S.Y. Diploma : Sem. III

[AE/ME]

Basic Electrical & Electronics Engineering

Time: 3 Hrs.] Prelim Question Paper Solution **[Marks : 70**

Section – A

Q.1 Attempt any SIX of the following : [12]

Q.1(a) Explain the following terms EMF, Current, Potential Difference, Power and Energy. [2]

Ans.: **(i) EMF**

Electromotive force, abbreviated EMF (denoted and measured in volts), is the electrical intensity or "pressure" developed by a source of electrical energy such as a battery or generator.

A device that converts other forms of energy into electrical energy (a "transducer") provides an emf as its output.

(ii) Current

An electric current is a flow of electric charge.

In electric circuits this charge is often carried by moving electrons in a wire. It can also be carried by ions in an electrolyte, or by both ions and electrons such as in an ionised gas.

(iii) Potential Difference

It is the difference in electric potential between two points.

The voltage between two points is equal to the work done per unit of charge against a static electric field to move a test charge between two points.

This is measured in units of volts.

(iv) Power

Electric power is the rate, per unit time, at which electrical energy is transferred by an electric circuit.

The SI unit of power is the watt, one joule per second.

(v) Energy

Electrical energy is the energy newly derived from electric potential energy or kinetic energy.

When loosely used to describe energy absorbed or maybe delivered by an electrical circuit.

Q.1(b) Define average value of an A.C. **[2]**

Ans.: (i) Definition :

The average value (I_{av}) of an AC is represented by that direct current (DC) which will transfer the same amount of charge across any circuit while flowing through the same time as is transferred by the given ac.

(ii) Derivation :

(a) Let the sinusoidally varying and alternating current be expressed as $i = I_m \sin\theta$. Figure below represents one cycle of its waveform.

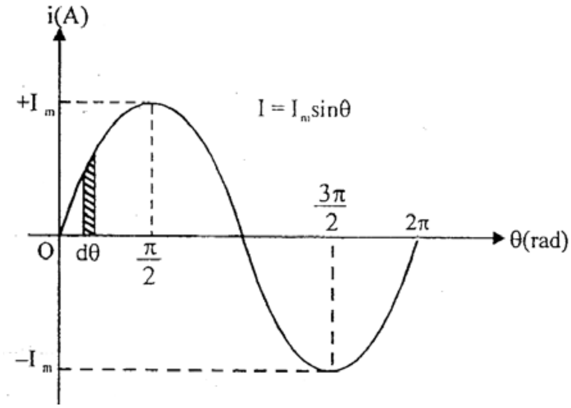


Fig.

(b) Consider an elemental strip with base = dθ. Let i be its height
- area of the strip = i.dθ
- the waveform is symmetrical i.e. + 1/2 cycle = –1/2 cycle,
- consider average value over 1/2 cycle only.

(c) Thus, average value = $I_{av} = \dfrac{\int_0^{\pi} i\,d\theta}{\pi} = \dfrac{I_m}{\pi}\int_0^{\pi} \sin\theta\,d\theta$

$$= \frac{I_m}{\pi}[-\cos\theta]_0^{\pi} = \frac{I_m}{\pi}[-\cos\pi - (\cos 0)]$$

$$= \frac{I_m}{\pi}[-(-1) - (-1)] = \frac{2I_m}{\pi}$$

$\therefore \quad I_{av} = \dfrac{2I_m}{\pi} = 0.637\ I_m$

[**Note :** in the case of a sinusoidally varying and alternating quantity only, Average value = 0.637 × max. value]

Q.1(c) State relation between phase and line current and voltages in a balanced star connection. **[2]**

Ans.: **For Star connected system**

$V_L = \sqrt{3}V_{PH}$ i.e. Line voltage = $\sqrt{3}$ phase voltage

$I_L = I_{ph}$ i.e. Line current = phase current

Q.1(d) What are the different types of power in AC circuit? Explain. **[2]**

Ans.: **There are three types of powers :**

(i) Active (Real or True) Power (P)

The active power is defined as the average power taken by or consumed by the given circuit.

OR

It is the product of V, I and cosine of the angle ϕ between V and I.

OR

It is the power developed in the resistance of the circuit. It is given by

$P = V.I. \cos \Phi$ (Unit: W OR kW)

$= I^2R$

Where Φ = Phase angle between V and I

(ii) Reactive Power (Q)

The reactive power is defined as the product of V, I and sine of the angle ϕ between V and I.

OR

It is the power developed in the reactance of the circuit. The reactive power is also called as imaginary power. It is given by

$Q = V.I. \sin \Phi = I^2 X_L$ (Unit: VAR OR kVAR)

(iii) Apparent Power (S)

Apparent power is defined as the product of rms values of voltage (v) and current (I). It is given by

$S = V.I. = I^2Z$ (Unit: VA OR kVA)

Q.1(e) Write emf equation of transformer and state the meaning of each term in it also state their units. **[2]**

Ans.: There are two emf equations of a transformer :

$E_1 = 4.44\, f\, \Phi m\, N_1$ volts

$E_2 = 4.44\, f\, \Phi m\, N_2$ volts

where,

E_1 = emf induced in primary winding of transformer in volts.

E_2 = emf induced in secondary winding of transformer in volts.

f = frequency of the applied electrical signal to the winding in Hertz.

Φ_m = maximum flux induced in the winding in webers.

N_1 = number of turns on primary winding.

N_2 = number of turns on secondary winding.

Q.1(f) Give classification of transformer on the basis of: **[2]**

(i) Construction **(ii) Supply system**
(iii) Power rating **(iv) Applications**

Ans.: **(i) Construction** : Core type, shell type, berry type transformer
(ii) Supply system : Single phase transformer, Three phase transformer
(iii) Power rating : VA and KVA
(iv) Applications : Distribution Transformer, Power Transformer, Current and Potential Transformer.

Q.1(g) Compare resistance split phase induction motor with capacitor start induction motor. **[2]**

Ans.:

	Resistance split phase I.M.	**Capacitor start I.M.**
(i)	To create the phase difference between current in the two windings, high resistance is connected in series with starting (auxiliary) winding.	To create the phase difference between current in the two windings, capacitor is connected in series with starting (auxiliary) winding.
(ii)	Split phase induction motors have moderate starting torque.	Capacitor start I. M. have high starting torque.
(iii)	So these motors are used in fans, blowers, centrifugal pumps, washing machine, grinder etc.	These motors have high starting torque hence they are used in conveyors, grinder, air conditioners, refrigerators, compressors etc.
(iv)	These motors are available in the size ranging from 1/20 to 1/2 KW.	They are available up to 6 KW.
(v)	Power factor is low.	Power factor is better.

Q.2 Attempt any THREE of the following : **[12]**

Q.2(a) Compare Electric and Magnetic Circuits. **[4]**

Ans.:

Basis	**Magnetic Circuits**	**Electric Circuits**
Definition	The closed path for magnetic flux is called magnetic circuit.	The closed path for electric current is called electric circuit.
Relation between flux and current	$\text{Flux} = \frac{\text{mmf}}{\text{reluctance}}$	$\text{Current} = \frac{\text{emf}}{\text{resistance}}$
Units	Flux φ is measured in weber (wb)	Current I is measured in amperes

MMF and EMF	Magnetomotive force is the driving force and is measured in Ampere turns(AT) Mmf = $\int H \cdot dI$	Electromotive force is the driving force and measured in volts (V) Emf = $\int E \cdot dI$
Reluctance and Resistance	Reluctance opposes the flow of magnetic flux S = $\frac{l}{a\mu}$ and measured in $\left(\frac{AT}{wb}\right)$	Resistance opposes the flow of current R = $\frac{\rho . l}{a}$ and measured in (Ω)
Relation between Permeance and Conduction	Permeance = $\frac{1}{\text{reluctane}}$	Conduction = $\frac{1}{\text{resistance}}$
Analogy	Permeability	Conductivity
Density	Flux density B = $\frac{\varphi}{a}\left(\frac{wb}{m2}\right)$	Current density J = $\frac{I}{a}\left(\frac{A}{m2}\right)$
Intensity	Magnetic intensity H = $\frac{NI}{l}$	Electric density E = $\frac{V}{d}$
Flux and Electrons	In magnetic circuit molecular poles are aligned. The flux does not flow, but sets up in the magnetic circuit.	In electric circuit electric current flows in the form of electrons.

Q.2(b) The equation of an alternating current is i = 62.35 sin 628t. **[4]**
Determine: (i) Frequency (ii) Time period
(iii) Maximum value (iv) Angular velocity

Ans.:

Given	**Required**
$i = 62.35 \sin(628t)$	f, t, I_m, ω

(1) $(I) f = \frac{w}{2\pi} = \frac{628}{2\pi} = 100$ c/s

(2) Time period = $\frac{1}{f} = \frac{1}{100} = 0.01\,s$

(3) Maximum value = 62.35 A (Given in equation)

(4) Angular Velocity = ω = 628 rad/sec (Given in equation)

Q.2(c) If a 3 phase 400 V, 50Hz, supply is connected to a balanced, 3 phase star connected load of impedance (3 + j6) ohm per phase. Calculate : **[4]**

(i) Phase current **(ii) Phase voltage**

(iii) Power factor **(iv) Total active power**

Given	Required
Star Connection $V_L = 400\,V, f = 50\,c/s, \bar{Z}_{ph} = (3 + j6)\,\Omega$	$V_{ph}, I_{ph}, p.f., P_T$

Ans.:

(1) $Z_{ph} = \sqrt{R^2 + X^2} = \sqrt{3^2 + 6^2} = \sqrt{9+36} = \sqrt{45} = 6.708\ \Omega$

(2) p.f. = $\cos\phi_{ph} = \dfrac{R_{ph}}{Z_{ph}} = \dfrac{3}{6.708} = 0.447$ (lagging)

(3) $V_{ph} = \dfrac{V_L}{\sqrt{3}} = \dfrac{400}{\sqrt{3}} = 230.94V$

(4) $I_{ph} = \dfrac{V_{ph}}{z} = \dfrac{230.94}{6.708} = 34.43A$

$\therefore\ I_L = I_{ph} = 34.43\ A$

(5) Active power $P_T = \dfrac{\sqrt{3}\,V_L I_L \cos\phi_{ph}}{1000}$

$= \dfrac{\sqrt{3} \times 400 \times 34.42 \times 0.45}{1000} = 10.66\ kW$

Q.2(d) A 50 KVA, 6600/250 V, 1 ϕ transformer has 52 secondary turns. Find: **[4]**

(i) No. of primary turns

(ii) Full load primary and secondary currents

Given	Required
$[KVA]_{FL} = 50,\ E_1 = 6600V,$ $E_2 = 250V, N_2 = 52$	$N_1, I_{1_{FL}}, I_{2_{FL}}$

Ans.:

(1) $\dfrac{E_2}{E_1} = \dfrac{N_2}{N_1}$

$\therefore\ \dfrac{250}{6600} = \dfrac{52}{N_1}$

$\therefore\ N_1 = 1372.8$

say 1373

(2) $I_{1_{FL}} = \dfrac{[KVA]_{FL} \times 1000}{E_1} = \dfrac{50 \times 1000}{6600} = 7.57A$

(3) $I_{2_{FL}} = \dfrac{[KVA]_{FL} \times 1000}{E_2} = \dfrac{50 \times 1000}{250} = 200A$

Q.3 Attempt any TWO of the following : [12]

Q.3(a) (i) Explain construction and working of autotransformer. [6]

(ii) Compare auto transformer with two winding transformer (any four).

Ans.: (i) Construction and working of autotransformer

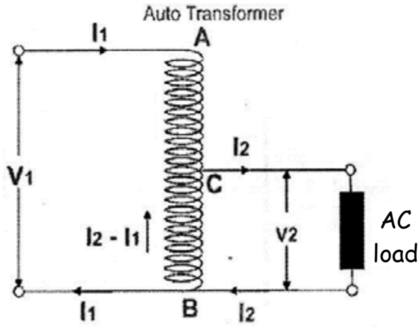


Fig. 1: Step Down auto transformer

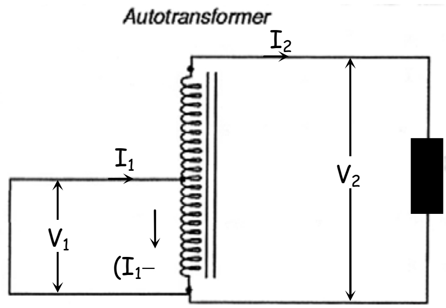


Fig. 2: Step Up auto transformer

An auto transformer has single winding which is used as primary and secondary winding. This winding is wound on laminated enameled magnetic core. As shown in fig. 1 the input is given to primary and output is taken from the part of the same winding. Thus the one winding serves as primary and secondary. This transformer is known as step down auto transformer.

As shown in fig. 2 the input is given to the part of winding and output is taken across the whole winding. So the part of winding acts as a primary winding and the whole winding acts as a secondary winding. With this construction we can step up the voltage. So this transformer known as step up auto transformer.

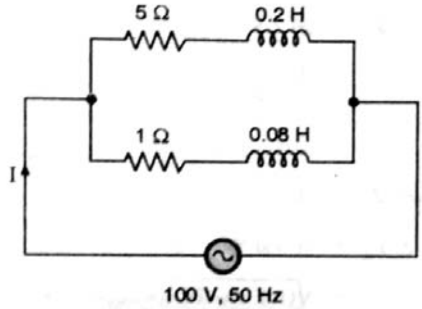
(ii) Compare auto transformer with two winding transformer

Parameter	Auto-transformer	Two-winding transformer
Number of windings	One winding common to both primary and secondary circuits	Two separate windings in primary and secondary circuits.
Volume	Less	More
Cost	Less	More
Efficiency	High	Low
Copper Loss	Less	More
Application	Variac, voltage boosters starting of a. c. motor	Power supply, isolation transformer
Weight	Less	More
Size	Small	Large
Voltage regulation	Better	Poor

Q.3(b) A coil having resistance of 5Ω and inductance of 0.2 H is arranged in parallel with another coil having resistance of 1Ω and inductance of 0.08 H. Calculate the current through the combination and power absorbed when a voltage of 100 V, 50 Hz is applied. Use impedance method. **[6]**

Ans.: **To find :** Current and power absorbed.

Step 1 : Draw the circuit diagram



Two coils

Coil 1 : $R_1 = 5\ \Omega$, $L_1 = 0.2$ H

Coil 2 : $R_2 = 1\ \Omega$, $L_2 = 0.08$ H

For coil 1

$X_1 = 2\pi f L_1 = 2\pi \times 50 \times 0.2 = 62.84\ \Omega$

$Z_1 = R_1 + jX_1 = 5 + j\,62.84 = 63.03 \angle 85.45^\circ\ \Omega$

For coil 2

$X_2 = 2\pi f L_2 = 2\pi \times 50 \times 0.08 = 25.13\ \Omega$

$Z_2 = R_2 + jX_2 = 1 + j\,25.13 = 25.15 \angle 87.72^\circ\ \Omega$

Step 2 : Calculate Z_{eq} and total current

$$Z_{eq} = \frac{Z_1 Z_2}{Z_1 + Z_2} = \frac{(63.03\angle 85.45^\circ)(25.15\angle 87.72^\circ)}{(63.03\angle 85.45^\circ) + (25.15\angle 87.72^\circ)}$$

$\therefore\ Z_{eq} = (17.98 \angle 87.07^\circ)\ \Omega$

Total current $$I = \frac{V}{Z_{eq}} = \frac{100\angle 0^\circ}{17.98\angle 87.07^\circ}$$

$I = 5.56 \angle -87.07^\circ$ Amp

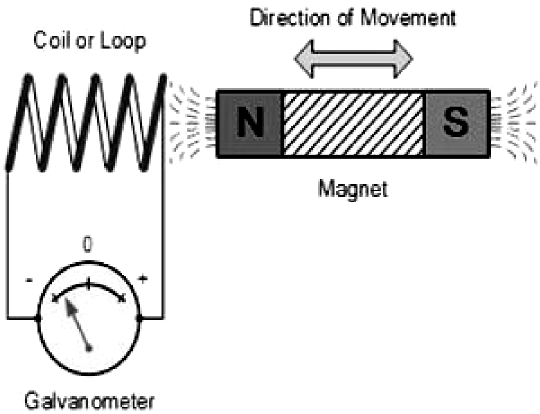
Step 3 : Calculate power absorbed

$P = V I \cos\phi = 100 \times 5.56 \times \cos(-87.07)$

Q.3(c) (i) Explain Faradays Law of Electromagnetic Induction. **[6]**

(ii) *Give the applications of Faradays Law of Electromagnetic Induction.*

Ans.: (i) Faradays Law of Electromagnetic Induction



Faraday's First Law

Any change in the magnetic field of a coil of wire will cause an emf to be induced in the coil. This emf induced is called induced emf and if the conductor circuit is closed, the current will also circulate through the circuit and this current is called induced current. Method to change magnetic field:

(i) By moving a magnet towards or away from the coil.
(ii) By moving the coil into or out of the magnetic field.
(iii) By changing the area of a coil placed in the magnetic field.
(iv) By rotating the coil relative to the magnet.

Faraday's Second Law

It states that the magnitude of emf induced in the coil is equal to the rate of change of flux that linkages with the coil. The flux linkage of the coil is the product of the number of turns in the coil and flux associated with the coil.

Consider, a magnet is approaching towards a coil. Here we consider two instants at time T_1 and time T_2. Flux linkage with the coil at time,

$T_1 = N\phi_1$ wb

Flux linkage with the coil at time,

$T_2 = N\phi_2$ wb

Change in flux linkage,

$N(\phi_2 - \phi_1)$

Let this change in flux linkage be,

$\phi = (\phi_2 - \phi_1)$

So, the Change in flux linkage

$N\phi$

Now the rate of change of flux linkage

$\frac{N\phi}{t}$

Take derivative on right hand side we will get the rate of change of flux linkage

$N\frac{d\phi}{dt}$

But according to Faraday's law of electromagnetic induction, the rate of change of flux linkage is equal to induced emf.

$E = N\frac{d\phi}{dt}$

Considering Lenz's Law.

$E = -N\frac{d\phi}{dt}$

Where,

flux Φ in Wb = B.A

B = magnetic field strength

A = area of the coil

Section – B

Q.4 Attempt any FIVE of the following : [10]

Q.4(a) Write down a colour code for the following resistors : [2]

(i) 270 Ω, ± 10%   (ii) 5.6 kΩ, ± 5%

Ans.: (i) Colour code for 270 Ω, ±10%

We know that 270 Ω = 27 × 10

In this case, the first significant digit is 2, second is 7 and the multiplying factor is 10.

(i.e. 27 × 10 = 270)

2	7	× 10	± 10%
↓	↓	↓	↓
Red	Violet	Brown	Silver

(ii) Colour code for 5.6 kΩ, ± 5%

We know that 5.6 kΩ = 56 × 100

In this case, the first significant digit is 5, second is 6 and multiplying factor is 100

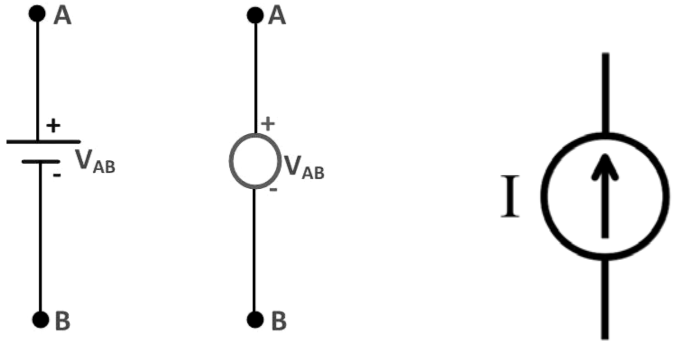
(i.e. 56 × 100)

5	6	× 100	± 5%
↓	↓	↓	↓
Green	Blue	Red	Gold

Thus the colour code for 5.6 kΩ, ± 5% resistor is green, blue, red and gold.

Q.4(b) What is voltage source and current source? [2]

Ans.: A voltage source is a two-terminal device which can maintain a fixed voltage. An ideal voltage source can maintain the fixed voltage independent of the load resistance or the output current. However, a real-world voltage source cannot supply unlimited current.



A current source is an electronic circuit that delivers or absorbs an electric current which is independent of the voltage across it.

Q.4(c) Compare RC and LC Filters. [2]

Ans.:

	RC Filters	LC Filters
(i)	Power loss is more.	Power loss is less.
(ii)	Ripple factor is high.	Ripple factor is low.
(iii)	Voltage regulation is poor.	Voltage regulation is good.
(iv)	It is only useful for small load current.	It is useful for heavy load current.
(v)	It is costlier.	It is cheaper.
(vi)	It also requires ventilation to conduct away the heat produced in the resistor.	It does not require any ventilation as heat is not produced in the inductor.

Q.4(d) Why Bridge Rectifier is the most widely used full-wave rectifier? [2]

Ans.: The bridge rectifier is the most widely used full-wave rectifier because of the following reasons :

(i) It does not require centre-tapped secondary winding transformer. If stepping up or stapping down of voltage is not required, then we may even achieve rectification without the transformer.

(ii) The PIV of each diode is equal to the peak secondary voltage V_m. This fact is of vital importance when higher DC voltages are required.

(iii) The TUF is very high. This leads to maximum conversion of AC power to DC power.

Q.4(e) What is Bipolar Junction Transistor? [2]

Ans.: Bipolar Junction Transistor :

- Diode circuits are useful in switching and waveshaping. However, diodes are not capable of amplifying currents or voltages.
- The electronic device that is capable of current and voltage amplification is the TRANSISTOR.
- There are two major types of transistor.
  (i) Bipolar Junction Transistor (BJT)
  (ii) Field-effect Transistor (FET)

Q.4(f) Given : β = 150, i_B = 15 μA and transistor is biased in the forward-active mode. To find : i_C = ?, i_E = ?, α = ? [2]

Ans.:

$i_C = \beta\, i_B = 150\,(15\,\mu A) = 2.25 mA$

$i_E = (1+\beta)\, i_B = (151)\,(15\,\mu A) = 2.27 mA$

$\alpha = \frac{\beta}{1+\beta} = \frac{150}{151} = 0.9934$

Q.5 Attempt any THREE of the following : [12]

Q.5(a) What are applications of LED? [4]

Ans.: Applications of LED :

(i) It is used in 7-segment, 16-segment and dot matrix displays which are used to indicate alphanumeric characteristics and symbols in various systems such as digital clocks, calculators, stereo tuners, microwaves ovens etc.
(ii) It is used for indicating power ON/OFF conditions, power level indicators or stereo amplifiers.
(iii) It is used in optical switching applications.
(iv) It is used in optical communication systems.
(v) It can be used as solid state video displays in place of CRTs.
(vi) It is used for checking the linearity, speed etc. of opto-electronic detection circuits.
(vii) It is used to indicate digital logic state.
(viii) It is used in image sensing circuits in videophones.
(ix) It is used to monitor/indicator voltage levels or polarities.
(x) It is used in burglar alarm systems.

Q.5(b) Define : [4]

(i) Peak Inverse Voltage (PIV)
(ii) Ripple factor
(iii) Rectification efficiency
(iv) Transformer Utilization Factor (TUF)

Ans.: (i) Peak Inverse Voltage (PIV)

The maximum value of reverse voltage that a diode can withstand without destroying its P-N junction during the non-conduction period is called peak inverse voltage. The diode should be so chosen as to withstand this reverse voltage.

(ii) Ripple factor

The ripple factor of a rectifier is a ratio of r.m.s. value of the alternating components in the load to the DC components in the load of a rectifier. It is denoted by a letter V which is defined as :

$$r = \frac{\text{RMS value of AC components in the load}}{\text{Average or d.c. components in the load}} = \sqrt{\left(\frac{I_{rms}}{I_{dc}}\right)^2 - 1}$$

It is an indication of how successful is a rectifier circuit in converting AC to DC. The ripple factor of half-wave and full-wave rectifier is 1.21 and 0.482 respectively. Thus, ripple factor is a measure of purity of the DC output of a rectifier.

(iii) Rectification efficiency

The rectification efficiency of a rectifier is a ratio of the DC power output delivered to the load to the AC power input supplied to the rectifier circuit. It is denoted by a latter t|, which is defined as

$$\eta = \frac{\text{DC power output}}{\text{AC input power from transformer secondary}}$$

It is a figure of merit (a measure of efficiency) to compare different rectifiers. The maximum rectification efficiency of half-wave and full wave rectifier is 40.6% and 81.2% respectively.

(iv) Transformer Utilization Factor (TUF)

It is the ratio of DC power delivered to the load to the AC rating of the transformer secondary. It is denoted as TUF and is defined as :

$$\text{TUF} = \frac{\text{DC power de livered to the load}}{\text{AC rating of the transformer secondary}}$$

The TUF for a halfwave rectifier is 0.287 whereas for centre-tap and bridge rectifier is 0.693 and 0.812 respectively.

Q.5(c) Write short note on BJT Construction. [4]

Ans.: BJT

- The bipolar junction transistor (BJT) has three separately doped region and contains two pn junctions.

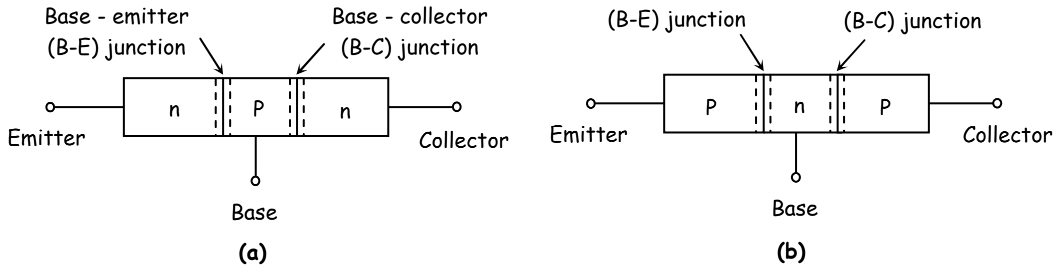


Fig.: Simple geometry of bipolar transistors : (a) npn and (b) pnp

- A single pn junction has two modes of operations viz forward bias and reverse bias (Recall operation of pn junction diode)
- The BJT, with two pn junctions; Base-emitter (B-E) junction and Base-collector (B-C) junction has four possible modes of operation as shown below.

B–E Junction	B-C Junction	Region of Operation
Reverse biased	Reverse biased	Cut-off region
Forward biased	Reverse biased	Forward active region
Forward biased	Forward biased	Saturation region
Reverse biased	Forward biased	Inverse active

- The three separately doped regions and their terminal connections are called the emitter, base and collector.
- The geometries and impurity doping concentrations of all three regions are different :
  (a) Emitter : This region is heavily doped (10^{18} impurities /cc)
  (b) Base : This region is lightly doped (10^{15} impurities /cc). The width of the base region is narrow. This is to enhance diffusion in the base and to reduce the recombination rate.
  (c) Collector : This region is medium doped (10^{16} impurities /cc) and has large surface area to handle large amount of power.
- The basic transistor principle is that the voltage between two terminals controls the current through the third terminal.
- **Why bipolar?**
  Current in the transistor is due to the flow of both electrons and holes, hence the name bipolar.
  If current in the transistor is due to the flow of only majority carriers then the transistor is called as “unipolar” transistor.
  Example : FET

Types of BJT

(i) npn bipolar transistor

(ii) pnp bipolar transistor

- In npn, a thin p-region is sandwiched between two n-regions. In contrast, pnp bipolar transistor contains a thin n-region sandwiched between two p-regions.

Q.5(d) Compare CB, CE, CC configuration of Transistor. [4]

Ans.:

	Parameter	**CB**	**CE**	**CC**
(i)	Common terminal between inputs and outputs	Base	Emitter	Collector
(ii)	Input current	I_E	I_B	I_B
(iii)	Output current	I_C	I_C	I_E
(iv)	Current gain	$\alpha = \frac{I_C}{I_B}$	$\beta = \frac{I_C}{I_B}$	$\gamma = \frac{I_E}{I_B} = (1 + \beta_{dc})$
(v)	Input Voltage	V_{EB}	V_{BE}	V_{BC}
(vi)	Output Voltage	V_{CB}	V_{CE}	V_{EC}
(vii)	Input resistance	Very low (20Ω)	low (1kΩ)	High (500kΩ)
(viii)	Output resistance	Very high (1MΩ)	High (40kΩ)	Low (50Ω)
(ix)	Application circuit	As preamplifier constant current source	Audio amplifier (voltage amplifier)	For impedance matching (Buffer)

Q.6 Attempt any TWO of the following : [12]

Q.6(a) What are the advantages of Integrated Circuits and What are the limitations of ICs? [6]

Ans.: The integrated circuits offer a number of advantages over conventional discrete circuits. Some of the important advantages are as given below :

(i) The physical size of an IC is extremely small (generally thousand times smaller) than that of discrete circuits.

(ii) The weight of an IC is very less as compared to that of an equivalent discrete circuits.

(iii) The reduction in circuit cost has become possible due to the processing of large quantities of identical ICs fabricated simultaneously on a single chip, i.e., batch processing.

(iv) The extremely high reliability is possible due to elimination of soldered connections and all components are fabricated simultaneously on a single chip.
(v) The improved functional performance is achieved because it is possible to fabricate even complex circuits for better functional characteristics.
(vi) The reduction in power consumption is achieved due to extremely small size of IC.
(vii) The response time and the operating speed is increased due to the absence of parasitic capacitance effect.
(viii) The suitability for small signal operation has become possible because the components are located very close to each other, which reduces the chances of stray electrical pick up.
(ix) Interconnection errors are non-existent in practice.
(x) Temperature differences between components of a circuit are small.
(xi) Close matching of components and temperature coefficients is possible.
(xii) In case of circuit failure, it is very easy to replace an IC by a new one.
(xiii) Active devices can be generously used as they are cheaper than passive components.

Limitations of ICs :

The integrated circuits suffer from some of the following limitations :
(i) Inductors cannot be fabricated directly.
(ii) It is neither convenient nor economical to fabricate capacitors and resistors exceeding 30 pF and 100 kΩ respectively. Thus, capacitors and resistors are limited in maximum value.
(iii) Low tolerances on capacitors and resistors and also small temperature coefficient are difficult to obtain.
(iv) It is not possible to fabricate high grade PNP unit very easily.
(v) It is not possible to eliminate the undesired parasitic elements completely due to the fact that the desired elements are to be isolated from each other.
(vi) Resistor and capacitor value are often dependent on voltage.
(vii) Low noise and high voltage operation are not easily obtained.
(viii) The transistors have large saturation resistance.
(ix) The power dissipation is limited to 10 watts.
(x) Being quite delicate, it cannot withstand rough handling or excessive heat.

Q.6(b) Compare Half And Full Wave Rectifiers. **[6]**

Ans.: A full-wave rectifier is preferred to a half-wave rectifier because its rectification efficiency is twice and its ripple factor is low. A bridge rectifier is most widely used full wave rectifier because its PIV is one-half and its transformer utilization factor is high that of centre-tap rectifier. For low DC voltage, the centre-tap full wave rectifier is preferred to a bridge rectifier because it has good voltage regulation for low voltages.

The comparison between different rectifiers is given below :

Rectifier Parameters	**Half-wave**	**Full-wave**	
		Centre-tap	**Bridge**
Number of diodes	1	2	4
Transformer necessity	No	Yes	No
Peak secondary voltage, v_s	V_m	V_m	V_m
Peak Inverse voltage	V_m	$2V_m$	V_m
Peak load current, I_m	$\frac{V_m}{(R_f + R_L)}$	$\frac{V_m}{(R_f + R_L)}$	$\frac{V_m}{(2R_f + R_L)}$
RMS current, I_{rms}	$\frac{I_m}{2} = 0.5 I_m$	$\frac{I_m}{\sqrt{2}} = 0.707 I_m$	$\frac{I_m}{\sqrt{2}} = 0.7071 I_m$
DC current, I_{dc}	$\frac{I_m}{\pi} = 0.318 I_m$	$\frac{2I_m}{\pi} = 0.636 I_m$	$\frac{2I_m}{\pi} 0.636 I_m$
Ripple factor , r	1.21	0.482	0.482
Form factor, F	1.57	1.11	1.11
Maximum rectification efficiency, η_{max}	40.6%	81.2%	81.2%
Transformer utilization factor (TUF)	0.287	0.693	0.812
Ripple frequency, f_r	fi	$2f_i$	$2f_i$

Q.6(c) (i) Short note on CE configuration and CE gain β **[6]**

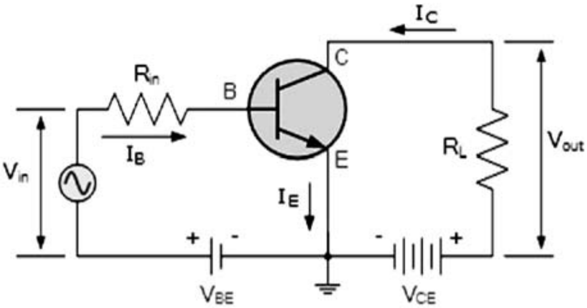
(ii) Relation between α and β.

Ans.: (i) The Common Emitter (CE) Configuration

In the Common Emitter or grounded emitter configuration, the input signal is applied between the base and the emitter, while the output is taken from between the collector and the emitter as shown. This type of configuration is the most commonly used circuit for transistor based amplifiers and which represents the "normal" method of bipolar transistor connection.

The common emitter amplifier configuration produces the highest current and power gain of all the three bipolar transistor configurations. This is mainly because the input impedance is LOW as it is connected to a forward biased PN-junction, while the output impedance is HIGH as it is taken from a reverse biased PN-junction.

The Common Emitter Amplifier Circuit



In this type of configuration, the current flowing out of the transistor must be equal to the currents flowing into the transistor as the emitter current is given as $I_E = I_C + I_B$.

As the load resistance (R_L) is connected in series with the collector, the current gain of the common emitter transistor configuration is quite large as it is the ratio of I_C/I_B. A transistors current gain is given the Greek symbol of Beta, (β).

As the emitter current for a common emitter configuration is defined as $I_E = I_C + I_B$, the ratio of I_C/I_E is called Alpha, given the Greek symbol of α. Note: that the value of Alpha will always be less than unity.

Since the electrical relationship between these three currents, I_B, I_C and I_E is determined by the physical construction of the transistor itself, any small change in the base current (I_B), will result in a much larger change in the collector current (I_C).

(ii) Relation between α and β.

By combining the expressions for both Alpha, α and Beta, β the mathematical relationship between these parameters and therefore the current gain of the transistor can be given as:

$$\text{Alpha } (\alpha) = \frac{I_C}{I_E} \quad \text{and} \quad \text{Beta } (\beta) = \frac{I_C}{I_B}$$

$$\therefore \quad I_C = \alpha.I_E = \beta.I_E$$

$$\text{as} \quad \alpha = \frac{\beta}{\beta+1} \qquad \beta = \frac{\alpha}{1-\alpha}$$

$$I_E = I_C + I_B$$

where: "I_C" is the current flowing into the collector terminal, "I_B" is the current flowing into the base terminal and "I_E" is the current flowing out of the emitter terminal.

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