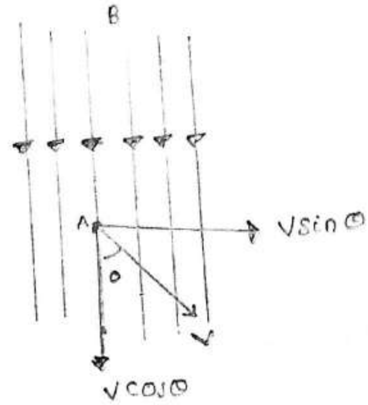
(1) self induced emf

(2) Mutually induced emf

When the conductor is moved in a stationary magnetic field in such a way that the flux linking it changes in magnitude, the emf induced in this way is called dynamically induced emf. It is so called because emf is induced in the conductor which is in motion.

consider a single conductor of length l meters moving at right angles to the magnetic field of B wb/m^2 with a velocity of v m/s. suppose the conductor moves through a small distance dx in dt seconds. The area swept by the conductor is $= l \times dx$





change in flux = flux density x Area swept = $B\,l\,dx$ wb.

According to Faraday's law of electromagnetic induction, the magnitude of induced emf is

$$e = N\frac{d\phi}{dt} = \frac{B\,l\,dx}{dt}$$

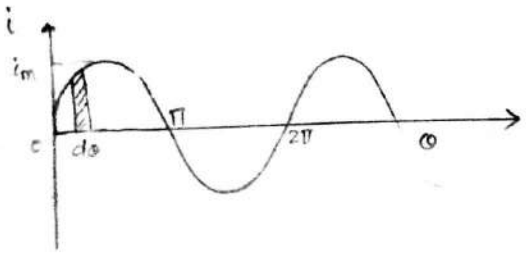
$$e = B\,l\,v \text{ volts.}$$

If the conductor A moves at angle θ with the direction of line of flux then induced emf is

$$e = B\,l\,v\sin\theta \text{ volts.}$$

2. Derive the expression for average value of sinusoidal wave form.

Ans



[Sinusoidal wave with maximum value I_m & time period 2π]

The equation of an alternating current varying sinusoidally is given by $i = I_m \sin\theta$ $(\theta = \omega t)$

consider an elementary strip of thickness dθ in the first half cycle of current wave

Let i be the mid-ordinate of this strip.

Area of strip $= i\,d\theta$

$\therefore$ Area of half cycle $= \int_0^{\pi} i\,d\theta$

$$= \int_0^{\pi} I_m \sin\theta \cdot d\theta = I_m (-\cos\theta)_0^{\pi}$$

$$= 2 I_m$$

Average value $I_{av} = \dfrac{\text{Area of half cycle}}{\text{Base length of half cycle}}$

$$\boxed{I_{av} = \frac{2 I_m}{\pi}} \quad \boxed{I_{av} = 0.637\, I_m}$$

Hence the half-cycle average value of ac is 0.637 times the peak value of ac.

$V = V_m \sin\theta$

III'ly Average value of voltage,

$$V_{avg} = \frac{1}{T} \int_0^{T} V \cdot d\theta$$

$$= \frac{1}{\pi} \int_0^{\pi} V_m \sin\theta \cdot d\theta = \frac{V_m}{\pi} (-\cos\theta)_0^{\pi}$$

$$\boxed{V_{avg} = \frac{2V_m}{\pi}} \quad \boxed{V_{avg} = 0.637\, V_m}$$

MODULE - 1

PART A

2. $$E = Pt$$

$$E = \int_0^i P\,dt$$

$$\because P = v \times i$$

$$= L\frac{di}{dt} \times i$$

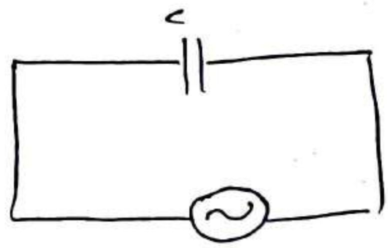
$$\therefore E = \int_0^i L\frac{di}{dt} \times i \times dt$$

$$= \int_0^i L i\,di$$

$$= L\left[\frac{i^2}{2}\right]_0^i$$

$$E = \frac{1}{2} L i^2$$

4.



Consider the purely capacitive circuit. An ac voltage is applied to it.

$$V = V_m \sin\omega t \longrightarrow (1)$$

$$Q = CV$$

$$i = \frac{dQ}{dt} = \frac{d(CV)}{dt}$$

$$i = C\frac{dV}{dt} \longrightarrow (2)$$

$$i = C\frac{d}{dt} V_m \sin\omega t$$

$$= V_m C . \cos\omega t \times \omega$$

$$i = \frac{V_m \cos\omega t}{1/C\omega} \longrightarrow (3)$$

where $\frac{1}{C\omega} = X_c$ [Capacitive reactance]

Now,

$$i = i_m \sin(\omega t + 90) \longrightarrow (4)$$

where $i_m = \frac{V_m}{1/C\omega}$

Eqn (4) and (1), says that current leads voltage by 90°.

Instantaneous power $= vi$

$= V_m \sin\omega t \times i_m \sin(\omega t + 90)$

$= V_m i_m \sin\omega t \times \cos\omega t$

$= V_m i_m \frac{\sin 2\omega t}{2}$

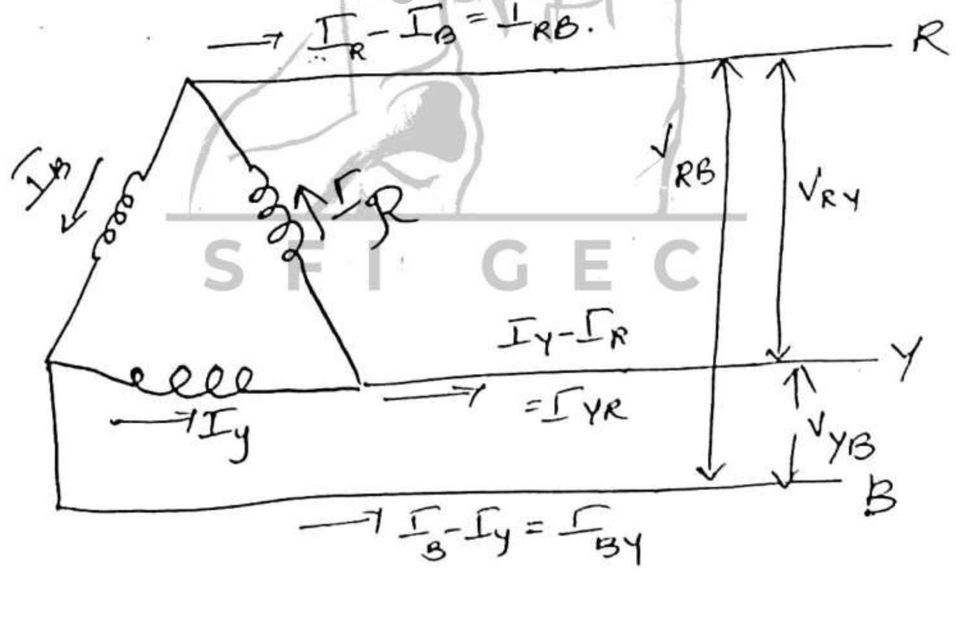
Average power over 1 complete cycle,

$$P_{avg} = \frac{1}{2\pi} \int_0^{2\pi} V_m i_m \frac{\sin 2\omega t}{2}$$

$$= \underline{\underline{0}}.$$

[∫ of sin over a complete cycle is zero]

5)



In a delta connected system,

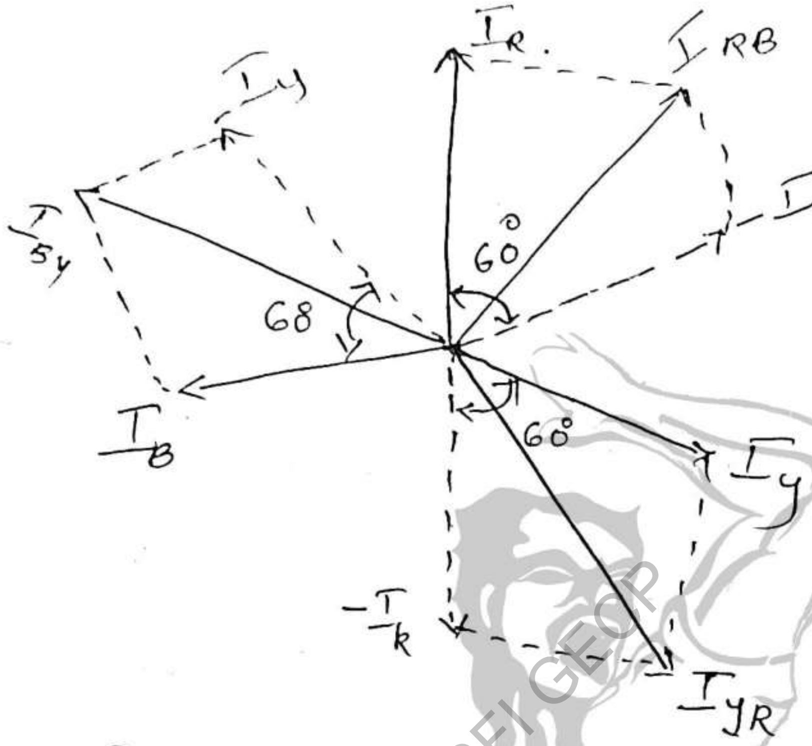
$V_{ph} = V_L$.

But $I_L \neq I_{ph}$.

$I_L = I_{RB}, I_{YR}, I_{BY}$

$I_{ph} = I_R, I_Y, I_B$.

Phasor diagram



$$\vec{I}_{RB} = \sqrt{(I_R)^2 + (-I_B)^2 + |2 I_R||I_B| \cos 60^\circ}$$

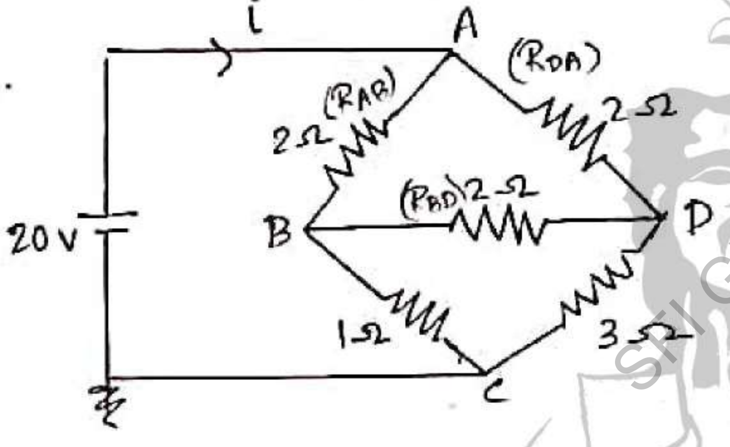
$$= \sqrt{I_{ph}^2 + I_{ph}^2 + \cancel{2} I_{ph}^2 \frac{1}{\cancel{2}}}$$

$$I_L = \sqrt{3 I_{ph}^2}.$$

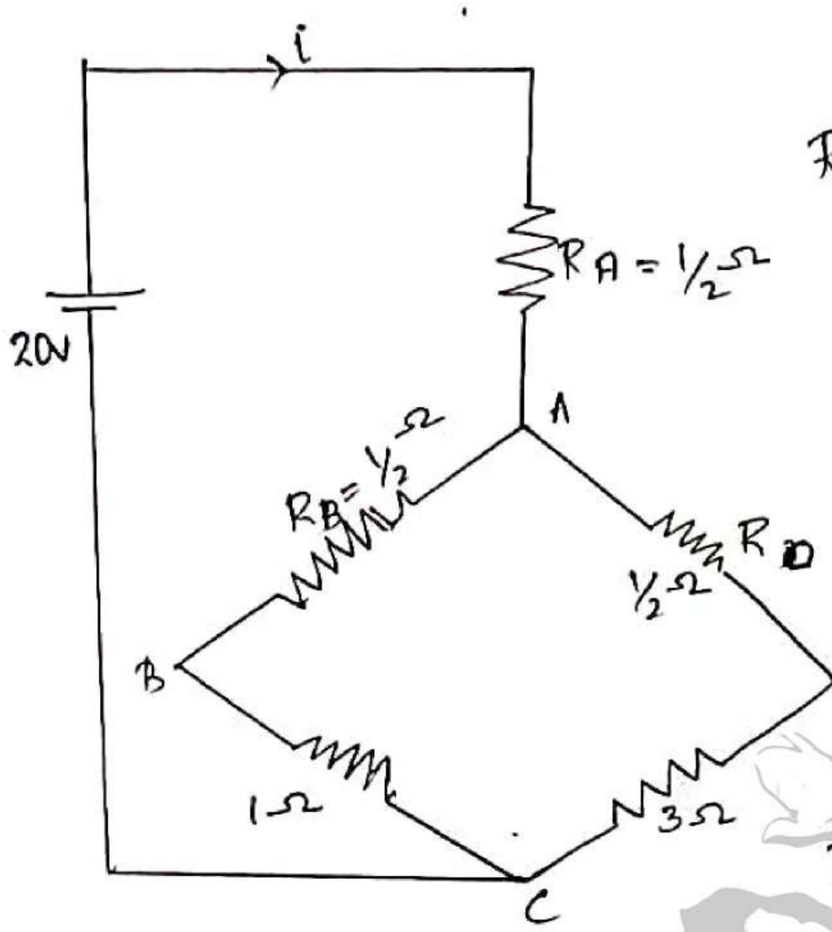
$$\boxed{\begin{array}{l} I_L = \sqrt{3}\, I_{ph} \\ V_L = V_{ph} \end{array}}$$

PART - B

6.



Converting this delta connection to star



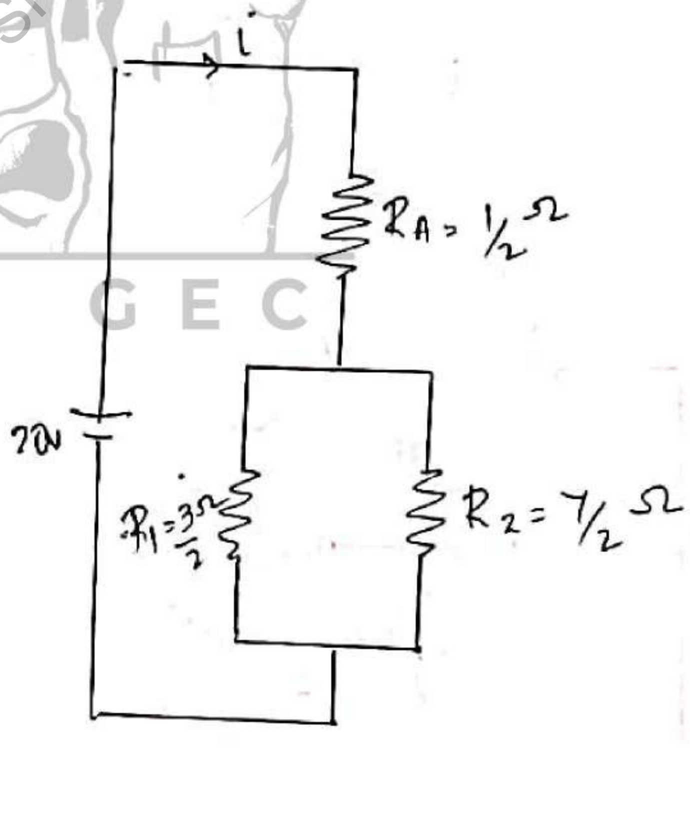
$$R_A = \frac{R_{AB} \times R_{DA}}{R_{AB}+R_{BD}+R_{DA}} = \frac{2\times 2}{2+2+2} = \frac{1}{2}\Omega$$

$$R_B = \frac{R_{AB} \times R_{BD}}{R_{AB}+R_{BD}+R_{DA}} = \frac{2\times 2}{2+2+2} = \frac{1}{2}\Omega$$

$$R_C = \frac{R_{BD} \times R_{DA}}{R_{AB}+R_{BD}+R_{DA}} = \frac{2\times 2}{2+2+2} = \frac{1}{2}\Omega$$

$$R_1 = \frac{1}{2} + 1 = \frac{3}{2}\Omega$$

$$R_2 = \frac{1}{2} + 3 = \frac{7}{2}\Omega \Longrightarrow$$



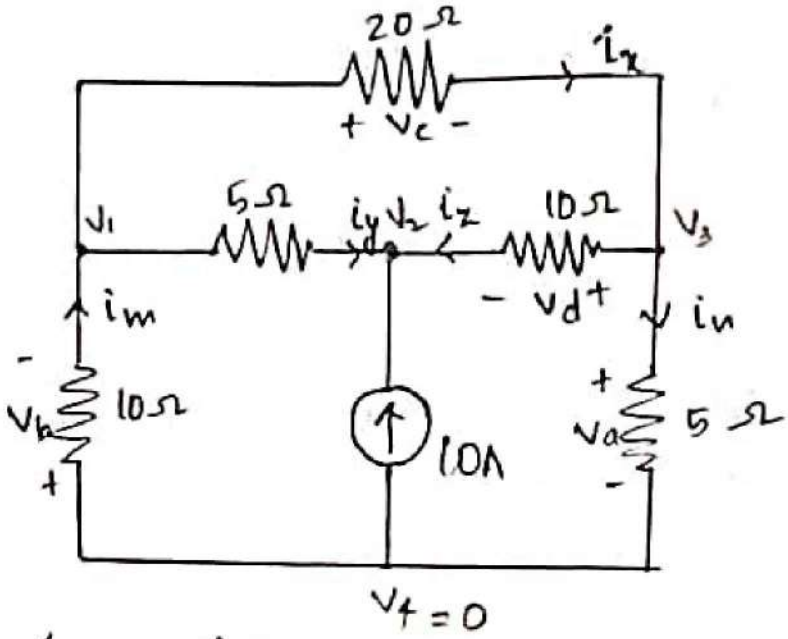
$$R_3 = \frac{R_1 \times R_2}{R_1+R_2} = \frac{\frac{3}{2}\times\frac{7}{2}}{\frac{3}{2}+\frac{7}{2}} = \frac{21}{20}\Omega$$

R_A and R_3 in series

$$\therefore R_{effective} = R_A + R_3 = \frac{1}{2} + \frac{21}{20} = \frac{31}{20}\Omega$$

$$I = \frac{V}{R} = \frac{20}{31}\times 20 = \frac{400}{31} = 12.9A$$

7.



Consider 4 nodes $V_1, V_2, V_3, V_4 = 0$

At node 1 (V_1)

$$i_x + i_y = i_m$$

$$\frac{V_1 - V_3}{20} + \frac{V_1 - V_2}{5} = \frac{0 - V_1}{10}$$

$$\frac{V_1}{20} + \frac{V_1}{5} - \frac{V_2}{5} + \frac{V_1}{10} - \frac{V_3}{20} = 0$$

$$\frac{7}{20}V_1 - \frac{V_2}{5} - \frac{V_3}{20} = 0 \quad \text{— (1)}$$

At node 2 (V_2)

$$i_y + i_z + 10 = 0$$

$$\frac{V_1 - V_2}{5} + \frac{V_3 - V_2}{10} + 10 = 0$$

$$\frac{V_1}{5} - \frac{3V_2}{10} + \frac{V_3}{10} = -10 \quad \text{— (2)}$$

At node 3 (V_3)

$$i_x = i_z + i_n$$

$$\frac{V_1 - V_3}{20} = \frac{V_3 - V_2}{10} + \frac{V_3}{5}$$

$$\frac{V_1}{20} + \frac{V_2}{10} - \frac{V_3}{20} - \frac{3V_3}{10} = 0$$

$$\frac{V_1}{20} + \frac{V_2}{10} - \frac{7V_3}{20} = 0 \quad \text{--- (3)}$$

Solving (1), (2) and (3)

$$V_1 = 45.45\,V$$
$$V_2 = 72.72\,V$$
$$V_3 = 27.27\,V$$

$$i_m = -\frac{V_1}{10} = -\frac{45.45}{10} = -4.545\,A$$

$$V_b = i_m \times 10 = -45.45\,V$$

$$V_a = V_3 - 0$$
$$= 27.27\,V$$

$$V_c = V_1 - V_3 = 45.45 - 27.27$$
$$= 18.18\,V$$

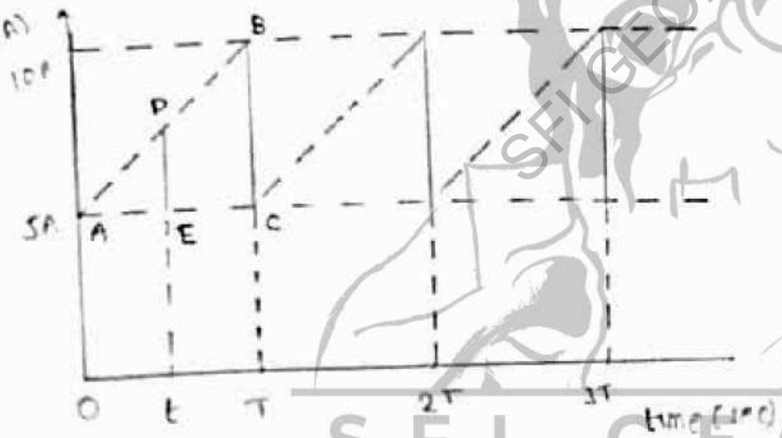
$$V_d = V_3 - V_2$$
$$= 27.27 - 72.72$$
$$= -45.45\,V$$

~~Va = -45.45V Vb~~

$V_a = 27.27\,V$ $\quad$ $V_b = -45.45\,V$

$V_c = 18.18\,V$ $\quad$ $V_d = -45.45\,V$

8. Determine the average value and rms value of current waveform shown in figure below.



slope of the curve AB, $= \frac{5}{T}$

consider the current i at any time t, it is seen that

$$\frac{DE}{AE} = \frac{BC}{AC} = \frac{5}{T}$$

$$\frac{i-5}{t} = \frac{5}{T} \Rightarrow i = \frac{5t}{T} + 5$$

Avg current $I_{av} = \frac{1}{T}\int_0^T i\,dt = \left[\frac{\text{area of half cycle}}{\text{Base length of half cycle}}\right]$

$$= \frac{1}{T}\int_0^T \left(\frac{5}{T}t + 5\right)\cdot dt$$

$$= \frac{1}{T}\left[\frac{5}{T}\frac{t^2}{2} + 5t\right]_0^T$$

$$= \frac{5}{2} + 5 = 7.5\text{ A}$$

$I_{avg} = 7.5$ A.

Mean square value, $= \frac{1}{T}\int_0^T i^2\,dt$

$$= \frac{1}{T}\int_0^T \left(\frac{5t}{T} + 5\right)^2\cdot dt$$

$$= \frac{1}{T}\int_0^T \left(\frac{25}{T^2}t^2 + \frac{50t}{T} + 25\right)\cdot dt$$

$$= \frac{1}{T}\left(\frac{25}{T^2}\frac{t^3}{3} + \frac{50}{T}\frac{t^2}{2} + 25t\right)_0^T$$

$$= \frac{25}{3} + \frac{50}{2} + 25 = \frac{175}{3}.$$

root mean square (rms) value = $\sqrt{\frac{175}{3}}$

$= 7.637A$

$I_{rms} = 7.637A$

9. (a) A coil of 50 Ω resistance is placed in a magnetic field of 1 mwb. The coil has 50 turns and a galvanometer of 400 Ω resistance is connected series with it. Find the average induced emf and the resulting current if the coil is moved in 0.1 second from the given field to another field of 0.2mwb.

Soln

$R = 50\Omega$, $\phi_1 = 10^{-3}$ wb

$N = 50$ $t = 0.1$ sec $\phi_2 = 0.2 \times 10^{-3}$ wb.

$$e = -N \cdot \frac{d\phi}{dt}$$

$$e = -N\left(\frac{\phi_2 - \phi_1}{t_2 - t_1}\right)$$

$$= \frac{-50\,(0.2 - 1) \times 10^{-3}}{0.1} = 400 \times 10^{-3}$$

$e = 0.4$ volt

since 400 Ω is series with 50 Ω effective resistance

$= 450\Omega$

$$I = \frac{e}{R} = \frac{0.4}{450.}$$

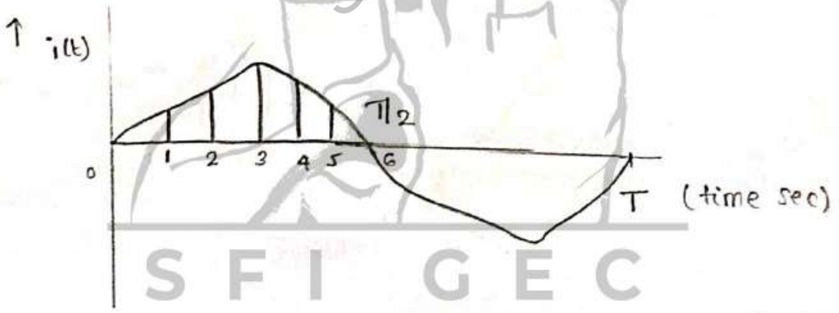
$I = 8.89 \times 10^{-4}$

$= 0.89mA$

varying wave forms.

The average value I_{av} of an alternating current is expressed by that steady current which transfer across any circuit the same charge as it transferred by that ac. In case of a symmetrical ac, the average value over a complete cycle is zero. Hence in their case the average value is obtained by adding or integrating the instantaneous value of current over a half cycle only. But in the case of an unsymmetrical alternating current the average value must always be taken over the whole cycle.

Consider a current waveform, is periodic in nature with time period T. It is +ve for first half cycle and -ve for second half cycle.



$$\text{average value of the wave form} = \frac{\text{Area over half cycle}}{\text{Time period of half cycle}}$$

$$= \frac{1}{T/2} \int_0^{T/2} i(t) \cdot dt = \frac{2}{T} \int_0^{T/2} i(t) \cdot dt$$

In this case only half cycle or that of the time period is used for computing the average value, as the average value of the waveform over a full cycle is zero.

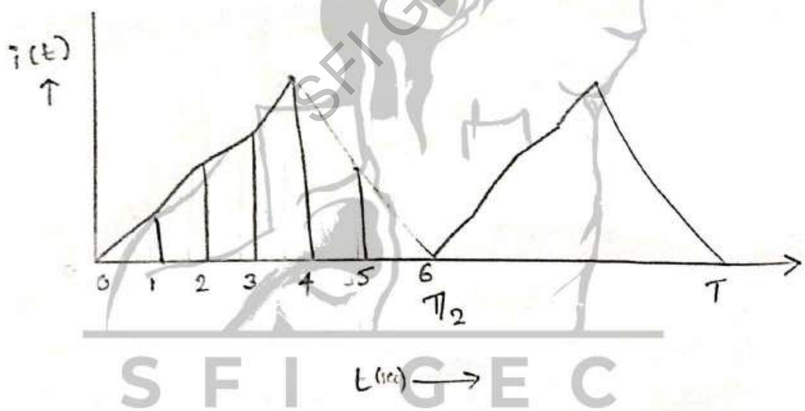
If the time period (T/2) is divided into 6 equal time intervals (ΔT)

$$I_{av} = \frac{(i_1 + i_2 + i_3 + i_4 + i_5 + i_6)\Delta T}{6 \times \Delta T}$$

$$= \frac{i_1 + i_2 + \cdots + i_6}{6} = \frac{\text{Area over half cycle.}}{\text{Base length / time period of half cycle.}}$$

RMS value.

The rms value of an ac is given by that steady current (dc) which when flowing through a given circuit for a given time produces the same heat as produced by the ac when flowing through the same circuit for the same time.



for rms value, the current in half time period subdivided into 6 time intervals. In the resistance R, the average value of energy dissipated is given by,

$$\propto \left(\frac{i_1^2 + i_2^2 + \cdots i_6^2}{6}\right) R.$$

$$I^2 R = \left(\frac{(i_1^2 + i_2^2 + \cdots + i_n^2)\Delta T}{n \times \Delta T}\right) R$$

$$I = \sqrt{\frac{(i_1^2 + i_2^2 + \cdots + i_n^2)\Delta T}{n\, \Delta T}} =$$

$$= \sqrt{\frac{\text{Area of } i^2 \text{ curve over half cycle}}{\text{Time period of half cycle}}}$$

$$= \sqrt{\frac{1}{T/2} \int_0^{T/2} i^2 \, dt} = \sqrt{\frac{2}{T} \int_0^{T/2} i^2 \, dt} = I_{rms}.$$

10) $R = 50\,\Omega$, $L = 0.1\,H$, $C = 40 \times 10^{-6}\,F$

$V = 220\,V$, $f = 50\,Hz \Longrightarrow \omega = 2 \times \pi \times 50$

$Z = \sqrt{R^2 + (X_L - X_C)^2}$

$X_L = L\omega$

$= 0.1 \times 2 \times \pi \times 50$

$= \underline{31.416}$

$X_C = \frac{1}{C\omega}$

$= \frac{1}{40 \times 10^{-6} \times 2 \times \pi \times 50}$

$= \frac{1}{4000 \times 10^{-3} \times \pi}$

$= \frac{10^3}{4 \times \pi}$

$= \underline{79.56}$

$X_C - X_L =$

$Z = \sqrt{50^2 + (48.16)^2}$

$= \sqrt{4819.386}$

$= \underline{69.42\,\Omega}$

ii) $i = \frac{V}{Z} = \underline{3.169\,A}$

iii) Power factor $\cos\theta = \frac{R}{Z}$

$= 0.7202$

iv) Phase angle $\phi = \cos^{-1}(0.7202)$

$= \underline{43.93^\circ}$

v) Power consumed $= Vi\cos\phi$

$= \underline{502.109\ \text{Watt}}$

11). $R = 22\,\Omega$ $\quad V = 415V,$

$L = 0.05H, \quad f = 50 \Longrightarrow \omega = 2\times\pi\times 50$

$$I_{ph} = \frac{V_{ph}}{Z_{ph}}.$$ for star.

$$Z_{ph} = \sqrt{R^2 + X_L^2}.$$

$$= \sqrt{22^2 + (0.05\times 2\times\pi\times 50)^2}$$

$$= \sqrt{22^2 + (15.707)^2}.$$

$$= \sqrt{730.71}.$$

$$= \underline{\underline{27.03}}\,\Omega.$$

line voltage $= 415V.$

$\therefore$ phase voltage $= \frac{V_L}{\sqrt{3}} = \underline{\underline{240V}}.$

$$I_{ph} = \frac{V_{ph}}{Z_{ph}} = \frac{240}{27.03} = \underline{\underline{8.879\,A.}}$$

$$I_{ph} = I_L = 8.879A.$$

$$Power = \sqrt{3}\, V_L I_L \cos\phi$$

$$\cos\phi = \frac{R_p}{Z_p} = \frac{22}{27.03} = 0.814$$

$$Power = \sqrt{3}\times 415\times 8.879\times 0.814$$

$$= 5195.14W$$

$$= \underline{\underline{5.2kW.}}$$

For delta.

$V_L = V_p = 415V.$

$Z_p = 27.03 \Omega$

$\cos\phi = 0.814.$

$$I_p = \frac{V_p}{Z_p} = \frac{415}{27.03} = 15.35\,A.$$

$$I_L = \sqrt{3}\, I_p$$

$$= 26.59\,A.$$

Power,

$$P = \sqrt{3}\, V_L I_L \cos\phi$$

$$= 15539.49$$

$$= 15.53\,kW.$$

PART A

12.

Active components	Passive components
→ Perform signal processing	→ Not capable of signal processing
→ Have gain or directionality	→ Do not have gain or directionality
→ Perform operation with / without the aid of passive components	→ Aid active component in functioning
→ A non linear circuit element	→ A linear circuit element
→ Most of them are unilateral devices	→ Most of them are bilateral devices
→ Equivalent circuit contains an energy source.	→ Equivalent circuit does not contain an energy source.
→ Requires bias or trigger voltage	→ Does not require any input for operation.
Examples:- Vacuum tubes, Diode Transistor, SCR, Integrated circuits etc.	Examples:- Resistors, Capacitors and inductors

13. Avalanche breakdown

In reverse - bias condition, a thermally generated carrier comes to the junction barrier and gains energy from the applied voltage. This carrier collides with a crystal ion and imports enough energy to break the covalent bond. Thus, a new electron - hole pair is generated. these new carriers may also gain sufficient energy from the applied field and produce still another pair of electron - hole when they collide with another crystal ion. In this chain process, each new carrier may, in turn, produce an additional pair of electron - hole. This chain process results in large reverse currents.

The diode is, then, said to be in the region of avalanche breakdown.

14 Potential divider biasing

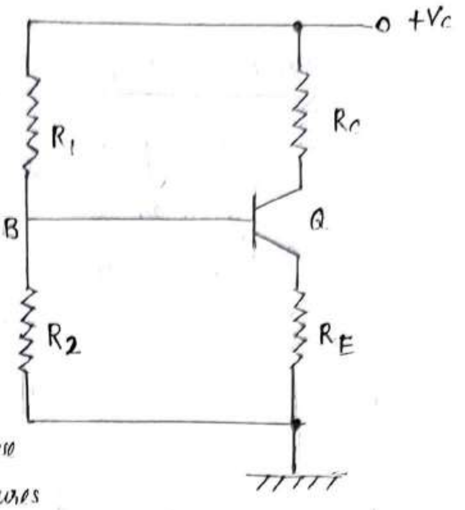


Figure shows the bias using a single power supply which is most commonly used for biasing a transistor amplifier. The biasing circuit is referred to as voltage divider bias or self bias circuit.

Here, voltage across R_2 is

$$\frac{V_{cc} R_2}{R_1 + R_2}$$

which ensures the forward biasing of base emitter junction. V_{cc} through R_c ensures the reverse biasing of collector-emitter junction. The resistor R_E provides thermal stabilization. If R_E is not present, the transistor may get damaged due to thermal runaway. If R_E is present, voltage drop across R_E increases with increase in current due to excess power dissipation. the resulting voltage drop is in a direction to reverse bias the base-emitter junction of the transistor. Therefore, base current is reduced, which in turn reduces the collector current. Corresponding reduction in power at collector junction stabilizes both I_B and I_C. The main limitation of this circuit is that its input resistance gets shunted by the parallel combination of R_1 and R_2.

15. Voltage gain:- To what extent an amplifier enlarges signals is expressed in terms of its voltage gain.

The voltage gain of an amplifier is given as

$$A_V = \frac{\text{Output AC voltage}}{\text{Input AC voltage}} = \frac{V_o}{V_{in}}$$

where V_o is output voltage and

V_{in} is input voltage.

Bandwidth

The frequency range over which the amplifier can be effectively used is its bandwidth. To get more bandwidth, we usually take the frequencies where the output voltage or gain drops $\frac{1}{\sqrt{2}}$ times the maximum value.

$$\text{Bandwidth} = (f_H - f_L)\,\text{Hz}$$

where f_H is the upper cutoff frequency and

f_L is the lower cutoff frequency.

16

AM	FM
→ The amplitude of the carrier signal varies in accordance with modulating signal, keeping frequency and phase constant.	→ The frequency of the carrier signal varies in accordance with modulating signal keeping amplitude and phase constant.
→ Modulation index (m_a) varies from 0 to 1.	→ Modulation index (m_f) can have values from 1 to any value
→ AM has only two side bands	→ FM has infinite no. of sidebands.
→ Lower band width compared to FM	→ Higher band width (ideally infinite) compared to AM.
→ In AM, all transmitted power is not useful. Most of the transmitted power is carrier which does not carry any information.	→ In FM, all transmitted power is useful. The total power remains constant.
→ Area of reception is large	→ Area of reception is smaller than AM.
→ AM broadcasts operate in the medium and high frequency (MF and HF) ranges.	→ FM broadcasts operate in very high frequency and ultra-high frequency (VHF and UHF) ranges.
→ Noise suppression not good	→ Noise suppression is better than AM.
→ AM is less complex and less expensive.	→ FM is more complex and more expensive.
→ Adjacent channel interference is more in AM than present in FM.	→ Adjacent channel interference is less in FM.
→ Modulating voltage amplitude determines RF carrier amplitude.	→ Modulating voltage amplitude determines RF carrier frequency.

PART-B

17 a] The important specifications of a resistor are

i] Resistance value: The value of a resistor is its resistance value expressed in ohms. The value is either written on its body or may be indicated by colour coding.

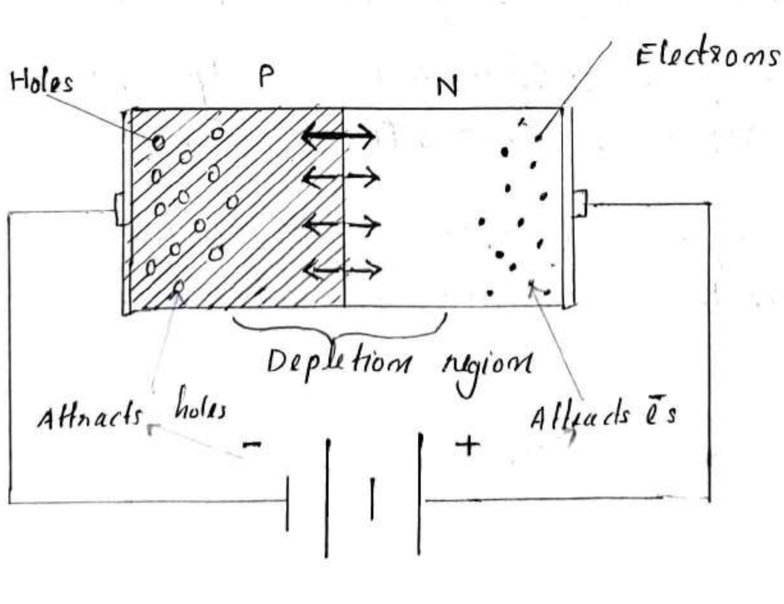
ii] Tolerance: The tolerance of a resistor is the percentage deviation from the rated value. Tolerance indicates how much the measured value of its actual resistance is different from its theoretical value, and it is calculated using percentages.

iii] Power Rating or Wattage Rating or Power Handling Capacity

It is the maximum power that the resistor can dissipate safely. Thus, if a resistor has a power rating of 1/4 watts, 1/4 watts is the maximum amount of power that should be fed in to the resistor. Beyond this rating, the temperature rise would be so high that the resistor gets damaged. The physical size of a resistor gives an indication of its wattage rating.

iv] Voltage rating: It is the maximum voltage that can be applied across a resistor.

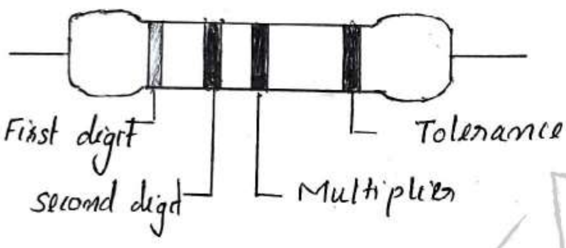
17 b]



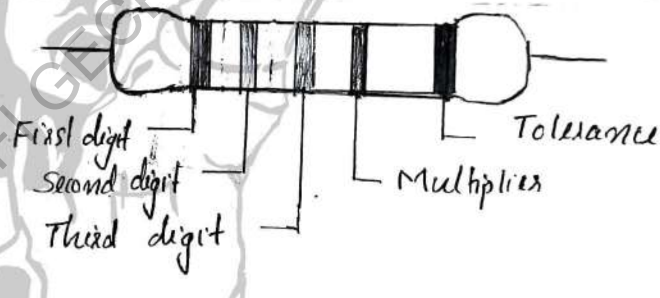
When a diode is connected to a battery as shown, holes in the n-side are forced to the left while electrons in the p-side are forced to the right. This results in an empty zone around the pn-junction that is free of charge carriers creating a depletion region. This depletion region acts as an insulator preventing current from flowing through the diode. When a diode is arranged in this way, it is said to be reverse biased.

18 a] Colour coding of resistors

Carbon resistors are small in size and are colour coded to indicate their resistance values.



4 Band colour coding



5 Band colour coding

4 Band colour coding

The first and second band represents the numerical value of the resistor, and the colour of the third band specifies the power-of-ten multiplier. The fourth band is used to determine the percentage tolerance of the resistor.

5 Band colour coding

The first, second and third band represents the numerical value of the resistor, and the colour of fourth band specifies the power-of-ten multiplier. The fifth band is used to determine the percentage tolerance of the resistor

-> The colour bands are always read from left to right.

Calculating Resistance Value

Example :-

A resistor with colour codes Brown, Red, Orange, Gold has a resistance value of $(12 \times 10^3 \pm 5\%)\,\Omega$.

another example :-

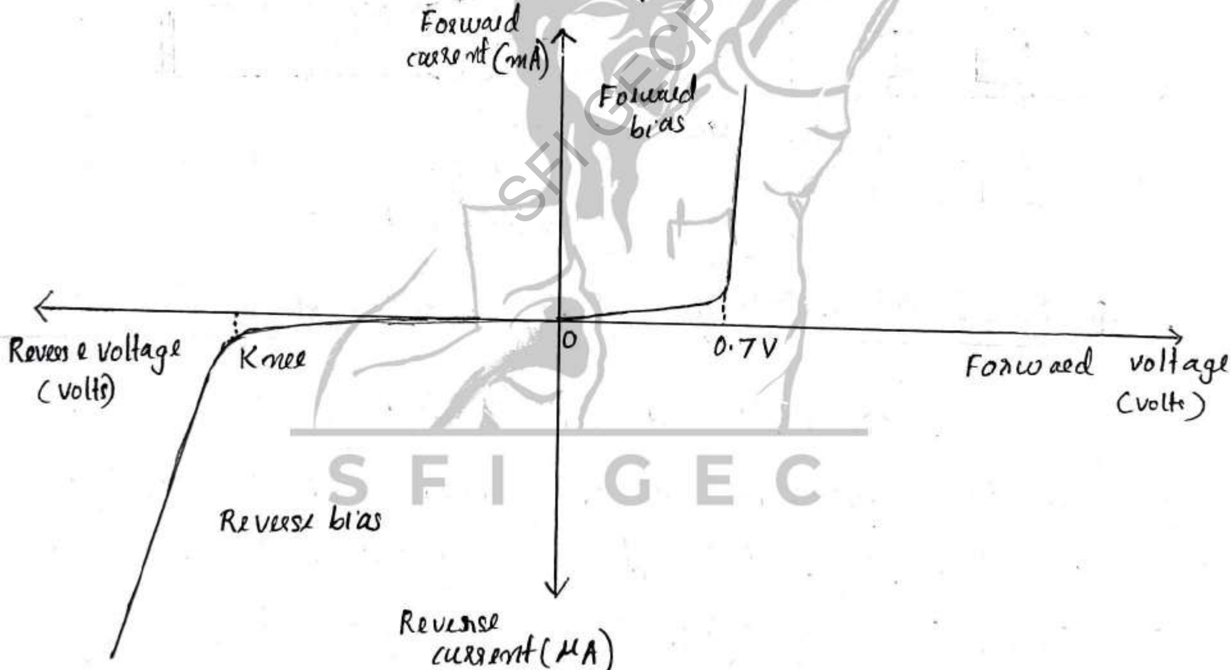
If colour code is Red, Yellow, Green, Gold, Silver.

Resistance = $(245 \times 10^{-1} \pm 10\%)\,\Omega$

Colour code

Colour	Digit	Multiplier	Tolerance
Black	0	10^0	-
Brown	1	10^1	$\pm 1\%$
Red	2	10^2	$\pm 2\%$
Orange	3	10^3	
Yellow	4	10^4	
Green	5	10^5	
Blue	6	10^6	
Violet	7	10^7	
Gray	8	10^8	
White	9	10^9	
Gold	–	10^{-1}	$\pm 5\%$
Silver	–	10^{-2}	$\pm 10\%$
No colour	–	-	$\pm 20\%$

18. b] The V-I characteristics of PN junction diode

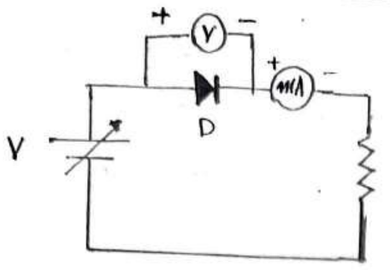


The VI characteristics of PN junction diodes is a curve between the voltage and current through the circuit.

A knowledge of these graphs helps in understanding how the device operates.

The entire V-I characteristics may be divided in ~~to~~ two parts namely : Forward characteristics and reverse characteristics.

Forward characteristics



forward bias

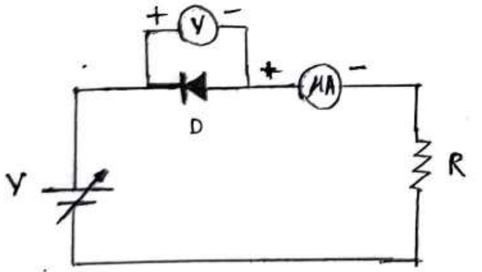
→ With forward bias to the PN junction i.e., P-type region connected to positive terminal and n-type region connected to negative terminal, the potential barrier is reduced.

→ At some forward voltage (0.7V for Si and 0.3 V for Ge), the potential barrier is altogether eliminated and current starts flowing in the circuit.

→ From now onwards, the current increases with the increase in forward voltage. thus, a rising curve is obtained with forward bias as shown in figure.

* From the forward characteristic, it is seen that at first, the current increases very slowly and the curve is non-linear. It is because the external applied voltage is used up in overcoming the potential barrier. However, once the external voltage exceeds the potential barrier voltage, the PN junction behaves like an ordinary conductor. therefore, the current rises very sharply with increase in external voltage. the curve is almost linear.

Reverse characteristics



→ With reverse bias to the PN junction i.e., P-type region connected to negative terminal and n-type region connected to positive terminal, potential barrier at the junction is increased.

Therefore, the junction resistance become very high and practically no current flows through the circuit. However, in practice, a very small current (of the order of μA) flows in the circuit with reverse bias as shown in the reverse characteristic. This is called reverse saturation current (I_s) and is due to the minority carriers.

19. a) Explain the working of a full wave bridge rectifier with capacitor filter (7)

Full-Wave Bridge Rectifier

This is also a full wave rectifier but it uses four diodes. The circuit diagram is shown in fig 1. During the positive half cycle, end A is positive with respect to B. This permits diode D1 and D2 to conduct whereas diodes D3 and D4 are reverse biased. Thus current flows from end A, through diode D1, through load R_L, through diode D2 and back to transformer secondary in the direction shown. A voltage of iR_L is developed across load with polarity as shown. During negative half cycle, the polarity on transformer secondary is reversed. Therefore diodes D1 and D2 get reverse biased and diodes D3 and D4 become forward biased. The current now flows from end B, through D3, through R_L, through D4 and back to transformer secondary in the same direction as above. Hence the voltage developed across R_L is of same polarity and magnitude as above. This is shown in fig(2)

fig (1) Bridge Rectifier

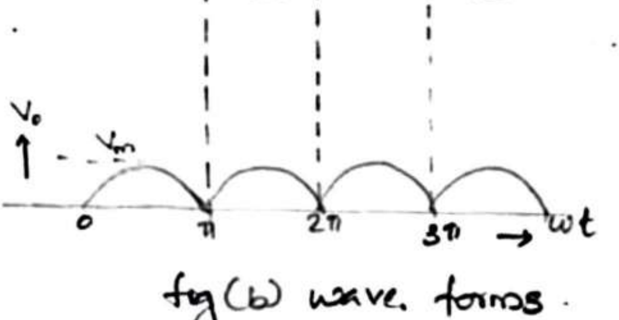
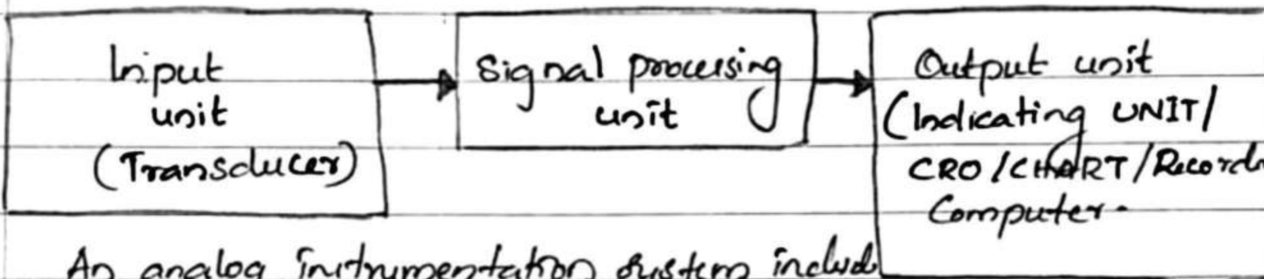


fig (b) wave forms

b) With a neat sketch explain the block diagram of an instrumentation system (3)

ans): Analog Instrumentation System

The block diagram is as shown below:



An analog instrumentation systems include three functional units:

1) The Primary Element/ Transducer

The input unit recieves the quantity whose value is to be measured and it is converted into proportional electrical signal such as voltage, current, resistance change, inductance or even capacitance . Thus, the changed variable contains the information of the measured variable. Such a functional element or device is called a transducer

2) The Secondary Element/Signal Processing Unit

The output of the transducer is provided to the input of the signal processing unit. This unit amplifies the weak transducer output and is filtered and modified to a form that is acceptable by the output unit. Thus this unit may have devices like: amplifiers, filters, analog to digital converters and so on.

3) The Final Element / Output Unit.

The output from the signal processing unit is fed to the input of the output unit. The output unit measures the signal and indicates the value to the reader. The indication may be either through: an indicating instrument, a CRO, digital computer and so on.

20)a) Line Regulation: In this type of regulation, series resistance and load resistance are fixed. only input voltage is changing. Output voltage remains the same as long as the input voltage is maintained above a minimum value.

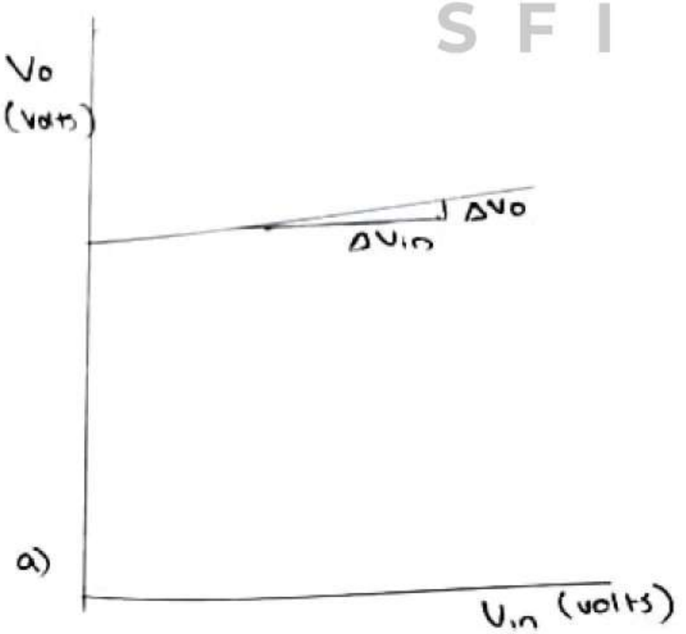
Percentage of line regulation can be calculated by

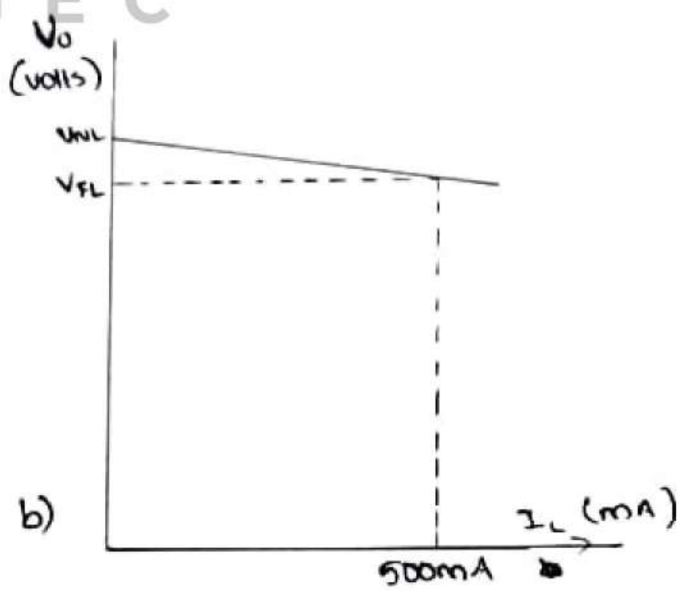
$$\frac{\Delta V_o}{\Delta V_{in}} \times 100$$

Load Regulation: In this type of regulation, input voltage is fixed and the load resistance is varying. Output volt remains the same, as long as the load resistance is maintained above a minimum value.

Percentage of load regulation can be calculated by

$$\frac{V_{NL} - V_{FL}}{V_{FL}} \times 100$$





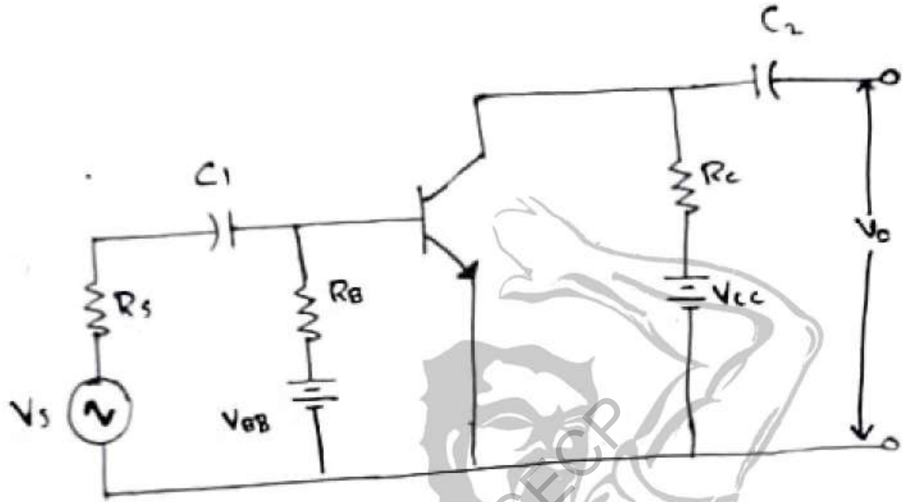
a) Line Regulation

b) Load Regulation.

20) b)

Transistor acts as an amplifier when it is operated in the active region. In active region, transistor offers linear operation by which output should be an exact replica of the input signal without change in its shape. Common Emitter amplifier is widely used configuration due to its high voltage gain and cascading capacity.

A simple CE amplifier is shown:

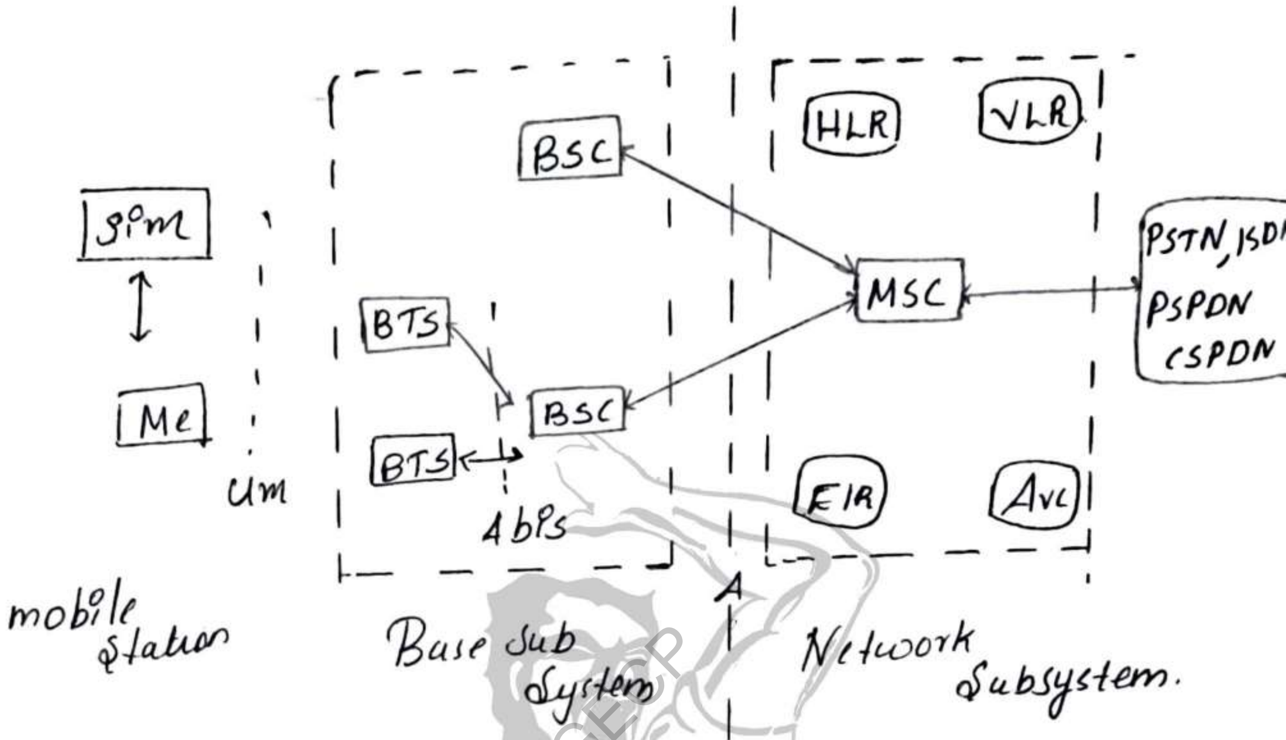


Here the AC input is applied between base and emitter terminals and output is available between collector and emitter terminals.

The components in CE amplifier are:

* V_{BB} - It is the dc source which forward biases the emitter junction.
* V_{CC} - It reverse biases the collector junction.
* R_B - to limit the base current
* R_C - It is connected to the collector terminal which acts as load
* V_s - The ac signal to be amplified.
* C_1 - Coupling capacitor. The signal is applied to base through C_1 which blocks dc components from the source and passes only ac components to base
* C_2 - It is also a coupling capacitor used to block dc component to the output terminals and pure ac output is obtained.

2) a) Global system for mobile communication (GSM) is a second generation cellelular standard



<u>Mobile station</u>

* <u>mobile</u> equipment
  - Portable hand held device
  - Uniquely identified by IMEI

* <u>SIM</u> (Subscriber identity module)
  - Smart card contains IMSI (International mobile subscriber identity)
  - Allow user to sent & receive calls
  - Can be moved from phone to phone

Base Station Sub system

a Base transceiver Station (BTS)

- Handle radio interface to mobile station
- Consists of one or more radio terminal for transmission & reception
- Communicate with MS & BSC

Base Station Controller (BSC)

- Provide all the control functions & physically links b/w MSC & BTS
- BSC handles call setup
- BSC also used for location updating

Network Sub system

Mobile Switching Centre (MSC)

- Performs call switching
- Interface of cellular network to PSTN
- MSC generally called heart of network
  - → Connect calls from sender to receiver
  - → Collect details of call made & received
  - → Supervise operation of rest of the network components
  - → Used to update billing information.

Home location register (HLR)

- Permanent database about mobile subscribers in large service area
- Contains administrative information of each subscriber such as IMSI, prepaid / postpaid, supplementary services
- Updates current location of the mobile

Visitor Location Register (VLR)

- Temporary database which updates when ever new mobile station enters into roaming area
- Control the mobile roaming in the area
- Reduce number of queries to HLR

Authentication Center (AuC)

- This register mainly used for security
- Store subscriber authentication data like passwords or PIN

Equipment Identity Register (EIR)

- EIR is a data base contain a list of all valid mobile stations equipments within the network, where each mobile station is identified by IMEI

EIR has 3 databases

→ white list for all known, good IMEI

→ Black list for all bad / stollen handset

→ Grey list - for all handsets / IMEI that are ... on observation

b) Antenna is an electrical system device which converts electrical energy to radio waves & vice versa.

- Major step in wireless communication.

Fundamentally from maxwells equation EM waves produced by accelerating current, and conductor carry those current EM waves propagate through space and we use them for communication. There are ~~xxxx~~ transmitting antenna which convert sound, light etc to EM waves & receiving antenna that convert EM wave to electrical signal. The way antenna radiate depends determined by its geometry & material. The goal of antenna design is to ensure the conversion between current and radiation occur efficiently

22)

a) $V_{am} = \sigma(V_c + V_m)\sin\omega_c t$

$= (V_c + V_m)\sin\omega_c t$

$V_{am} = (V_c + V_m \sin\omega_m t)\sin\omega_c t$

$= V_c\left(1 + \frac{V_m}{V_c}\sin\omega_m t\right)\sin\omega_c t$

$= V_c(1 + m\sin\omega_m t)\sin\omega_c t$

$\sin A\sin B = \frac{1}{2}\left(\cos(A-B) - \cos(A+B)\right)$

$V_{am} = V_c\sin\omega_c t + mV_c\sin\omega_m t\sin\omega_c t$

$= V_c\sin\omega_c t + mV_c\sin\omega_m t\sin\omega_c t$

$= V_c\sin\omega_c t + \frac{mV_c}{2}\cos(\omega_c t - \omega_m t) - \frac{mV_c}{2}\cos(\omega_c + \omega_m)t$

20) $V_{AM} = V_c \cos \omega_c t + \frac{mV_c}{2} \cos(\omega_c - \omega_m)t + \frac{mV_c}{2} \cos(\omega_c + \omega_m)t$

$\frac{mV_c}{2} \cos(\omega_c - \omega_m)t \rightarrow$ lower side band

$\frac{mV_c}{2} \cos(\omega_c + \omega_m)t \rightarrow$ upper side band

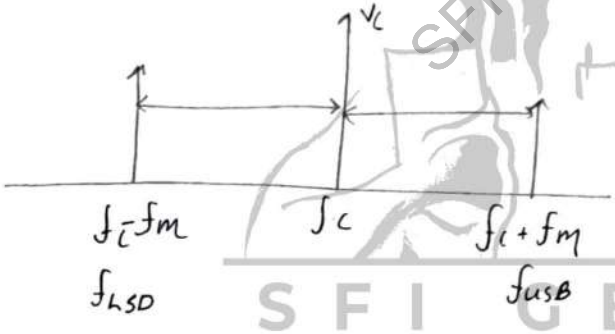
$V_c \cos \omega_c t \rightarrow$ carrier signal

frequency of lower side band $f_c - f_m$

~~f~~ of frequency of upper side band $= f_c + f_m$

Amplitude $= \frac{mV_c}{2}$

frequency spectrum.



Band width $= f_{USB} - f_{LSB}$

$= f_c + f_m - f_c + f_m$

$= \underline{\underline{2f_m}}$

Modulation Index

Ratio of amplitude of modulating & carrier signal

$m = \frac{V_m}{V_c}$

modulation index have value between 0 & 1

- The entire network coverage area is divided into cells.
- A cell is a basic geographic unit of a cellular system. It is the area around an antenna where a specific frequency range is used. It is represented as a hexagonal shape
- ~~The~~ A ~~cellular~~ group of cells is called a cluster.
- A cellular concept is a system level idea which makes the use of multiple low-power transmitter each providing coverage to a small portion of service area
- An area is divided into a number of cells, each one is served by a base station
- Each base station is allocated a portion of total number of channels or frequencies available to entire system