DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Subject Name:**Basic Electrical And Electronics Engineering** **Subject Code**: **T104**

PART A-ELECTRICAL

UNIT 1-DC CIRCUITS

Definition of Voltage, Current, Power & Energy, circuit parameters, Ohm's law, Kirchoff's law & its applications- Simple Problems - Division of current in Series & parallel circuits - star/delta conversion - Node and mesh methods of analysis of DC circuits.

UNIT II-AC CIRCUITS

Concepts of AC circuits - rms value, average value, form and peak factors - Simple RLC series circuits - Concept of real and reactive power - Power factor - Introduction to three phase system - Power measurement by two wattmeter method.

UNIT-III-ELECTRICAL MACHINES AND POWER PLANTS

Faraday’s law of Electromagnetic induction, Fleming's Right & Left hand rule - Principle of DC rotating machine, Single phase transformer and single phase induction motor (Qualitative approach only) - Simple layout of thermal and hydro generation (block diagram approach only). Fundamentals of fuses and circuit breakers

PART B - ELECTRONICS

UNIT -IV ELECTRONIC CIRCUITS

V-I Characteristics of diode - Half-wave rectifier and Full-wave rectifier - with and without capacitor filter - Transistor - Construction & working - Input and output characteristics of CB and CE configuration - Transistor as an Amplifier - Principle and working of Hartley oscillator and RC phase shift oscillator - Construction and working of JFET & MOSFET.

UNIT-V DIGITAL ELECTRONICS

Boolean algebra - Reduction of Boolean expressions - De-Morgan's theorem - Logic gates - Implementation of Boolean expressions - Flip flops - RS, JK, T and D. Combinational logic - Half adder, Full adder and Subtractors.Sequential logic - Ripple counters and shift registers.

UNIT-VI COMMUNICATION AND COMPUTER SYSTEMS

Model of communication system - Analog and digita! - Wired and wireless channel. Block diagram of various communication systems - Microwave, satellite, optical fiber and cellular mobile system.Network model - PAN, LAN, MAN and WAN - Circuit and packet switching - Overview of ISDN.

UNITI
DC CIRCUITS

Definition of Voltage, Current, Power & Energy, circuit parameters, Ohm's law, Kirchoff's law & its applications – Simple Problems - Division of current in Series & parallel circuits - star/delta conversion - Node and mesh methods of analysis of DC circuits.

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2 Marks

1. State ohm's law.

At constant temperature, the current flowing through a conductor is directly proportional to the potential difference across the ends of the conductor.

V α I (or) V = I * R.

Where **R** is the resistance of the conductor in ohm.

2. Define current.

The rate of flow of charge (Free electron) is called as current. Current is represented by **'I'**. Its unit is Ampere **(A).**

3. Define Voltage or emf.

Voltage or electro motive force (emf) represents the electric pressure or potential difference between two ends of the conductor that tends to create an electron flow.

Voltage is represented by '**V' (or) 'E'**. Its unit is volt.

4. Define potential difference.

The work done in moving a coulomb of charge between the two points is called the potential difference. It is measured in volt.

5. Define power.

Power is the rate of doing work and its unit is Watt (or) Joule per second. It is the product of current and voltage.

P = V x I (DC Circuits)

6. Define electrical energy.

The total work done in an electric circuit is called electrical energy. It is the product of power and time for which current flows through a circuit. Its unit is Joules (or) Watt-sec

Energy = P x t = V x I x t = I x R x t

ONE electrical unit = 1 kWh

7. State Kirchhoff's current law. (KCL)

It states that the algebraic sum of the currents meeting at any junction is zero.

(Or) It can be also stated that the sum of current entering the junction is equal to the sum of current leaving the junction.

$$I_1 + I_2 = I_3 + I_4$$

8. Define Active element.

Active elements are those which supplies voltage or current to the circuit to operate it. It can be either voltage or current source. Examples: Generator, Transistor, Vacuum Tubes, etc.

9. State Kirchhoff's voltage law. (KVL) (JAN 2014, JAN 2010, APRIL 2010,APRIL 2011,NOV /DEC 2011)

It states that in a closed circuit the algebraic sum of the product of the current and resistance of all the elements plus the algebraic sum of the EMFs induced in the circuit is equal to zero.

(Or) It can be stated that the sum of the Potential drop is equal to the sum of the Potential rise.

Σ IR + Σ emf = 0 (for DC circuits) or **Σ IZ + Σ emf = 0** (for AC circuits)

Where, R-Resistance

Z- Impedance.

10. Define Passive element.

Passive elements are defined as the one which either dissipates energy in the form of heat or one which stores the energy.

Examples: **Resistance** dissipates energy in the form of heat

Inductance stores energy in the form of magnetic field.

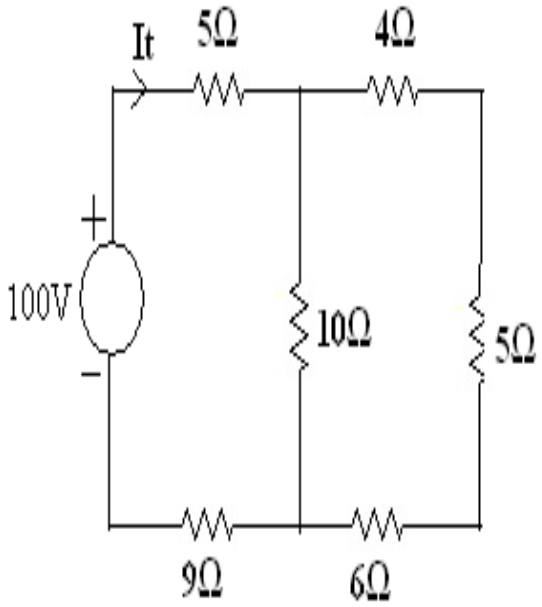
Capacitance stores energy in the form of electrostatic field.

11. Differentiate between AC and DC supply.

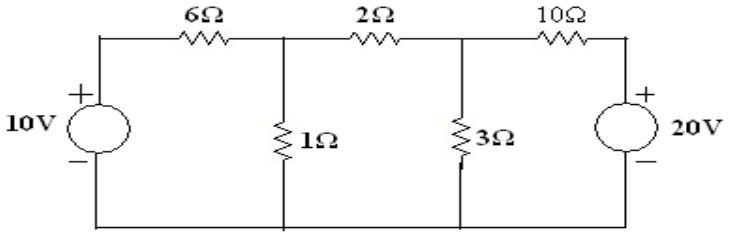
Sl. No.	AC supply	DC supply
1	Its magnitude varies with time	Here the magnitude is constant with respect to time
2	It has a constant frequency or variable frequency	Generally it has zero frequency
3	It is bidirectional in nature	It is unidirectional
4.	AC cannot be stored	DC can be stored Eg:Battery

9 Marks

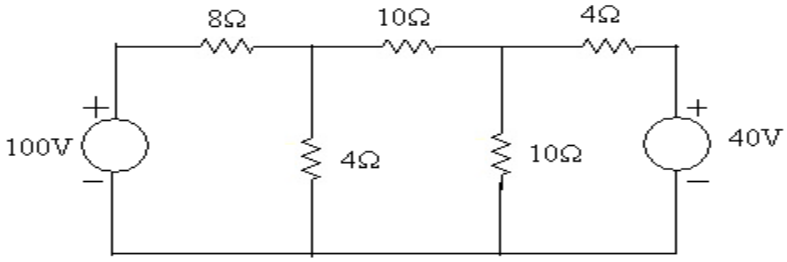
1) a) Derive the effective resistance for series circuit.(4)(MAY 2014.)
b) For the circuit shown in figure. Calculate equivalent resistance of the circuit and the total circuit current. (5)



2) Find the current through 2Ω resistor in the network using node voltage analysis. (9)(MAY 2014.)



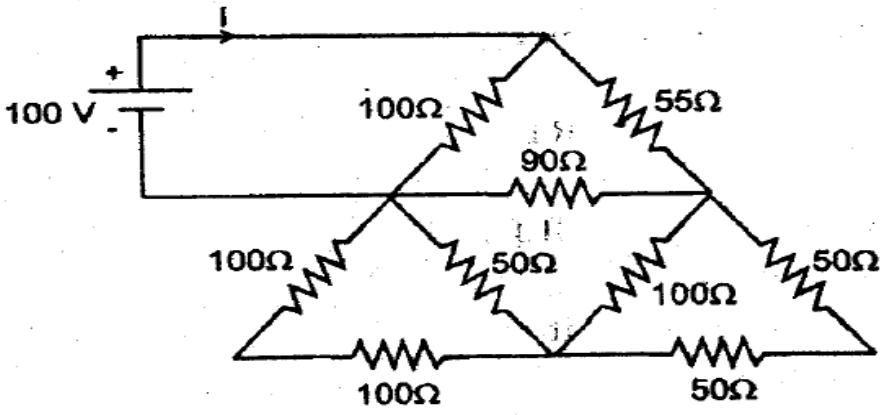
3) a) Derive the expression for the equivalent resistance of three resistance connected in parallel. (4)
4) b) Derive the expression for the delta to star transformation for three resistors. (5) (JAN2014)
5) Write mesh equation of the network by inspection and find the power absorbed by 8Ω resistor.(9)(JAN 2014)
6)



a) State and explain Kirchhoff's laws
b) Two resistors 4Ω and 6Ω are connected in parallel. If the total current is 12A, find the current through each resistor.(MAY 2013)

7) A series RL circuit has R=20Ω and L=0.05H and is connected to 250V, 50Hz supply. Calculate,(MAY 2013)
a)Current
b)Power Factor
c)Real Power

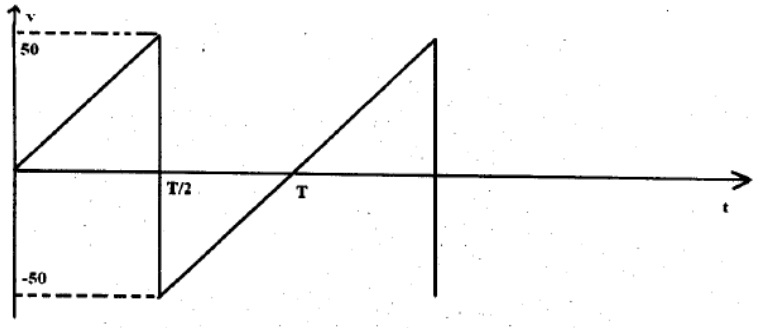
8) Determine the total current taken from the source. (JAN 2013) (9)



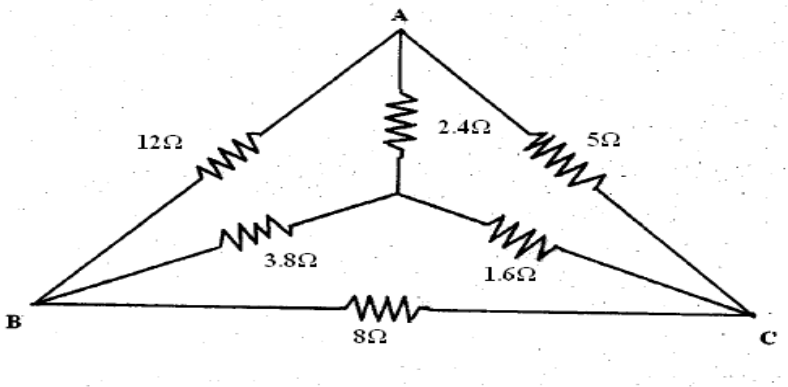
9) A coil having a resistance of 7Ω and an inductance of 31.8mH is connected to 230V, 50Hz supply. Calculate the circuit, power factor and power consumed.(JAN 2013)

10) A resistor is connected in series and a parallel combination of two resistors of 24 ohm and 8ohm. The power dissipated in the circuit is 64W, when the applied voltage is 24V. Calculate R. (9) (MAY 2012.)

11) Obtain the average value, RMS value, form factor and peak factor of the voltage waveform given below. (MAY 2012.) (9)

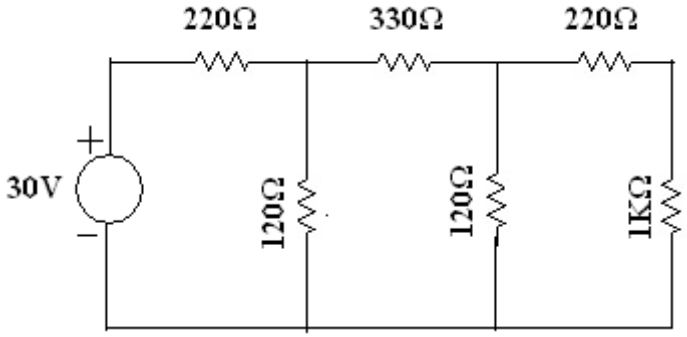


12) Find the equivalent resistance between B and C (9) **(**NOV/DEC 2012**.)**



13) 12. A choke coil takes a current of 2.5A when connected across 250V main and consumes 400W. Find a) the power factor b) resistance of the coil c) inductance of the coil d) apparent power e) reactive power (9) **(**NOV/DEC 2012**.)**

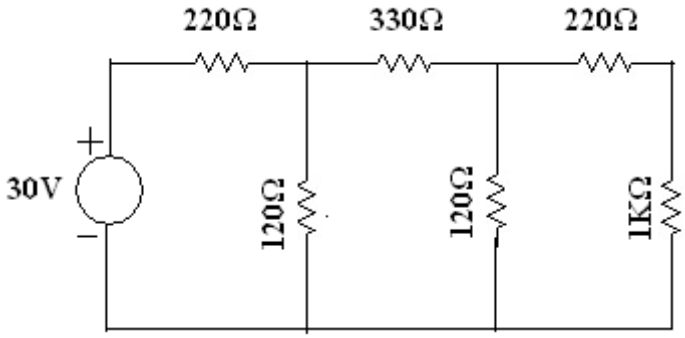
14) Prove Kirchhoff's current law at the node 'A' and Kirchhoff's voltage law in the first loop from left in the circuit show in figure 1. (9) (APR 2011)



15) With an Example explain the node and mesh analysis. (9) **(**NOV/DEC 2012**.)**

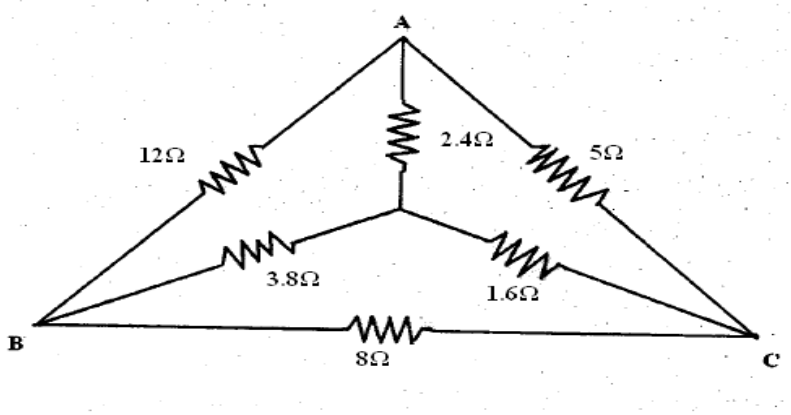
16) a) Explain node analysis with an example. (6) (APR 2011)
b) Write short notes on active and passive Elements. (3)

17) Prove Kirchhoff's current law at the node 'A' and Kirchhoff's voltage law in the first loop from left in the circuit show in figure 1. (9)(APR 2011)



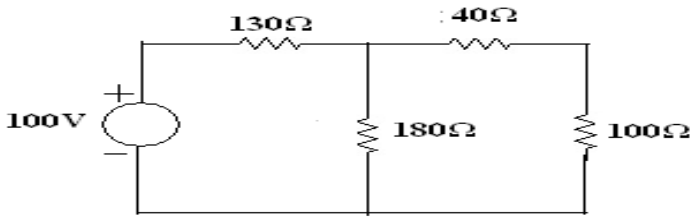
18) A resistance of 100Ω is connected in series with a 50μF capacitor to a supply at 200V, 50Hz. Find the a) impedance, current, power factor and the phase angle b) the voltage across resistor and capacitor. Also draw the phasor diagram.(9)(JAN 2011)

19) Find the equivalent circuit between B and C (9) (JAN 2011)

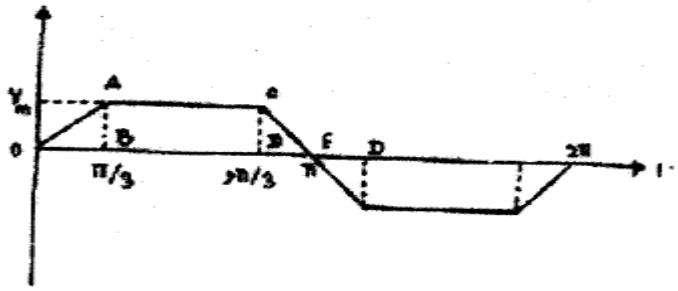


20) An inductive coil takes 10A and dissipates 1000W when connected to a supply at 250V, 25Hz.. Calculate the impedance and the effective resistance, the reactance, the inductance and the power factor. (9) (JAN 2011)

21) In the circuit shown in figure, find the value of current through 100Ω (9) (APR 2010)



22) Find the average, RMS, Form factor and peak factor of the following waveform. (9) (APR 2010)



23) Define RMS value, average value and form factor. Derive the rms value of pure sine wave. (9) (JAN 2010)

UNIT – II
AC CIRCUITS

Concepts of AC circuits – rms value, average value, form and peak factors – Simple RLC series circuits – Concept of real and reactive power – Power factor - Introduction to three phase system - Power measurement by two wattmeter method.

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2 Marks

1. What is the expression for 3-phase power?

$$\mathbf{P = 3\ V_\Phi\ I_\Phi\ Cos\ \Phi\ Watts}$$

Where, V_Φ – is the phase voltage

I_Φ – is the phase current

Φ – Phase angle between V & I

(Or)

$$\mathbf{P = \sqrt{3}\ V_L\ I_L\ Cos\ \Phi\ Watts}$$

Where, V_L – is the line voltage

I_L – is the line current

Φ – Phase angle between V & I

2. What are line and phase voltages and what is the relation between them?

Line-Line voltage or simply line voltage is defined as the voltage between any two lines of a 3-phase system. It is represented by E_L. Various line voltages are E_{RY}, E_{YB}, and E_{BR}.

Phase voltage is defined as the voltage between one line and the neutral wire of a star connected system. It is represented by E_p. Various phase voltages are E_{RN}, E_{YN}, and E_{BN}.

In Delta Connected System, Line voltage = Phase Voltage ($E_L = E_P$)

In Star Connected System, Line voltage = $\sqrt{3}$ Phase Voltage ($E_L = \sqrt{3}E_P$)

3. What are line and phase currents and what is the relation between them?

Line current is one which that flows in the 3 lines. It is represented by E_L. Various line currents are I_R, I_Y, and I_B.

Phase current is one which that flows between any two phases. It is represented by I_P. Various phase currents are I_{RY}, I_{YB}, and I_{BR}.

In Delta Connected System, Line current = $\sqrt{3}$ Phase current ($I_L = \sqrt{3}\ I_P$)

In Star Connected System, Line current = Phase current ($I_L = I_P$)

4. What are the advantages of 2-wattmeter method of power measurement over the 3-wattmeter method?

1. Number of wattmeter required is less. i.e. only two instead of three.
2. Since number of wattmeter is reduced the losses due to the wattmeter coils is less and hence the accuracy is more.
3. Power factor of the system can also be determined using 2-wattmeter method.

5. What is the difference between single-phase and three-phase AC supply?

Sl. No.	Single phase AC supply	Three phase AC supply
1	It has one conductor	It has three conductors
2	Low power applications	Huge power applications
3	It has two lines Phase(P) and Neutral line(N) for return path	It has three or four lines. ➢ R-Red ➢ Y-Yellow ➢ B-Blue ➢ N-Neutral ➢ In a three wire system for current flow in R phase Y & B acts as the return path and so on. ➢ Four wire system which includes Neutral is found in star connected systems

6. Define balanced load

A load is said to be a balanced load, if the power factor and phase current in the 3-phase are equal.

7. What is phase sequence?

The order in which voltage in the three phases reach their maximum value or minimum value is called the phase sequence

8. Give advantage of 3 phase system over single phase system.

a) In a three phase circuit, the total power is more uniform unlikely, in a single phase circuit the power varies widely.
b) Generation, transmission and distribution of power is more economical in three phase system compared to single phase system.
c) Three phase machines have better power factor and efficiency.

9. Define leading and lagging angle

Leading angle: The leading quantity is one which reaches its maximum or minimum value earlier as compared to the reference quantity. **The angular difference between reference vector and leading vector.**

Lagging angle: The lagging quantity is one which reaches its maximum or minimum value after the reference quantity. **The angular difference between reference vector and lagging vector.**

10. Define one cycle.

One complete set of +ve and –ve values of a alternating quantity is defines as one cycle.

11. Define Time period.

The time required for an alternating quantity to complete one cycle is defines as the time period. It is denoted by 'T'.

12. Define Frequency.

The number of cycles per second is defined as frequency. It is denoted by 'f'. Its unit is Hz (Hertz) or cps (cycles per second).

13. Define Amplitude or peak value or crest value.

The maximum value of the alternating quantity in a cycle is defined as amplitude. It is otherwise known as peak value or crest value.

14. Define Phase difference.

When two alternating quantity of same frequency have different zero points or maximum points, they are said to be out of phase. i.e. they have phase difference between them.

15. Define instantaneous values.

The value of alternating quantity at any instant is called instantaneous values.

16. Define average value.(JAN 2014)

It is defined as the average of instantaneous values taken over one complete cycle of the wave.

$$I_{avg} = \frac{i_1^2+i_2^2+\cdots+i_n^2}{n}$$

17. Define RMS (Root mean square) value..(APRIL 2011)

The steady current (DC) which when flows through a given resistor for a given time produces the same amount of heat as is produced by the alternating current when flowing through the same resistor for the same time is call RMS or Effective value of the alternating current.

$$\mathbf{I_{RMS}} = \sqrt{\frac{i_1^2+i_2^2+\cdots+i_n^2}{n}}$$

18. Define Form factor.(MAY 2013,NOV /DEC 2011)

Form factor is defined as the ratio of RMS value to average value of an alternating quantity.

$$\textbf{Form Factor, } \mathbf{K_f} = \frac{RMSValue}{AverageValue}$$

19. Define Peak factor.(JAN 2010.JAN 2012, APRIL/ MAY 2012)

Peak factor is defined as the ratio of Peak value to RMS value of an alternating quantity. It is also known as Amplitude or Crest factor.

$$\textbf{Peak Factor, } \mathbf{K_a} = \frac{PeakValue}{RMSValue}$$

20. Define Real power (P).(APRIL 2011)

Real power is defined as the actual power consumed in an AC circuit. It is denoted by P. Its unit is watt.

$$\mathbf{P = V\ I\ Cos\Phi\ watt}$$

Where, V – RMS value of the voltage

I – RMS value of the current

Φ – Phase angle between V & I

21. Define Reactive power (Q).(JAN 2011)

Reactive power is defined as the power consumed by the pure reactance (Either inductive or capacitive or both) in the AC circuit. It is denoted by Q. Its unit is Volt Ampere Reactive (VAR)

Q = VI SinΦ VAR

Where, V – RMS value of the voltage

I – RMS value of the current

Φ – Phase angle between V & I

22. Define Apparent power (S)

Apparent power is defined as the total power consumed in the AC circuit. It is given by the sum of Real and Reactive power. It is denoted by S. Its unit is Volt Ampere.

S = P + j Q (or) S = V I

Where, P – Real Power

Q – Reactive power

V – RMS value of the voltage

I – RMS value of the current

23. Define power factor (P.F)(APRIL 2010)

Power factor is defined as the Cosine of the angle between the input voltage and input current. P.F = Cos Φ

(Or) It is defined as the ratio of real power to apparent power. **P.F. =** $\frac{Real power}{Apparent power}$

It is given by P.F. = $\frac{R}{Z}$

9 Marks

1) **A coil having a resistance of 7Ω and an inductance of 31.8mH is connected to 230V, 50Hz supply. Calculate the circuit, power factor and power consumed.(JAN 2013)**

Given:

R=7Ω

L= 31.8 mH =$31.88*10^{-3}$ = 0.0318 H

V=230 V

f = 50 Hz

To find

Current, I=?

Power factor, p.f =?

Power = ?

Solution

I = V/Z

w.k.t,

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

$= \sqrt{(7^2 + {X_L}^2)}$

$X_L = 2\Pi fL = 2\Pi(50)(0.0318) = 9.98\Omega$

$Z = \sqrt{(7^2 + 9.98^2)}$

$=12.19\Omega$

I =V/Z = 230/12.19

I =18.86A

Power factor,

$\Phi = \tan^{-1}(X_L/R)$

$= \tan^{-1}(9.98/7)$

$\Phi = 54.95^o$

p.f = cosΦ

$= \cos(54.95^o)$

p.f = 0.57 (lag)

Average Power = |V||I| cosΦ

= 230* 18.86* 0.57

Average Power =2472.54 W

2) **A series RL circuit has R=20Ω and L=0.05H and is connected to 250V, 50Hz supply. Calculate,(MAY 2013)**

a)Current
b)Power Factor
c)Real Power

Given:

R=20Ω
L= 0.05H
V=250 V
f = 50 Hz

To find

Current, I=?
Power factor, p.f =?
Real Power = ?

Solution

I = V/Z
w.k.t,

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

$= \sqrt{(20^2 + 15.7^2)}$

$X_L = 2\Pi fL = 2\Pi(50)(0.05) = 15.7\Omega$

$Z = \sqrt{(20^2 + 15.7^2)}$

$= 25.42\Omega$

$I = V/Z = 250/25.42$

I =9.83A

Power factor,

$\Phi = \tan^{-1}(X_L/R)$

$= \tan^{-1}(15.7/20)$

$\Phi = 38.13^o$

$p.f = \cos\Phi$

$= \cos(38.13^o)$

p.f = 0.786 (lag)

Active Power=Real Power

Real Power = |V||I| cosΦ
= 250* 9.83* 0.786

Average Power =1931.5 W

3) **A resistor of 20Ω and an inductor of 0.2H and a capacitor of 100μF are connected in series across 220V, 50Hz supply. Determine,(MAY 2014.)**
Impedance (2)
Current(2)
Power Factor(2)
Active Power(2)
Reactive Power(1)

Solution:

R = 20Ω
L = 0.2H
C = 100μF
V = 220V, f = 50Hz

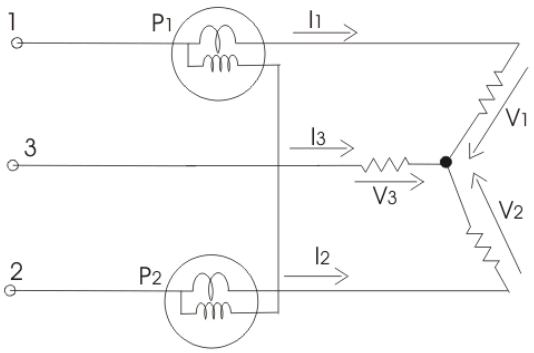
$X_L = \omega L = 2\pi f L$
$= 2\pi*50*0.2 = 62.83\Omega$
$X_C = 1/\omega C = 1/2\pi f C$
$= 1/(2\pi*50*100*10^{-6})$
$= 31.8\Omega$
$Z = R+jX_L - jX_C$
$= \sqrt{R^2 + (X_L{}^2 - X_C{}^2)}$
$= \sqrt{20^2 + (62.83^2 - 31.8^2)}$
$= 36.91\Omega$
$I = V/Z = 220/36.91 = 5.96$ A
$p.f = \cos\Phi = R/Z = 20/36.91 = 0.541$

Real Power ,$P = VI\cos\Phi = 220*5.96*0.541 = 709.35$W
$\Phi = \tan^{-1}\{(X_C - X_L)/R\}$
$= \tan^{-1}\{(31.8 - 62.8)/20\}$
$= -57.19 = 57.19$ lagging
$Q = VI\sin\Phi = 220*5.96*\sin(57.19)$
$= 1102.02$ VAR

4) **Explain the two wattmeter method of measurement of three phase power with neat phasor diagram. (or)Explain the two wattmeter method of power measurement for three phase system (or) Prove that two wattmeters are sufficient to measure three phase power. (MAY 2014, JAN 2014, MAY 2013. JAN 2010, NOV/DEC 2012, JAN 2013)**

Measurement of Three Phase Power by Two Wattmeters Method

In this method we have two types of connections (a)Star connection of loads (b)Delta connection of loads. When the star connected load, the diagram is shown in below-

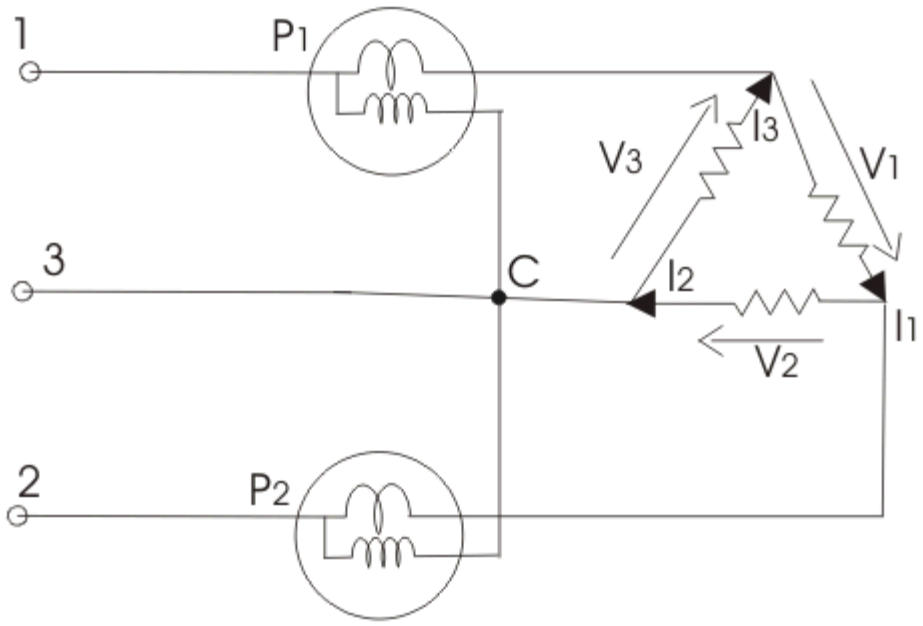


For star connected load clearly the reading of wattmeter one is product phase current and voltage difference (V_2-V_3). Similarly the reading of wattmeter two is the product of phase current and the voltage difference (V_2-V_3). Thus the total power of the circuit is sum of the reading of both the wattmeters. Mathematically we can write

$$P = P_1 + + P_2 = I_1(V_1 + V_2) + I_2(V_2 - V_3)$$

but we have I_1+I_2+I_3=0,hence putting the value of I_1+I_2=-I_3.

We get total power as $V_1I_1+V_2I_2+V_3I_3$. When delta connected load, the diagram is shown in below



The reading of wattmeter one can be written as

$$P_1 = -V_3(I_1 - I_3)$$

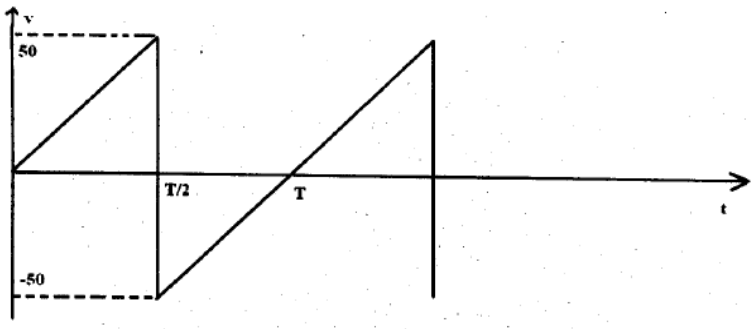
and reading of wattmeter two is

$$P_2 = -V_2(I_2 - I_1)$$

$$Total\ power\ is\ P = P_1 + P_2 = V_2I_2 + V_3I_3 - I_1(V_2 + V_3)$$

but $V_1+V_2+V_3=0$, hence expression for total power will reduce to $V_1I1+V_2I_2+V_3I_3$.

5) **Obtain the average value, RMS value, form factor and peak factor of the voltage waveform given below. (MAY 2012.) (9)**



Solution:

Average value

Average value = Area under one half cycle/ period

Area under one half cycle = $\frac{(½)*50*(T/2)}{T/2}$

Average value = 25 Volts

RMS value

$$\text{RMS value} = \sqrt{\frac{Area\ under\ the\ squared\ curve}{Period}}$$

$$= \sqrt{\frac{1/3\times T/2\times 50^2}{T/2}}$$

= 28.86 volts

Form factor = RMS value / Average value

= 28.86/25 = 1.15

Peak factor = peak value / RMS value = 50/28.86 = 1.73

6) **Find the Effective and average value, form factor and peak factor of a full wave rectified sine wave?(9)(JAN 2014, JAN 2010)**

Solution:

Full wave rectified sine wave

Mean square value = Area under one squared curve / period

Mean square value = $\frac{1}{\pi}\int_0^{\pi} I_m^2 sin^2\theta d\theta$

$$= \frac{I_m^2}{\pi}\int_0^{\pi}\frac{1-cos2\theta}{2}d\theta$$

$$= \frac{I_m^2}{2\pi}\left(0-\frac{sin2\theta}{2}\right)_0^{\pi}$$

$$= \frac{I_m^2}{2\pi}(\pi-\frac{sin2\pi}{2}-0+\frac{sin0}{2})$$

$$= \frac{I_m^2}{2\pi}\times\ \pi = \frac{I_m^2}{2\pi}$$

RMS value = $I_m/\sqrt{2}$

Average value

Average value = Area under the curve for one complete cycle/ Period

$= \frac{1}{\pi}\int_0^{\pi} I_m sin\theta d\theta$ (∵ the given wave is symmetrical)

$= \frac{I_m}{\pi}(-cos\theta)_0^{\pi} = \frac{I_m}{\pi}(1+1) = 2I_m/\pi$

Form factor = RMS value / Average value

$= \frac{Im/\sqrt{2}}{\frac{2Im}{\pi}} = \frac{Im \times \pi}{\sqrt{2} \times 2Im} = 1.11$

Peak factor = Peak value / RMS value = $\frac{Im}{Im/\sqrt{2}} = \sqrt{2}$.

7) **A choke coil takes a current of 2.5A when connected across 250V main and consumes 400W. Find a) the power factor b) resistance of the coil c) inductance of the coil d) apparent power e) reactive power (9) (NOV/DEC 2012.)**

Solution:

I = 2.5A

P = 400 W

V = 250V

P = VI cosΦ

400 = I^2R

400 = $(2.5)^2$ *R

Resistance, R = 400/2.5^2 = 64 Ω

Inductance, **Z** =V/I

= 250/2.5 = **100 Ω**

$X_L = \sqrt{Z^2 - R^2}$

$= \sqrt{100^2 - 64^2}$

= 76.83Ω

$X_L = \omega L = 2\pi f L$

76.83 = 2 π(50)L

L = 0.244H

p. f = cosΦ = R/Z

= 64/100 = **0.64 lagging**

(or)

P = VIcosΦ

400 = 250*2.5* cosΦ

cosΦ = 400/625

= 0.64 lagging.

Reactive power = I^2X_L

= 2.5^2 *76.83

= **480.18VAR**

Apparent power = I^2Z = 2.5^2*100 = 625 VA

8) **An inductive coil takes 10A and dissipates 1000W when connected to a supply at 250V, 25Hz.. Calculate the impedance and the effective resistance, the reactance, the inductance and the power factor. (9) (JAN 2011)**

Solution:

I= 10A

P = 1000W (unless specified the given power is actual power)

V= 250V; f = 25 Hz

Inductive coil will also have certain resistance. So it is equivalent to an R-L circuit.

Power = VI cosΦ = I^2 R = 1000

$(10)^2$* R= 1000

R = 1000/100 = **10 Ω**

Impedance, Z = V/I = 250/10 = **25 Ω**

$\mathbf{X_L} = \sqrt{Z^2 - R^2}$

$= \sqrt{25^2 - 10^2}$

= **22.91 Ω**

$X_L = \omega L = 2\pi f L$

$22.91 = 2\pi\ (25*L)$

L = 0.146 H

p.f. = cosΦ = R/Z =10/25 =**0.4 lagging**

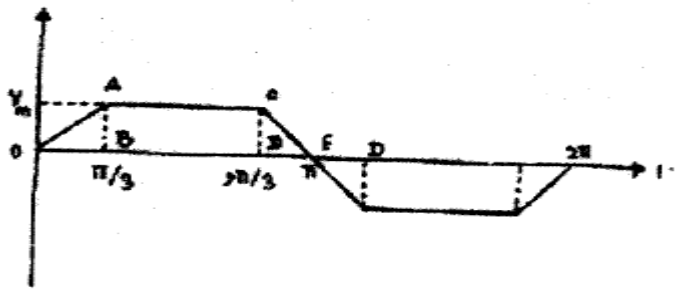
otherwise

P=VIcosΦ

1000 = 250(10)cosΦ

cosΦ = 1000/2500 =0.4 lagging

9) **Find the average, RMS, Form factor and peak factor of the following waveform. (9) (APR 2010)**



Solution:

Symmetrical trapezoidal waveform is given

(i) Average value = area under one half cycle/period (base)

Area under one half cycle = area of the triangle from 0 to ∏/3 +area of the rectangle for the period ∏/3 to 2∏/3 +area of the triangle from 2∏/3 to ∏

$$= \frac{1}{2} V_m \frac{\pi}{3} + V_m \frac{\pi}{3} + \frac{1}{2} V_m \frac{\pi}{3}$$

$$= V_m \frac{\pi}{3} (\frac{1}{2} + 1 + \frac{1}{2})$$

Average value = $(2/3)V_m\pi/\pi$
= $(2/3)V_m$

(ii) RMS value

RMS value = $\sqrt{\frac{Area\ under\ the\ squared\ curve}{Period}}$

Area under the squared curve = 1+2+3

$= \frac{1}{3}V_m^2\frac{\pi}{3} + V_m^2\frac{\pi}{3} + \frac{1}{3}V_m^2\frac{\pi}{3}$

$= V_m{}^2 * \frac{\pi}{3}(\frac{1}{3} + 1 + \frac{1}{3})$

$= \frac{5}{9} V_m{}^2 \pi$

$= \sqrt{\frac{5}{9\pi}\ Vm2\ \pi}$

= 0.745 V_m volts

(iii) Form factor

Form factor = RMS value/ Average value
= $0.745V_m/(2/3\ V_m)$ = 1.11

(iv) Peak factor

Peak factor = Peak value/ RMS value
= V_m /$(0.745V_m)$ = 1.342

10) **A resistance of 100Ω is connected in series with a 50μF capacitor to a supply at 200V, 50Hz. Find the a) impedance, current, power factor and the phase angle b) the voltage across resistor and capacitor. Also draw the phasor diagram. (9) (APR 2011)**

Solution:

R =100Ω , C = 50μF = 50 x 10^{-6} F
V= 200 V, f = 50 Hz
Impedance, $\bar{Z} = R - jX_c$
X_C = 1/(ωC) = $1/(2\pi fc)$
= $1/(2\pi * 50*50*10^{-6})$
= 63.66Ω
Impedance Z = $\sqrt{R^2 + X_C^2}$

= $\sqrt{100^2 + 63.66^2}$

Current, I =V/Z
= 200/118.54
= 1.69A
p..f. = cosØ =R/Z = 100/118.54 = 0.844 leading
phase angle = Ø = $\cos^{-1}$ 0.844
= 32.48^o

Voltage across resistor = IR = 1.69* 100

V_R = 169 V

Voltage across capacitor = IX_C

V_C = 1.69*63.66 = 107.59 V

11) **A 3phase 400V supply is connected to a balanced star connected load of impedance 8+j6Ω in each branch. Find the line current, power factor and total power. (9) (JAN 2011)**

Solution:

V_L = 400 V

$Z = 8+j6\Omega = 10\angle 36.86^0$

In Y connected system,

$E_P = E_L/\sqrt{3}$

$= 400/\sqrt{3} = 231$ V

Current in each phase = $E_P / Z = 231/(10\angle 36.86^0)$

$I_P = 23.1\angle -36.86^0$ A

In Y connection, $I_L = I_P$

I_L = 23.1 A

Total power = $\sqrt{3}V_L I_L \cos\Phi = \sqrt{3}\,(400)23.1(\cos\angle -36.86^0)$

= 12805 W

Power factor, $\cos\Phi = \cos\angle -36.86^0 = 0.800$ lagging

UNIT-III

ELECTRICAL MACHINES AND POWER PLANTS

Faraday's law of Electromagnetic induction, Fleming's Right & Left hand rule - Principle of DC rotating machine, Single phase transformer and single phase induction motor (Qualitative approach only) - Simple layout of thermal and hydro generation (block diagram approach only). Fundamentals of fuses and circuit breakers.

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2 Marks

1. State Fleming's left hand rule?

Stretch the thumb, forefinger and middle finger of your left hand, so that they are perpendicular to each other.

Forefinger -- Direction of Magnetic field

Middle finger -- Direction of Current

Thumb finger -- Direction of Motion of conductor.

2. State Fleming's right hand rule?

Stretch the thumb, forefinger and middle finger of your right hand, so that they are perpendicular to each other.

Forefinger -- Direction of Magnetic field

Middle finger -- Direction of Induced EMF

Thumb finger -- Direction of Motion of conductor.

3. What is a generator?(MAY 2013)

Generator is an electrical machine, in which mechanical energy is converted into electrical energy.

4.What is the principle of a DC Generator?

Whenever a conductor cuts magnetic flux, dynamically induced e.m.f is produced in it according to Faraday's laws of Electromagnetic induction. This e.m.f causes a current to flow if the conductor circuit is closed.

5. State the principle of a DC motor?

A DC motor is an electrical machine which converts electric energy into mechanical energy.

It is based on the principle that when a current carrying conductor is placed in a magnetic field, it experiences a mechanical force whose direction is given by Fleming's Left hand rule and the magnitude of the force in given by F = B I *l* Newton.

6. Mention the types of DC Motor & Applications.(JAN 2013)

(a) **DC Series motor** -- Constant speed motor

Used in Drilling, Spinning, etc…

(b) **DC Shunt motor** -- Variable speed motor

Used in Electric Traction, conveyors, etc…

(c) **DC Compound Motor** – Variable speed motor

Used in Rolling Mills, Printing press, etc.

7. What is the use of a commutator in a DC Generator?

Commutator is also called as split rings. Its function is to rectify i.e. to convert the alternating current induced in the armature conductors into unidirectional current in the external load circuit.

8. Mention the types of loss occuring in a D.C machine?

(a)Iron loss

i) Hysteresis loss : It is due frequent magnetic reversals
ii) Eddy current loss: It is due leakage flux in the air gap.

(b)Copper loss -- occurs due to the resistance of the windings

(c)Mechanical loss

- Friction loss -- Due to frictions in the bearings and brushes

- Winding loss -- Losses occurring in the air gap of the machine.

9. What is the working principle of single phase induction motor?

The working principle of induction motor is mutual induction, which is similar to that of a transformer. The stator receives electrical supply which produces a revolving flux in the rotor and hence the rotor rotates.

10. Why single phase induction motor is not self starting?

- When a single phase supply is fed to stator winding, it produces a flux which is only alternating (or pulsating) in nature.
- It does not produce synchronously revolving flux, as in case of a two or three phase stator winding, fed from two or three phase supply.
- Now, the alternating or pulsating flux acting on a stationary rotor cannot produce rotation. That's why single phase induction motor is not self starting.
- If the rotor of such a machine is given an initial start by hand or some other means, then immediately a torque arises and the motor accelerates to its final speed.

11. What are the types of single phase induction motors?

- Split phase
- Capacitor start induction run
- Capacitor start capacitor run
- Shaded pole.

12. What is an alternator?

An alternator or AC generator is a synchronous machine which converts mechanical energy into electrical energy and produces alternating emf.

13. What is the principle of an alternator?

The alternator works on the principle of Faraday's law of electromagnetic induction. Whenever a conductor links with a magnetic field either the conductor is moving or the field is moving an emf is induced in the conductor.

14. What are the different types of alternators? Which is in common use?

Alternators are of two types

i) Rotating armature type

ii) Rotating field and stationary armature type. Rotating field type is commonly used.

15. What are the main parts of an alternator?

The main parts of an alternator are i) Rotor (Salient pole type or cylindrical type), ii) Stator (Frame, core and Armature conductors) and iii) Exciter.

16. What is a Transformer? What is its principle?(APRIL 2010)

A transformer is a static device, which is used to increase or decrease the voltage level without change in frequency.

The basic principle of a transformer is Mutual induction between two coils which are linked by a common magnetic flux.

17. Mention the losses occurring in Transformer?

1) Core loss or iron loss:

This includes,

a) Hysteresis loss : It is due frequent magnetic reversals
b) Eddy current loss: It is due leakage flux in the air gap.

2) Copper loss: This loss occurs due to the resistance of the transformer windings.

18. What are the advantages of Thermal power plant?

1. The fuel (i.e. coal) used is quite cheap.
2. Less initial cost as compared to other generating stations.
3. It requires less space as compared to the hydro power plant.
4. The cost of generation is lesser than that of the diesel power plant.

19. What are the disadvantages of Thermal power plant?

1. It pollutes the atmosphere due to the production of large amount of smoke and fumes.
2. Running cost is more.

20. What are the advantages of Hydro power plant?

1. It requires no fuel as water is used for the generation of power and hence less running cost.
2. Pollution is less as no smoke or ash is produced.
3. It is comparatively simple in construction and requires less maintenance.
4. In addition to the generation of electrical energy, they also help in irrigation and controlling floods.

21. What are the disadvantages of Hydro power plant?

1. It involves high capital cost due to construction of dam.
2. There is uncertainty about the availability of huge amount of water due to dependence on weather conditions.
3. It requires high cost of transmission lines as the plant is located in hilly areas which are quite away from the consumers.

22. Name the types of Alternator based on their rotor construction.

Alternators can be classified into the following **two types** according to its rotor construction:

- Smooth cylindrical type alternator (non projected)
- Salient pole alternator(projected type)

23. Why is the stator core of Alternator laminated?

The stator core of Alternator is laminated to reduce eddy current loss.

24. What is the use of commutator and brush in a D.C machine? (NOV /DEC 2011)

The commutator converts the alternating emf into unidirectional or direct emf. The brushes are mainly used to collect current from the commutator.

25. What is the basic principle of operation of D.C motor?

The basic principle of operation of D.C motor is that a current carrying conductor placed in a magnetic field, experiences a force tending to move it.

26. State Faraday's Law?(JAN 2014)

Whenever a current carrying conductor cuts the magnetic lines of force an emf is induced.

27. What is a prime mover?

The basic source of mechanical power, which drives the armature of the generator, is called prime mover.

28. State Lenz's law?

Any induced emf will circulate a current in such a direction as to oppose the cause producing it.

$$e = -N \, d\varphi/dt$$

29. How are hysteresis and eddy current losses minimized?

- Hysteresis loss can be minimized by selecting materials for core such as silicon steel & steel alloys with low hysteresis co-efficient and electrical resistivity.
- Eddy current losses are minimized by laminating the core.

30. Differentiate between AC and DC Transmission.

Sl. No.	AC Transmission	DC Transmission
1	Generate power at high voltage	Generate power at low voltage
2	Voltage drop is more	Less voltage drop is less
3	AC voltage can be easily stepped up or stepped down.	No such process
4.	AC cannot be stored	DC can be stored Eg:Battery

31. Define Single line diagram?(APRIL 2010,JAN 2011,JAN 2012, APRIL/ MAY 2012)

This shows the relationship of electrical components by one line.

11 Marks

1) Discuss the construction and operation of transformer. (9)(MAY 2014,MAY 2013,NOV/DEC 2012)

TRANSFORMER

Transformer is a static device which transfers electrical energy from one circuit to another circuit without changing the supply frequency. This conversion is possible by the faraday's law of induction.

Alternating voltage is connected across one of the windings called the primary winding. The second winding is called secondary winding. In both the windings emf is induced by electromagnetic induction.

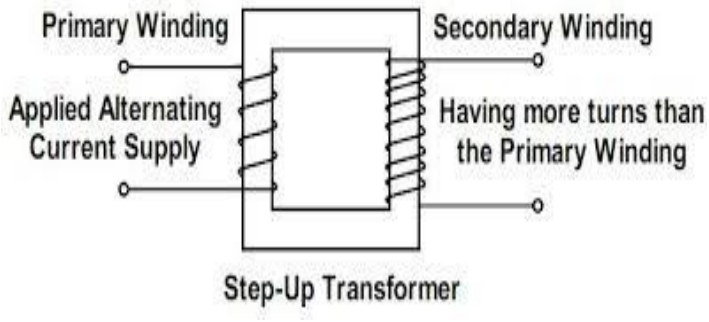
Construction:

The following are the essential requirements of transformer.

1. Good magnetic core
2. Two windings
3. Time varying magnetic flux

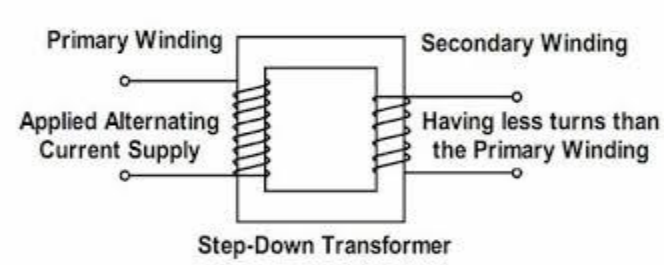
The transformer core is generally laminated and is made out of a good magnetic material such as silicon steel. The laminated sheets have a thickness of 0.35mm and are joined together to form a core. Using laminated sheets reduces hysteresis loss. These laminations are coated by dark point throughout and it reduces eddy current losses windings are made up of copper.

Step up transformer



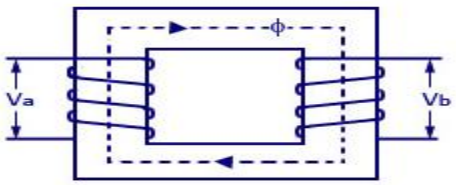
If no. of turns in secondary winding is higher than the primary winding, it is called step-up transformer. It increases the voltage or converts lower voltage to higher voltage.

Step down transformer



If no. of turns in secondary winding is less than the primary winding, it is called step-up transformer. It decreases the magnitude of voltage or converts higher voltage to lower voltage.

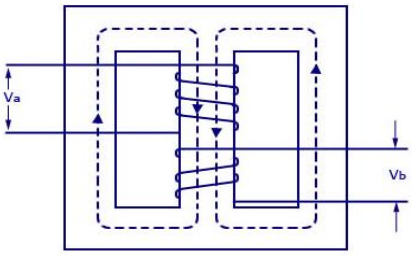
Core type



Core type

Winding surround a considerable part of core and has only one magnetic path. It has two limbs for two windings.

Shell type



Here core surrounds the considerable part of windings. Two windings are carried by central limb. It has two parallel paths of magnetic flux.

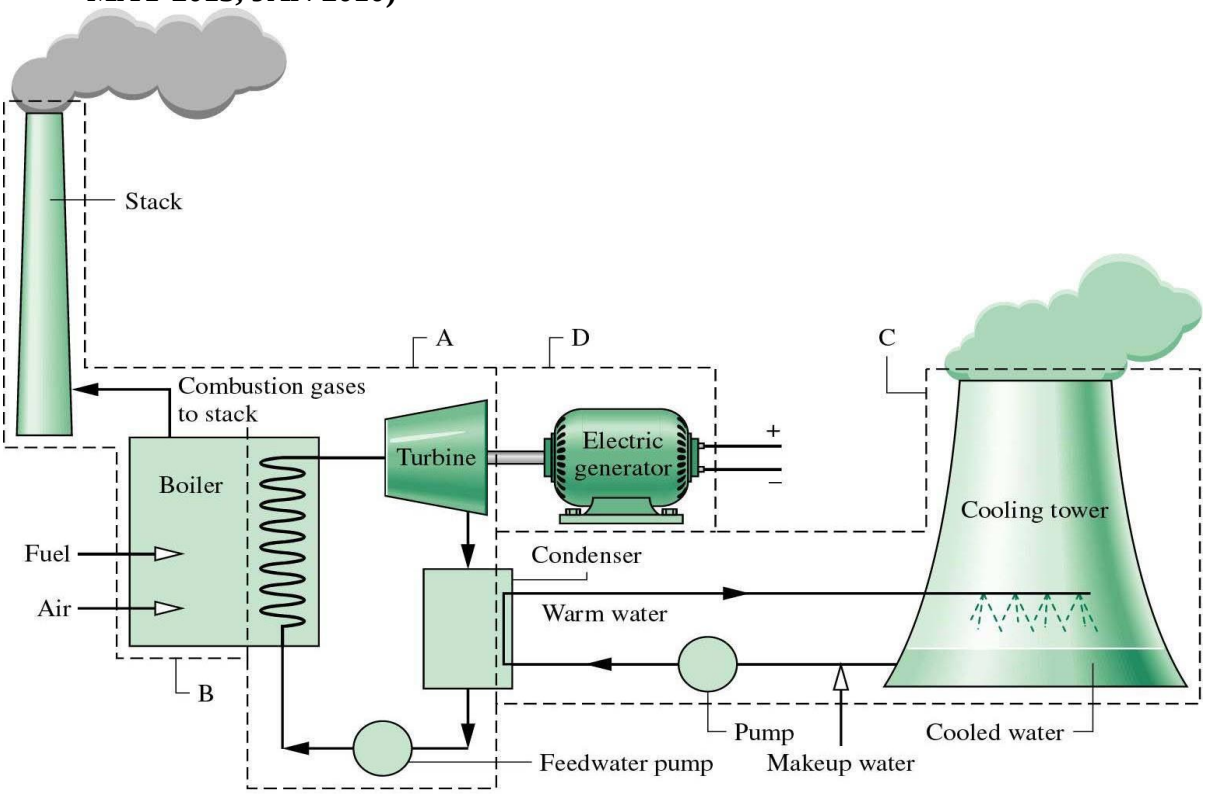
Working principle of a transformer

When the primary winding is connected to an ac source exciting current flows through the winding. As the current is alternating, it will produce an alternating flux in the core which will be linked by both the primary and secondary windings.

The induced emf in the primary winding(E1) is almost equal to the applied voltage V1 and will oppose the applied voltage. The emf induced in the secondary winding(E2) can be utilized to deliver power to any load connected across the secondary.Thus power is transferred from the primary to the secondary circuit by electromagnetic induction.

The flux in the core will alternate at the same frequency as the frequency of the supply voltage. The frequency of induced emf in the secondary is same as that of supply voltage. The magnitude of the emf induced in the secondary winding will depend upon its number of turns.

2) **Explain with neat block diagram thermal power plant. (9)(MAY 2014, JAN 2014, MAY 2013, JAN 2010)**



MajorComponentsofaThermal PowerPlant

i) Coal and Ash circuit:

In this circuit, the coal from the storage area is taken to the boiler by means of coal handling equipments such as belt conveyors, bucket elevators, etc. For example, a thermal power plant of 400MW capacity requires 500 to 6000 tonnes of coal per day. So highly reliable and efficient devices should be used.

After the pulverized coal is burnt at 1500◦C - 2000◦C by combustion, then it gets collected in the ash pit. It is removed from the ash pit by ash handling system like belt conveyors, screw conveyors, etc. Sufficient space should be provided for ash storage.

ii) Air and flue gas circuit:

The air from the atmosphere gets heated in the air preheater. The air receives its heat from the hot flue gas passing to the chimney. The hot air enters the boiler and helps in the combustion of fuel in the boiler.

The flue gases after combustion in the boiler furnace, pass around the boiler tubes, heating the water present in the tubes. The fuel gases then pass through a dust collector which removes any dust (or) solid particles.

The filtered flue gas passes through the economizer and preheater and is forced out through the chimney by a draught fan.

iii) Feed water and steam circuit:

The superheated steam from the boilers enters the steam turbine, the superheated steam temperature is about 600°C at a pressure of 300Kg/cm^2. The steam expands in the turbine causing the turbine blades to rotate. After doing mechanical work the blades losing its energy, the steam becomes wet and the pressure of steam becomes less.

The wet steam passes through a condenser where it completely becomes water. The condensed water that has a temperature of 30◦C to 40◦C is collected in a tank called hot well. The water from the hot well is fed into the boiler through the economizer. The economizer preheats the water before entering it. The economizer receives its heat from the flue gases leaving the boiler. Pre-heating the feed water in the economizer increases the boiler efficiency and helps quicker production of steam.

iv) Cooling water circuit:

As the name suggests in this circuit water is circulated around the condenser to condense the steam coming out of the turbine. Cooling water enters the condenser at 10◦C to 15◦C and leaves at 20◦C to 25◦C. Plenty of water is required for condensing the steam in the condenser. The water may be taken from sources such as river (or) lake.

Working principle:

Thermal power plant is usually known as steam power plant. Power stations that burn coal (or) oil have three main parts- the boiler, the turbines and the generator. The power stations burns coal (or) oil to produce heat in the boiler. The boiler is lined with pipes carrrying water, which boils and turns to steam. The steam is then passed through pipes to machines called turbines.

Turbines have huge “wheels” fitted with hundreds of steel fan like blades. The steam rushes through the turbines at high speed causing both the wheels and the turbines shaft to spin. The spinning shaft turns the rotor of the electric generator creating magnetic field, thereby producing electricity.

The used steam then cools in the cooling towers and changes back into water. This changing process is called ‘condensation’. The water returns to the boiler and is heated up again.

3) With neat sketches, explain the principle of operation of a single phase induction motor. (9) (,MAY2012, JAN 2011,JAN 2014,JAN 2013)

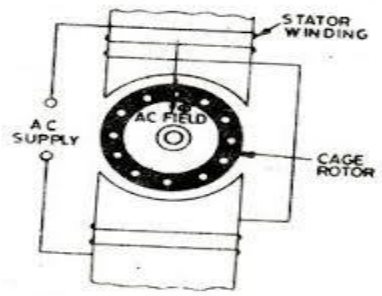
SINGLE PHASE INDUCTION MOTOR

Single phase motors are small motors. These motors have power rating in fractional horse power range. These motors are used in hours, offices, shops and factories. They provide motive power for fans, washing machines, hand tools like drillers, record player, refrigerators, juice makers etc. single phase motors are simple in construction. The main disadvantages of these motors are

1. Lack of starting torque
2. Reduced power factor
3. Low efficiency

Single phase induction motors arewidely used in domestic, industrial and machine tool applications. The capacity of this motor varies from fractional horse power (1/2 Hp) to 5Hp.

Construction

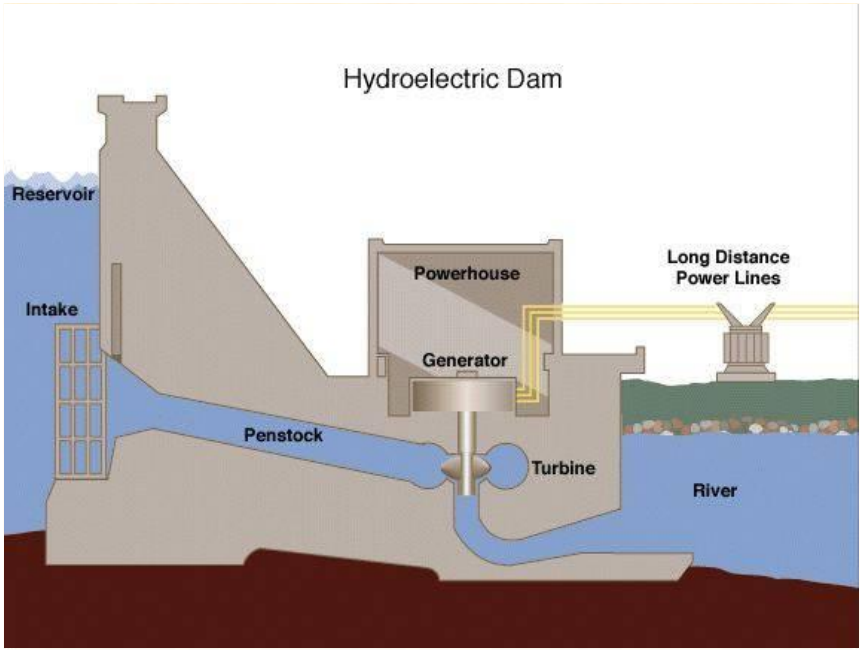


The construction of 1φ induction motor is similar to 3φ induction motor. It consists of two parts. One is stator and another one is rotor. The air gap between stator and rotor is uniform. There is no external connection between stator and rotor.

When starter winding is energized with single phase supply, an alternating flux is setup, but it is not a revolving field.

This alternating flux when acting on stationary motor cannot produce rotation. Only a revolving field results in the rotation of rotor. So, 1φ induction motor is not self starting. However, if rotor is given an initial start by hand or by other means, the motor may start and run.

4) Explain with neat block diagram the hydraulic power plant/ hydro power plant (9) **(**NOV/DEC 2012**,**APR 2010)**)**



ThevariouscomponentsofHPPareasfollows:

i) Water Reservoir:

In a reservoir the water collected from the catchment area is stored behind a dam. Catchment area gets its water from rain and streams. Continuous availability of water is a basic necessity for a hydro-electric plant. The level of water surface in the reservoir is called "Head water level".

ii) Dam:

The purpose of the dam is to store the water and to regulate the outgoing flow of water. The dam helps to store all the incoming water. It also helps to increase the head of the water. In order to generate a required quantity of power it is necessary that a sufficient head is available.

iii)Spillway:

Excess accumulation of water endangers the stability of dam construction. Also in order to avoid the overflow of water out of the dam especially during rainy seasons spillways are provided, this prevents the rise of water level in the dam. Spillways are passages which allows the excess water to flow to a different storage area away from the dam.

iv) Gate:

A gate is used to regulate (or) control the flow of water from the dam.

v) Pressure channel:

It is a passage that carries water from the reservoir to the surge tank.

vi) Surge tank:

A surge tank is a small reservoir or tank which water level rises or falls due to sudden changes in pressure.

A surge tank serves the following purposes:

a) To reduce the distance between the free water surface in the dam and the turbine, thereby reducing the "water-hammer effect" on penstock.

b) To reduce as a supply tank to the turbine when the water in the pipe is accelerated during increased load conditions and as a storage tank when the water is decelerating during reduced load conditions.

vii) Inlet valve:

Water from the penstock flows to the turbine through the inlet valve. The valve may be partially closed or open thereby regulating the pressure of water flowing to the turbine.

viii) Penstock:

Penstock is a closed pipe of steel (or) concrete for supplying water under pressure to the turbine.

ix) Hydraulic turbine(Prime mover):

The hydraulic turbine converts the energy of water into mechanical energy. The mechanical energy (rotation) available on the turbine shaft is coupled to the shaft of an electric generator and electricity is produced.

The water after performing the work on the turbine blades is discharged through the draft tube. The prime movers which are in common use are Pelton wheel, Kaplan turbine, Francis turbine.

x) Draft tube:

It is connected to the outlet of the turbine. It allows the turbine to be placed above the tail water level.

xi) Tail water level (or) tail race:

Tail water level is the water level after the discharge from the turbine. The discharged water is sent to the river, thus the level of the river is the tail water level.

xii) Electric generator, step up transformer and Pylon:

As the water rushes, through the turbine it spins the turbine shaft, which is coupled to the electric generator. The generator has a rotating electromagnet called a rotor and a stationary part called a stator.

The rotor creates a magnetic field that produces an electric charge in the stator. The charge is transmitted as electricity. The step-up transformer increases the voltage of the current coming from the stator. The electricity is distributed through power lines also called as Pylon.

Working principle:

Potential energy is the energy which a substance has due to its position (or) state. The water behind a dam has a potential energy because of its position. The water can fall from this position and exert a force over a distance and therefore do work.

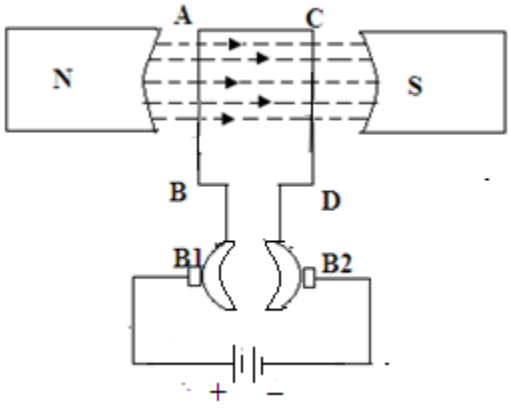
In a hydro –electric power plant the force is used to drive a turbine, which in turn drives the electric generator. Because gravity provides the force which makes the water fall, the energy stored in water is called " gravitational potential energy".

5) **With a neat sketch, explain the construction and working of DC motor. (9) (APR 2011, JAN 2010)**

DC MOTORS

While a DC generator converts mechanical energy in the form of rotation of the conductor into electrical energy, a motor does the opposite.

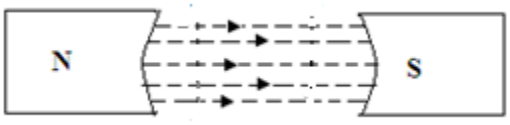
The input to a DC motor is electrical and the output is mechanical rotation. The fundamental principles and construction of the DC motors are identical with DC generators.



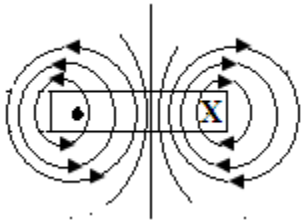
Principle *of* Operation:

The basic principle of operation of dc motor is "whenever a current carrying conductor is placed in a magnetic field, the conductor experiences a force tending to move it".

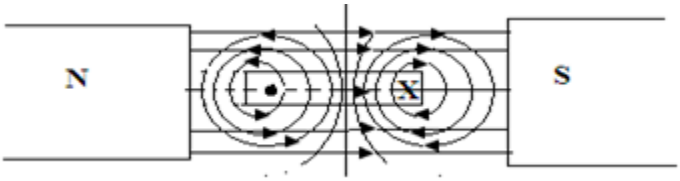
The magnetic field between two poles N and S is



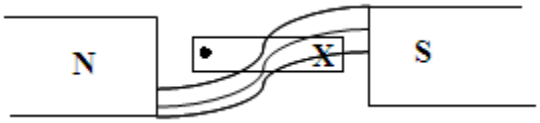
A current carrying conductor along with the direction of the flux loops around it.



If a current carrying conductor is placed between two magnetic poles,



In the two edge of current carrying conductor, the direction of flux loop is anticlockwise in one edge and clockwise in another edge which denoted by x.



If a current carrying conductor is placed between two magnetic poles both the field will be distorted.

Above the conductor, the field is weakened(less flux) and below the conductor, the field is strengthened.

Therefore the conductor tends to move upwards. The force exerted upwards depends upon the intensity of the main field flux and the magnitude of the current.

In the other edge the direction of flux loop is reversed. Here the field of below the conductor is less and field of the above the conductor is more. Then the conductor tends to move downwards.Thus the electrical energy is converted into mechanical energy.

The magnitude of the force experienced by the conductor in a motor is given by,

F= BIlNewtons,

Where,

B= Magnetic field density in wb/m^2
I= Current in amperes
l= length of the conductor in meter

The direction of motion is given by Fleming's left hand rule, which states that if thumb, fore finger, and middle finger of left hand are held such that fingers shows three mutually perpendicular directions.

Middle finger- direction of current
Fore finger- direction of magnetic field
Thumb- direction of motion of conductor

In a DC motor a strong electromagnetic field and large number of conductors housed in an armature and carrying current, make the armature rotate.

Both the motion is equal and opposite, then rotate in clockwise direction, as it move in clockwise, rotating comes to central position. It central position the connection between commutator and brushes are lost, connection lost, current is not flow. But armature coil will not stop. It will continue to rotate because of inertia and once again commutator touches the brushes and current will flow.

6) **Explain the operation of DC generator. (9) (APR 2010)**

DC GENERATOR

Principle and essential parameters:

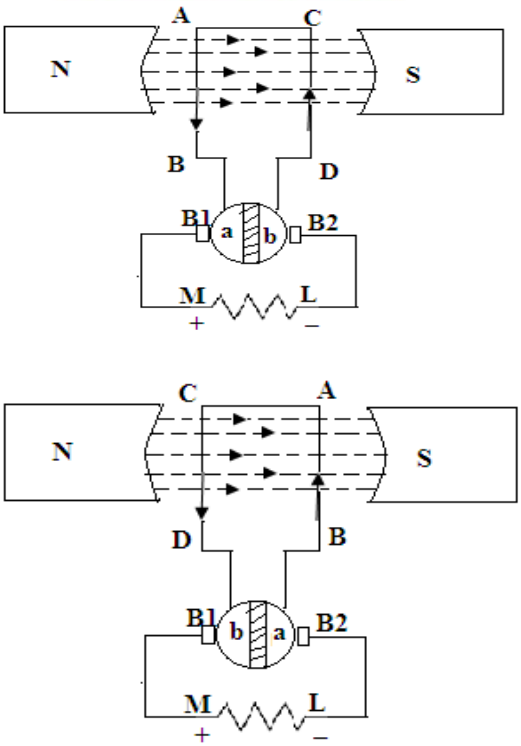
Although most of the electrical machines in service are AC machines, the DC machines are of greater percentage at industrial importance.

DC generator converts mechanical energy into electrical energy.It is based on the principle that whenever flux is linked or cut by conductor, an emf is induced which will cause a current to flow if the circuit is closed. The direction of induced emf is given by Fleming's right hand rule.Principle and the essential parameters are same as that of AC generator.

Construction:

Similar to that of AC generator but to make the flow of current uni-directional instead of alternating in the external circuit, the slip rings are replaced by split rings.

The split rings are made up of a cylindrical conducting material which is cut or splitted into two equal halves and are insulated from each other by a thin sheet of mica.



N & S-Electro magnet

ABCD- rectangular coil

a& b- split rings

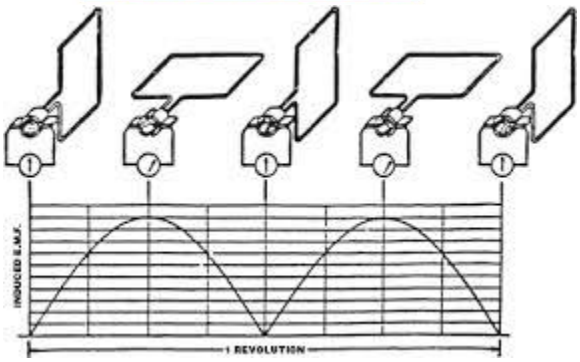
B1 & B2- carbon brushes

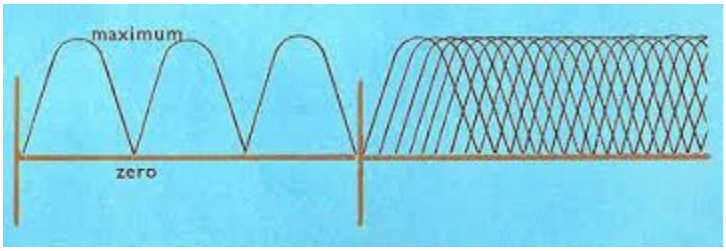
----> Flux lines

Working:*Conversion of AC to DC*

In the fig(a), first half revolution current flow along ABMLCD i.e B1 is connect with segment 'a' acts as positive end of the supply and 'b' as negative end.

In the next half revolution, the direction of the induced current in the coil has reversed. But at the same time, the positions of segments a and b have also reversed with the result that brush B1, always comes in touch with the positive terminal of the load and B2 with the negative terminal of the load.





The current is unidirectional but not continuous like pure DC. To make the current as uniform(as perfect dc current), several coils are wound over the armature at different inclination at equal intervals.

Each coil is provided with its own pair of commutator. They are together connected in series. So that the instantaneous current through each coil might get added up at the brushes. Hence the algebraic sum is practically constant.

Another important point to remember is, even in the armature of a DC generator, the induced voltage is alternating, only because of split rings 'dc' is got at the external circuit.

7) **Explain the operation of AC generator. (9)**

AC GENERATOR

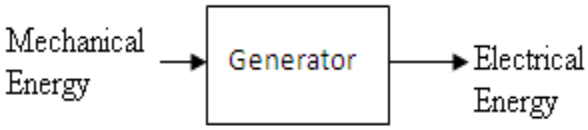
Principle, construction and working of an AC generator:

Principle:

An electrical generator is a machine which converts mechanical energy into electrical energy. The energy conversion is based on the principle of the production of dynamically induced emf. Whenever a conductor cuts the magnetic flux, dynamically emf is induced in it, according to faraday's law of electromagnetic induction. This emf causes a current to flow, if the conductor circuit is closed. The direction of induced emf is given by Fleming's right hand rule.

Thumb- direction of motion of conductor

Fore finger- direction of the magnetic field
Middle inger- direction of the current flow



The important components of a generator are

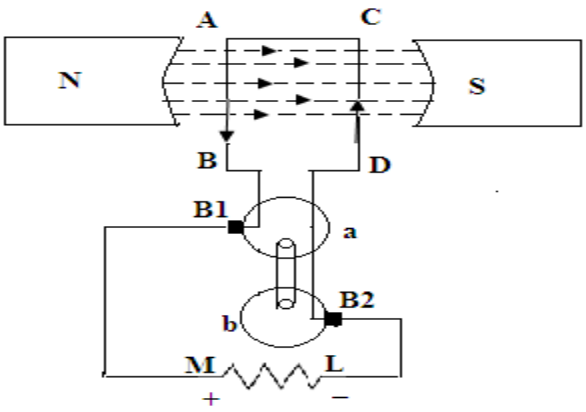
1. A magnetic field
2. Conductors
3. Motion of conductor with respect of magnetic field

Construction:

A single turn rectangular copper coil ABCD rotating about its own axis in a magnetic field produced by the permanent magnets or electromagnets. Here single coil is assumed but in actual generator we have multiple coils.

Two ends of the coils are joined to two slip rings **a** and**b** which is insulated from each other and from the central shaft.

Two brushes made up of carbon or graphite are pressed against the slip rings. Their function is to collect the current induced in the coil and to pass it to the external load.



Rotating coil → Armature

Magnets →Field magnets

Working of an AC Generator

Assume the coil is rotating in clockwise direction. As the coil changes its positionin the field, the flux linked with it changes. Hence an emf is induced in it which is proportional to the rate of change of flux linkages.

$$e = N\frac{d\varphi}{dt}, \text{ where } N=1$$

Generated emf waveform for one cycle

Position 1: 0˚

When plane of the coil is right angles to the lines of flux(assume 0˚). ABCD is perpendicular to φ. Flux linkage the plane is maximum but the rate of change of flux is zero. Because in this position of the coil, sides AB and CD does not cut the flux and hence no emf is induced in the coil.

Position2: 45˚

When the plane of the coil rotates 45˚ to the lines of flux. Flux linked with the coil is reduced slightly from the maximum. But the rate of change of flux linkage slightly increases and hence induced emf(+ve) increases.

Position 3: 90˚

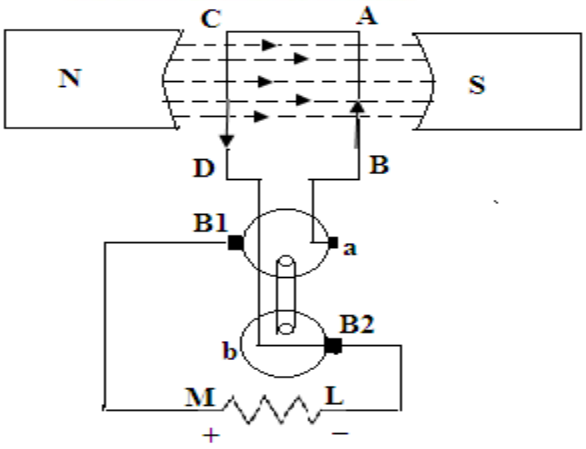
When the plane of coil still rotates to reach 90˚. At this position flux linked is minimum and rate of change of flux is maximum. Hence maximum current flow(+ve) and therefore emf is maximum.

Position 4: 135˚

When the plane of coil still rotates 135˚. At this position flux linking the plane is increased slightly. But rate of change of flux decreases slightly. Emf is also reduced slightly (+ve).

Position 5: 180˚

When the plane of coil still rotates to reach 180˚. At this position flux linking the plane is maximum. Rate of change of flux in the conductor reduces completely. Hence emf induced is zero.



Position 6: 225˚

When the plane of coil still rotates to reach 225˚. At this, position is changed to DCBA and the current flow is in negative direction. Flux linking the plane is slightly reduced and rate of change of flux increases slightly.emf is produced (-ve).

Position 7:

At position 7, max emf is produced.

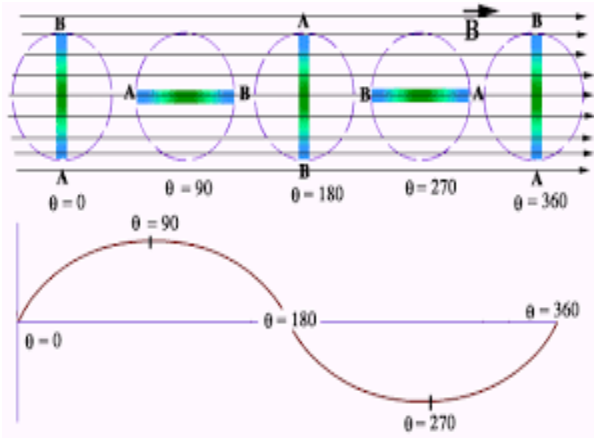
Position 8:

At position 8, emf is reduced

Position 9:

At position 9, emf induced is zero similar to position 1.

The below working is illustrated for one cycle similarly the cycle continues until there is required magnetic field and the revolving conductor.



After half revolution, the current obtained from such a generator reverse its direction after every half revolution. Such a current which undergoes periodic reversal is known as alternating current (AC). Therefore the machine which generates AC is known as AC generator.

8) **Fundamentals of Fuses and circuit breakers (9)**

Fuses: A fuse is a short piece of wire (or) thin strip wjich melts, when excessive current flows through it for sufficient time. It is inserted in series with, the circuit to be protected. The symbol of fuse is shown below:

Under normal operating conditions, the fuse element will be at a temperature below its melting point. Therefore the normal load current flows without overheating. However when a short circuit condition (or) overload occurs, the current through the fuse element increases beyond its rated capacity. This in turn raises the temperature and fuse elements ,elts.

Types of fuse:

i) Low voltage fuse eg: Catridge fuse.

ii) High voltage fuse eg: HRC fuse.

Current rating of fuse element:

It is the current in which the fuse element can normally carry current without overheating (or) melting.

Fusing current:

It is the minimum current at which fuse element melts and thus disconnects the circuit protected by it.

Fusing factor:

It is the ratio of minimum fusing current to the current rating of fuse.

Fusing factor= minimum fusing current/ current rating of fuse.

Circuit breakers:

A circuit breaker is an equipment which can open (or) close a circuit under all conditions normally no load condition, full load condition and fault conditions. It is also designed that it can operate manually (or) by remote control. The basic construction of circuit breaker is shown below:

Under normal operating conditions, the contacts remains closed and the circuit breaker carries the full load current continuously. In this condition, the emf in the secondary winding of current transformer is insufficient to operate the trip coil of the circuit breaker.

When a fault occurs, the resulting overcurrent in the CT primary winding increases the secondary emf. This energizes the trip coil of the breaker and moving contacts are pulled down, thus opening contacts and hence the circuit will be protected.

During the contacts are pulled, arc's are produced. The voltage that appears across the contacts of the circuit during the arc period is called as Arc voltage.

9) **Derive the emf equation of DC generator. (9)**

Emf Equation of a Generator:

Let f- flux/ pole (wb)

Z→ total number of armature conductors
Z= no. of slots x no. of conductor/ slot
P→number of generator poles
A→ number of parallel paths in armature
N→armature rotation (rpm)
E →emf induced in any parallel path

Generated EMF = EMF generated in any one parallel path

$E_g = E$

Avg. emf generated/conductor = $\frac{d\varphi}{dt}$(volt)

Now, flux cut/ conductor in one revolution, dφ = φp (wb)

No. of revolutions/ second = $\frac{N}{60}$

Time taken for one revolution (dt) =$\frac{60}{N}$ (sec)

Hence according to Faraday's law of electromagnetic induction,

Emf generated/ conductor =$\frac{d\varphi}{dt}$=$\frac{\varphi p}{60/N}$

Emf generated per conductor = $\frac{\varphi pN}{60}$ volts

For wave wound generator,

Number of parallel paths=2

Number of conductor in one path= $\frac{Z}{2}$

Emf generated/ path=$\frac{\varphi pN}{60} \times \frac{Z}{2}$

Emf generated/ path =$\frac{\varphi pNZ}{120}$

For lap wound generator,

Number of parallel paths = P

Number of conductors in one path= $\frac{Z}{P}$

Emf generated/ path= $\frac{\varphi pN}{60} \times \frac{Z}{P}$

In general generated emf (Eg) = $\frac{\varphi zN}{60} \times \frac{p}{A}$ volts

Where, A=2 for wave wound generator

A=p for lap wound generator

UNIT – IV
ELECTRONIC CIRCUITS

V-I Characteristics of diode - Half-wave rectifier and Full-wave rectifier – with and without capacitor filter - Transistor - Construction & working - Input and output characteristics of CB and CE configuration - Transistor as an Amplifier - Principle and working of Hartley oscillator and RC phase shift oscillator - Construction and working of JFET & MOSFET

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2 Marks

1. **Define amplifier. (**JAN 2013,MAY 2013)

An amplifier is a device which amplifies or increases magnitude of any current or voltage applied at its input.

2. What is rectifier?(APRIL 2010)

A rectifier is defined as an electronic device for conversion of AC voltage or current into unidirectional (DC) voltage or currents. A semiconductor diode is used as a rectifier.

3. What is meant by half wave rectifier?

A half wave rectifier is one which converts an AC voltage into a pulsating DC voltage for only half cycle of the applied voltage.

4. What is meant by full wave rectifier?

A full wave rectifier is a two diode rectifier that converts the applied alternating voltage into a pulsating DC (unidirectional) voltage for the full cycle of the AC voltage.

5. Define ripple factor.

It is defined as the ratio of the effective value of the AC components of voltage or current to the direct or average value of the voltage or current.

$$\text{RF}=\frac{AC component}{DC component}$$

6. What is ripple?

The pulsating output voltage of a rectifier consists of a DC component and alternating voltage components. The unwanted AC components of rectified voltage constitute the 'ripple voltage'.

7. What is ripple voltage?

Ripple voltage is not a pure sinusoidal voltage but consists of a fundamental sine wave component and harmonics, therefore in progressively reducing amplitudes. In case of full wave rectifier, the fundamental ripple frequency is twice the supply voltage frequency.

8. Define a filter.

The function of filter circuit is to reduce the ripple to as small as possible so that the output is a pure DC.

20. What is the advantage of bridge rectifier over centre tap?

- Centre tapped transformer is not needed.
- For the same secondary voltage, the output is doubled than that of the centre –tap circuit.

21. Define oscillator

A device which works on the principle of positive feedback, producing the waveform of desired frequency is called an oscillator.

22. Define principle of RC- phase shift oscillator

In this oscillator a phase shift of 180^o is obtained with a RC phase shift circuit. A further phase shift of 180^o is produced due to the transistor properties. Hence, energy supplied back to the tank circuit is assured of correct phase to satisfy the barkhasusen criterion.

$$fo = \frac{1}{2\pi RC\sqrt{6}}$$

23. Define Barkhausen criterion of oscillator.

Barkhausen criterion is required for oscillating circuit for oscillation

$$\mathbf{Av' = \frac{Av}{1-\beta.Av}}$$

Av' -overall gain of a positive feedback amplifier

Av- gain of an amplifier without feedback and also called open loop gain.

β.Av - Product of feedback fraction and open loop gain. It is called loop gain.

Conditions:

- The magnitude of the product of the open loop again of the amplifier and feedback fraction is unity. (β.Av =1) then (Av- β.Av =0)

- The total phase shift around a loop, as the signal proceed from input through amplifier, feedback network back to input again, completing a loop, its precisely 0^o or 360^o

24. Define the principle of Hartley oscillator

Hartley oscillator is an LC oscillator which uses a parallel tuned LC circuit for feeding back a signal of proper amplitude and phase hence oscillation can be sustained.

$$fo = \frac{1}{2\pi\sqrt{LC}}$$

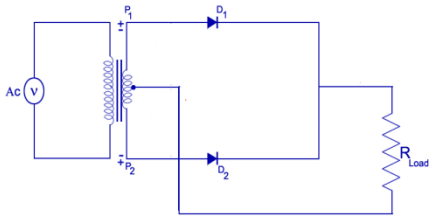
25. What are advantages of Common emitter over common collector?

Common emitter has highest power gain when compared to common collector. Phase reversal of 180^o is occurred in output of common emitter where as no phase shift occurred in common collector.

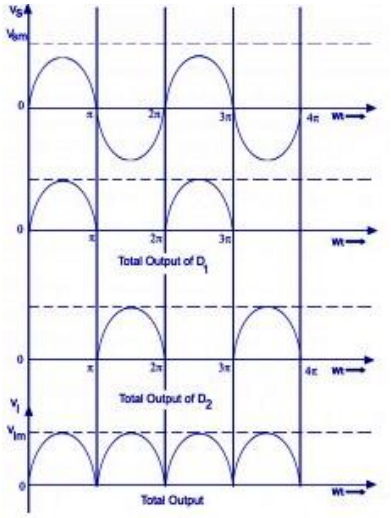
9 Marks

1) **Draw the circuit diagram of fullwave rectifier network supplying a resistive load. Explain the operation of the network with relevant waveforms. (or) With suitable waveform explain the working of full wave rectifier(9)(JAN 2014)**

Full wave rectifier



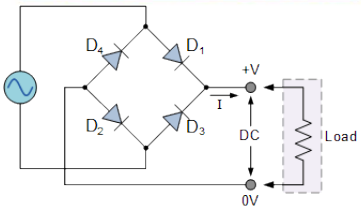
An ac input is applied to the primary coils of the transformer. This input makes the secondary ends P1 and P2 become positive and negative alternately.
For the positive half of the ac signal, the secondary point D1 is positive, GND point will have zero volt and P2 will be negative. At this instant diode D1 will be forward biased and diode: D2 will be reverse biased. The diode D1 will conduct and D2 will not conduct during the positive half cycle. Thus the current flows.
During the negative half cycle, the secondary ends P1 becomes negative and P2 becomes positive. At this instant, the diode D1 will be negative and D2 will be positive with the zero reference point being the ground, GND. Thus, the diode D2 will be forward biased and D1 will be reverse biased. The diode D2 will conduct and D1 will not conduct during the negative half cycle.



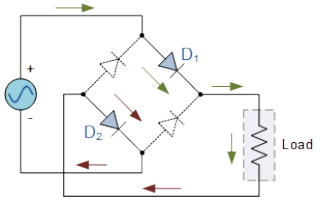
2) **Explain the working of full wave bridge rectifier circuit with a neat diagram.**

- Full Wave Bridge Rectifier uses four individual rectifying diodes connected in a closed loop “bridge” configuration to produce the desired output.
- The main advantage of this bridge circuit is that it does not require a special centre tapped transformer, thereby reducing its size and cost.

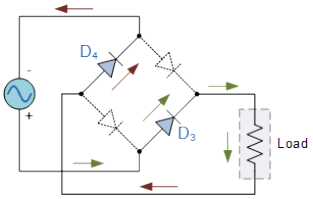
The four diodes labelled D_1 to D_4 are arranged in “series pairs” with only two diodes conducting current during each half cycle



During the positive half cycle of the supply, diodes D1 and D2 conduct in series while diodes D3 and D4 are reverse biased and the current flows through the load as shown below.

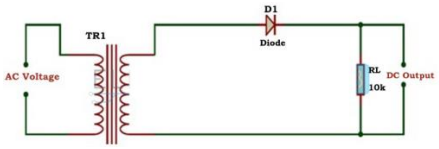


During the negative half cycle of the supply, diodes D3 and D4 conduct in series, but diodes D1 and D2 switch "OFF" as they are now reverse biased. The current flowing through the load is the same direction as before.



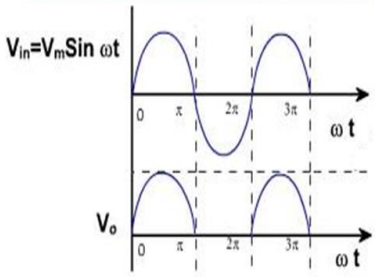
3) **With suitable waveform explain the working of half wave rectifier(5)(APRIL 2010)**

- The half wave rectifier is a type of rectifier that rectifies only half cycle of the waveform.
- The half rectifier consist a step down transformer
- The diode is connected to the transformer
- Load resistance is connected to the cathode end of the diode.
- The circuit diagram of half wave transformer is shown below:



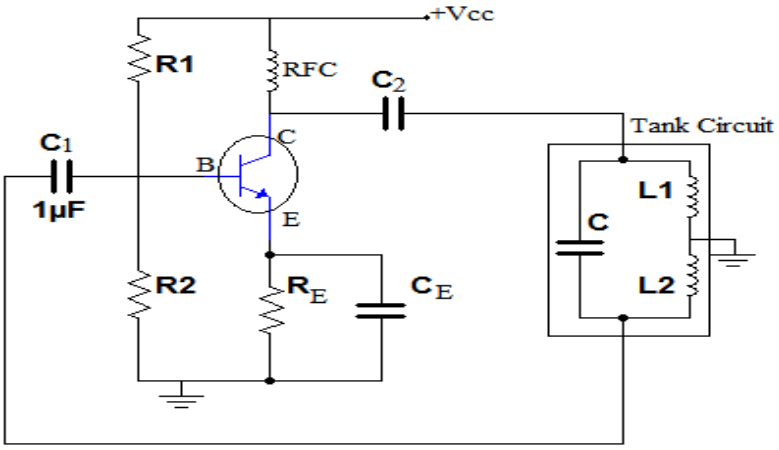
When the AC input is positive or during positive half cycle, the diode is forward-biased and lets the current through it.

When the AC input is negative, the diode is reverse-biased and the diode does not let any current through, meaning the output is 0V.



4) **Draw and explain the principle and working of Hartley oscillator. (9)(MAY 2013, MAY 2012)**

HARTLEY OSCILLATOR:



The resistors R1, R2and RE are used to provide d.c bias to the transistor. Radio frequency choke (RFC) is connected between the collector and the Vcc supply.

It acts as a load for the collector and also permits an easy flow of d.c current, but block a.c current.

The capacitorC1called blocking capacitor further blocks the d.c currents reaching at the base.The capacitor C2 connected between the collector and the tuned circuit is called coupling capacitor. It permits only the a.c currents to pass to the tank circuit and blocks the d.c currents.

The capacitor CE is the emitter bypass capacitor.

The tank circuit consists of two coils L1 and L2. The coil L1 is inductively coupled to coil L2 and the combination works as an autotransformer. The feedback between the output and

input circuits are accomplished through autotransformer action, which also introduces a phase shift of 180°.

The phase reversal between the output and input voltage occurs because they are taken from the opposite ends of the coils (L1and L2) with respect to the tap, which is grounded. It may be noted that the tap on the combination of L1 and L2 coils is actually connected to the transistor emitter terminal via ground and through the capacitor CE.

Since transistor also introduces a phase shift of 180°, therefore the total phase shift is 360° and hence the feedback is positive.

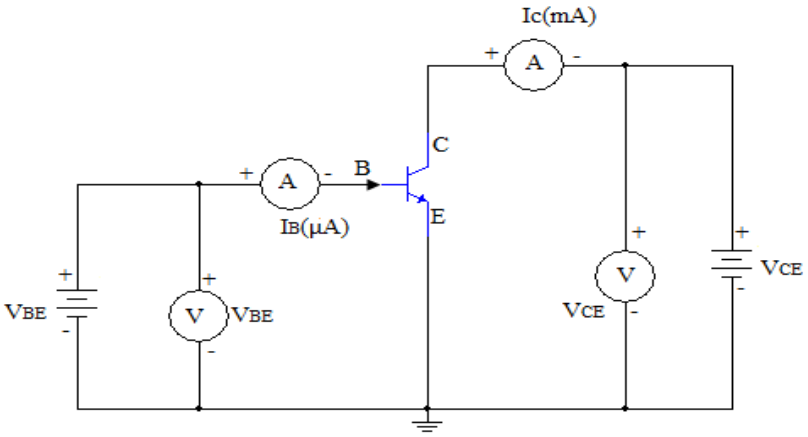
The frequency of oscillations is given by the relation,

$f_0=\frac{1}{2\pi\sqrt{LC}}$

5) **Draw the circuit of CE amplifier and explain its working.(9) (or) Explain the working of an emitter follower with neat circuit and waveform.(9) (or) Explain the working of BJT in CE configuration with suitable diagrams and characteristic curves (9) (JAN2014, JAN2013, APRIL 2011)**

VI CHARACTERISTICS OF COMMON EMITTER

Base- input terminal. Collector- output terminal. Emitter-common terminal



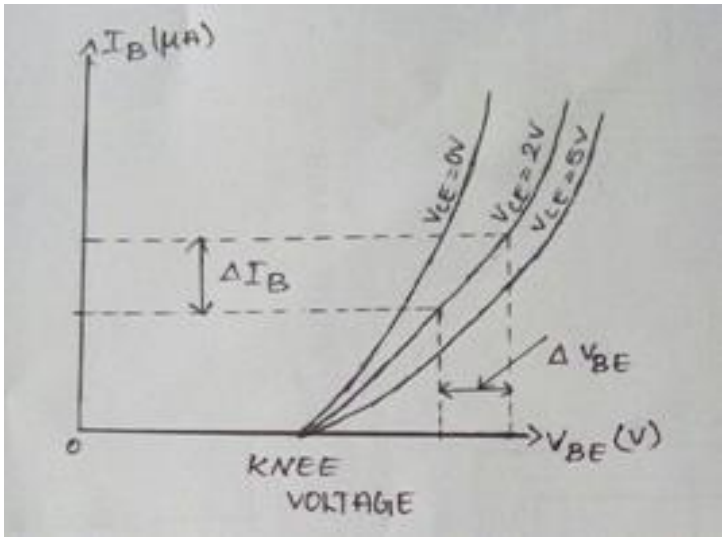
Input Characteristics:

Collector to emitter voltage is kept constant at zero volts. Base current is increased from zero to equal steps by increasing V_{BE}.

The value of V_{BE} is noted for each setting of I_B. This procedure is repeated for higher fixed values of V_{CE}, and the curves of $I_B$vs V_{BE} are drawn.

When V_{CE}=0, Emitter Base junction is forward biased and the junction behaves as a forward biased diode. Hence input characteristics V_{CE}=0 is similar to that of forward biased diode.

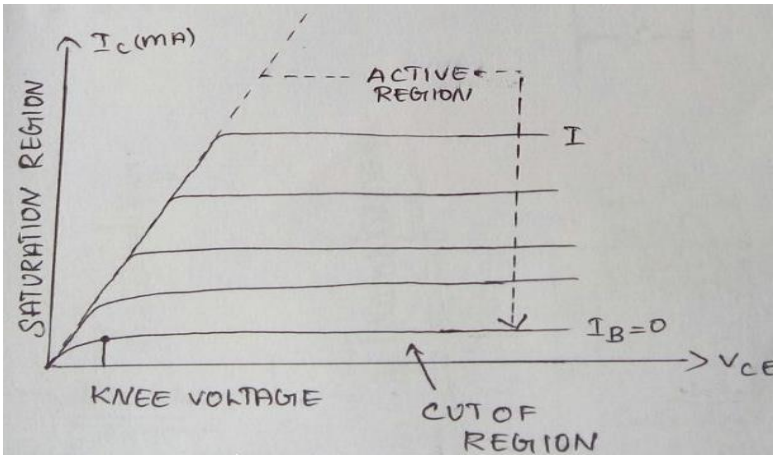
When VCE is increased, the width of the depletion region at reverse biased collector base junction will increase. Hence effective width of base will decrease. This effect causes a decrease in the base current I_B.



Hence to get same value of I_B as that of V_{CE}=0, V_{BE} should be increased. But the curve shifts to right as V_{CE} increase.

Input impedance Zi=$\frac{\Delta VBE}{\Delta IB}$

Output Characteristics



To determine the output characteristics, IB is kept constant at suitable value by adjusting BE voltage V_{BE}.

V_{CE} is increased in suitable equal steps from zero and collector current Ic is noted for each setting of V_{CE}.

Now the curves I_C vs V_{CE} are plotted for different constant values of I_B.

Output impedance, Zo=$\frac{\Delta VCE}{\Delta IC}$

Saturation Region

OA is called saturation region.

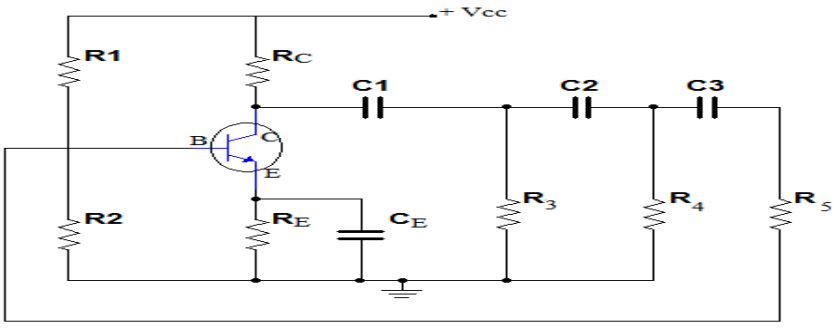
In this region,an increase in I_B doesnot cause a corresponding large change in I_C. The ratio of V_{CE} to I_C at any point in this region is called saturation resistance.

The region below the curve for I_B=0 is called cut off region. Central region where the curves are uniform in spacing and slope is called active region.

If transistor is to be used as a linear amplifier it should be operated in active region.

6) **Explain the working of RC phase shift oscillator using suitable diagram. (9)(JAN 2011)**

RC PHASE SHIFT OSCILLATOR



The oscillator circuits employing LC elements have two general drawbacks.

1. They suffer from frequency instability and poor waveform.

2. They cannot be used for very low frequencies because they become too much bulky and expensive.

Good frequency stability and waveform can be obtained from oscillators employing resistive and capacitive elements. Such amplifiers are called RC or phase shift oscillator and have the additional advantage that they can be used for very low frequency.

In a phase shift oscillator, a phase shift of 180° is obtained with a phase shift circuit instead of inductive or capacitive coupling.

A further phase shift of 180° is introduced due to transistor properties.

The fig shows a transistor phase shift oscillator which uses a three section RC feedback network for producing total phase shift of 180° (i.e. 60° per section) in the signal I feedback to base.

Since CE amplifier produces a phase reversal of the input signal, total phase shift becomes 360° or 0° which essential for sustained oscillation.

The circuit will stop oscillating when phase shift differ from 180°.

Frequency of oscillation is $F=\frac{1}{2\pi RC\sqrt{6}}$

Where R3=R4=R5=R and C1=C2=C3=C

ADVANTAGES

1. The circuit is simple to design

2. Can produce output over audio frequency range

3. Produce sinusoidal output waveform

4. It is fixed frequency oscillator.

DISADVANTAGES

1. By changing the values of R and C, the frequency of the oscillator can be changed. But the values of R and C of all three sections must be changed simultaneously to satisfy the oscillating condition. But it is practically impossible.

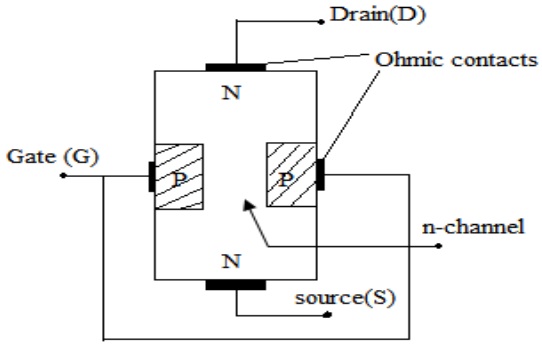
2. The frequency stability is poor due to the changes in the values of various components, due to effect of temperature, aging etc.

7) **Explain the working of JFET with a neat circuit diagram and necessary waveforms. (9)**

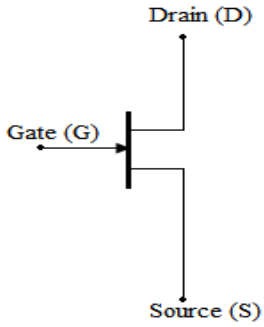
JUNCTION FIELD EFFECT TRANSISTOR

Construction of n- Channel JFET

The structure and symbol of n-channel JFET are illustrated as,



Structure for n-channel JFET



Symbol for n-channel JFET

A small bar of extrinsic semiconductor material, n type is taken and its two ends, two ohmic contacts are made which is the drain and source terminals of FET.

Heavily doped electrodes of P type material form pn junction on each side of the bar.

The thin region between the two p gates is called the channel. Since this channel is in the n type bar, the FET is known as n channel JFET.

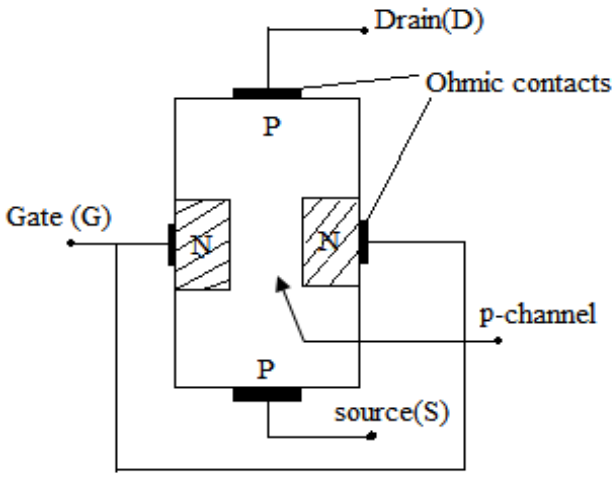
The electrons enter the channel through the terminal called source and leave through the terminal called drain.

The terminals taken out from heavily doped electrodes of p type material are called gates.

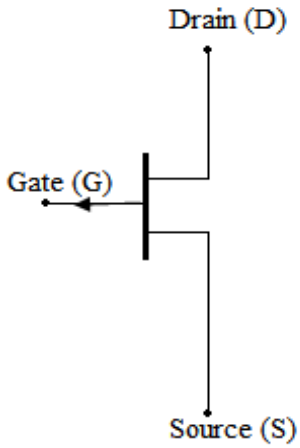
Usually, these electrodes are connected together and only one terminal is taken out which is called gate as shown in figure.

Construction of P-Channel JFET

The device could be made of p type bar with two n type gates are shown in below Figure. Then this will be p channel JFET.



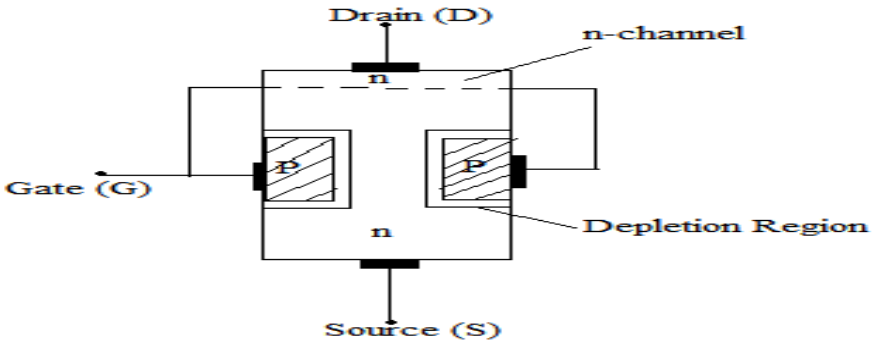
Structure for p-channel JFET



Symbol for p-channel JFET

UNBIASED JFET

In the absence of any applied voltage JFET has gate channel junctions under no bias condition. The result is a depletion region at each junction as shown in below figure.



This represent same depletion region of a diode under no bias conditions.Recall also that depletion region is that region which doesnot have any free carriers and therefore is unable to support conduction through the region.

Operation of JFET

In JFET the pn junction between gate and source is always kept in reverse biased conditions.

Since the current in a reverse biased pn junction is extremely small, practically zero the gate current in JFET is often neglected and assumed to be zero.

The voltage V_{DD} is applied between drain and source.

Gate terminal is kept open.

The bar is of n type material. Due to polarities of applied voltage as shown in below figure, the majority carriers (i.e) the electrons start flowing from the source to the drain.

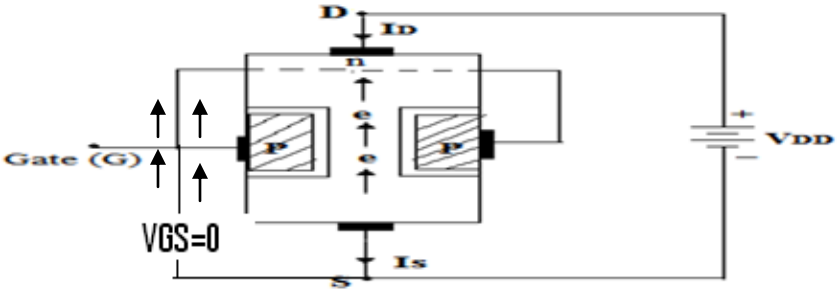
This flow of electrons makes the drain current, ID. The majority carriers move from source to drain through the gate regions. This space is commonly known as n channel JFET with gate open and VDD is applied between drain and source channel.

The width of this channel can be controlled by varying the gate voltage. The effect of gate voltage on channel width and on draincurrent ID

Consider the cases shown in below figures.

CASE 1: NO BIAS VOLTAGE ON GATES

Case 1 shows that an n-channel JFET with the gate directly connected to the source terminal.



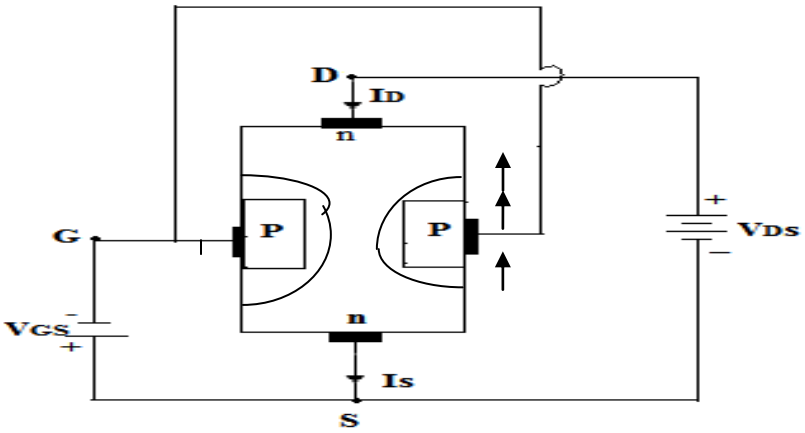
When drain voltage VDS is applied, a drain current ID flows in the direction shown. Since the n material is resistive, the drain current causes a voltage drop along the channel. This voltage drop reverse biased the pn junctions and causes the depletion region to penetrate into the channel.

Since gate is heavily doped and the channel is lightly doped, the width of the depletion region will mainly be spread in the channel shown in case 1. This penetration depends on the reverse bias voltage.

From case 1 we can observe that depletion region width is more at the drain side as compared to source side because near the junction, voltage at drain side is more than the voltage at the source side. This shows that reverse bias is not uniform near the junction; it gradually increases from source side to drain side.

CASE 2: SMALL NEGATIVE GATE SOURCE BIAS

The depletion region does not contain charge carriers, the space between two depletion regions are available for the conducting portion of the channel.

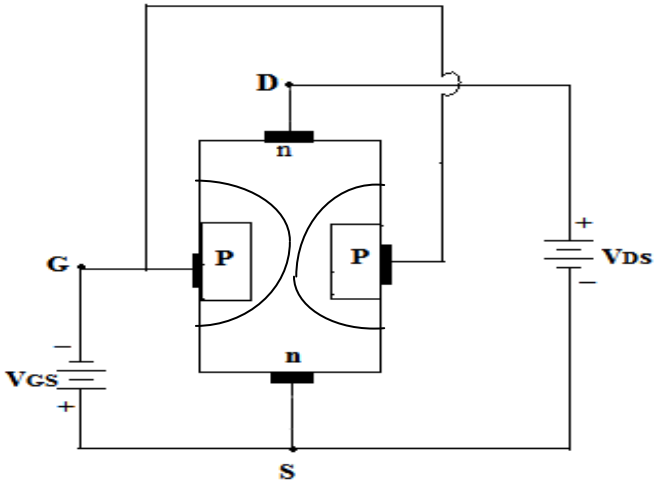


If externally apply reverse bias voltage to the gate, the reverse bias will further increase and hence increase the penetration of the depletion region, which reduces the width of the conducting portion of the channel.

As width of the conducting portion of the channel reduces, the number of electrons flowing from source to drain reduces and hence the current flowing from drain to source reduces.

CASE 3: LARGE NEGATIVE SOURCE BIAS

If we go on increasing the reverse bias voltage to the gate as shown in figure, depletion regions will increase more and more and stage will come when the width of the depletion regions will be equal to the original width of the channel leaving zerowidth for conducting portion of the channel as shown in above figure.



This will prevent any current flow from drain to source and this will cut off the drain current. The gate to source voltage that produces cut off is known as cut off voltage and it is denoted by V_{GS}(off).

The gate to source VGS at which the drain current is zero(or completely cut off) is called pinch off voltage. It is designated by the symbol VP or V_{GS}(off).

When the gate is shorted to source, there is minimum reverse bias between gate and source pn junction making depletion region width minimum and conducting channel width maximum.

In this case, maximum drain current flows which are designated by I_{DSS} and this are the maximum possible drain current in JFET.

From the above cases, it is cleared that the gate to source voltage controls the current flowing through channel and hence FET is also called voltage controlled current source.

8) **Explain the working of MOSFET with a neat circuit diagram and necessary waveforms. (9)**

MOSFET

Metal oxide semiconductor field effect transistor is an important semiconductor device and is widely used in many circuits applications.

The main advantage of MOSFET over JFET is that the input impedance of a MOSFET is much more than that of a JFET because of very small gate leakage current.

Since, the gate of MOSFET is insulated from the channel it is also termed as insulated gate field effect transistor(IGFET).

TYPES of MOSFET

There are two basic types of MOSFET.

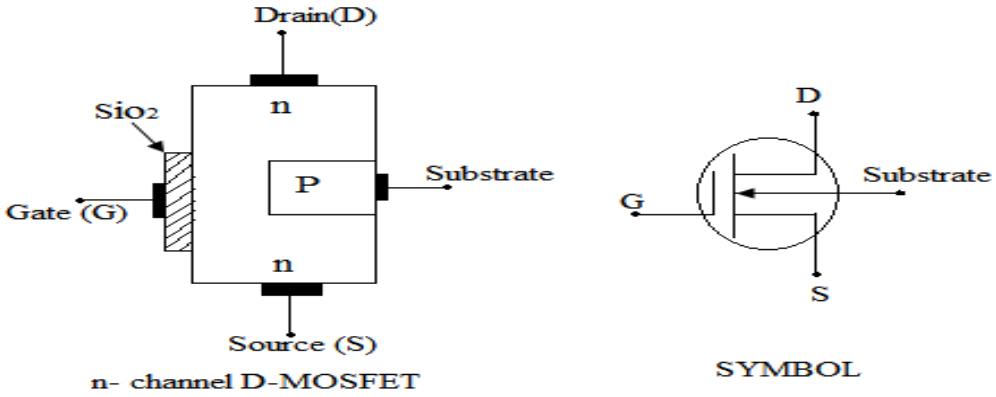
1. Depletion type MOSFET(D-MOSFET)

2. Enhancement type MOSFET (E-MOSFET)

4.3.3.1 DEPLETION TYPE MOSFET(D-MOSFET)

Construction of n- channel MOSFET:

The basic construction of n-channel depletion type MOSFET is illustrated as,

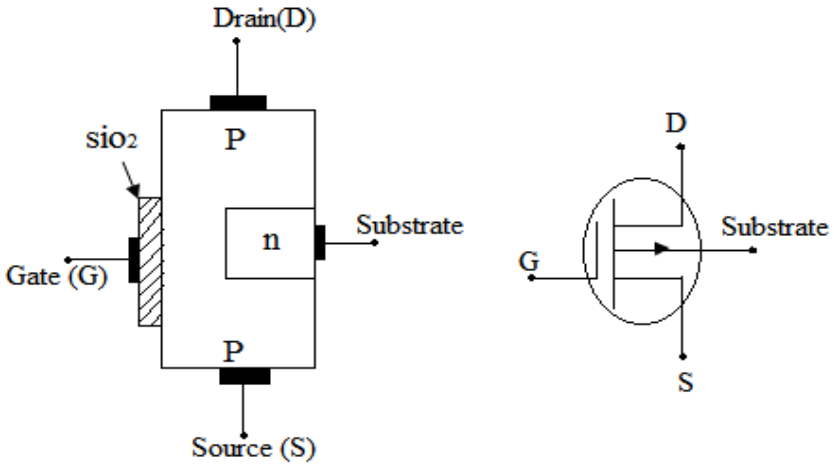


n- channel D-MOSFET

SYMBOL

N-channel D-MOSFET is a piece of n-type material with a p-type region called substrate on the right and insulated gate on the left. The free electrons in n channel flowing from source to drain must pass through narrow channel between the gate and p-type region.

A thin layer of metal oxide sio2 is deposited over a small portion of the channel. A metallic gate is deposited over the oxide layer. Gate is insulated from channel because sio2 is an insulator. This arrangement forms as a capacitor.



P - channel D-MOSFET

SYMBOL

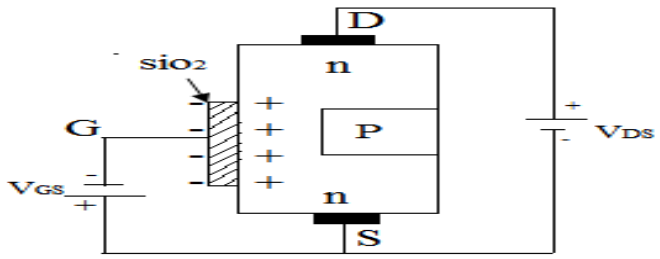
OPERATION OF D_MOSFET

1. Depletion Mode

2. Enhancement Mode

1. Depletion mode

Negative gate operation is called depletion mode.

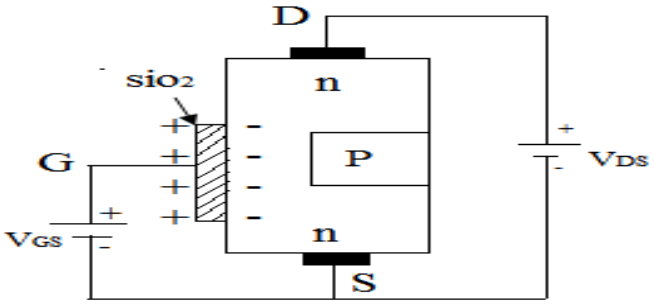


Since gate is negative, it means electrons are on the gate. Theseelectrons are on the gate. These electrons repel the free electrons in n-channel leaving a layer of positive ions in a part of channels.

Therefore lesser number of free electrons are made available for current conduction through n-channel greater the negative voltage on the gate, lesser is the current from source to drain.

2. Enhancement Mode

Positive gate operation is called enhancement mode.

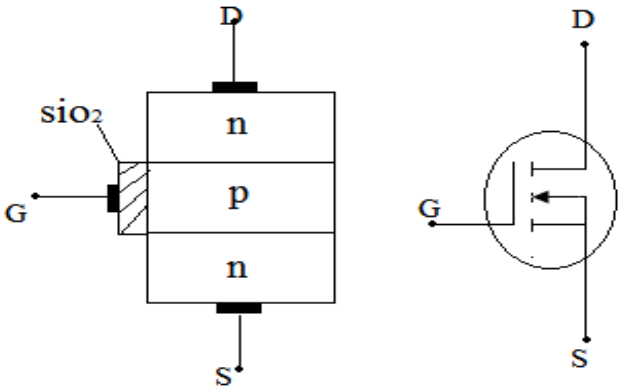


Since the gate is positive, it induces negative charges in the n-channel. These negative charges are the free electrons are drawn into the channel. Because these free electrons are added to those already in the channel is increased. Thus positive voltage enhances or increases the conductivity of the channel.

Greater the positive voltage on the gate, grater the conduction from source to drain.

4.3.3.2 ENHANCEMENT TYPE MOSFET

Its gate construction is similar to that of D-MOSFET. It has no channel between source and drain so it is called as OFF-MOSFET.

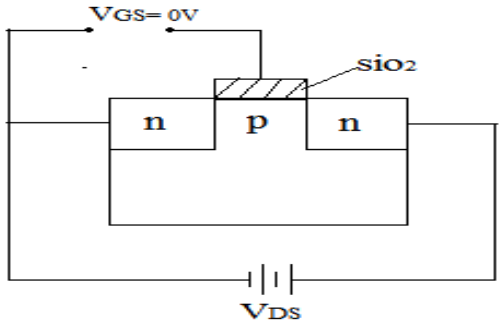


n-channel E-MOSFET Symbol

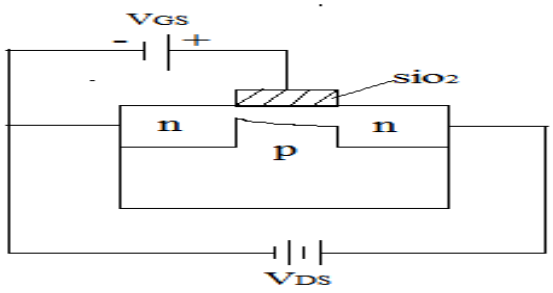
It requires a proper gate voltage to form a channel. It can be operated only in E-Mode.

It is only by the application of VGS of proper magnitude and polarity that device starts conducting. The minimum value of VGS of proper polarity that turns o the E-MOSFET is called threshold voltage(VGS (th)).

1. When VGs=0v, there is no channel. The P substrate has only a few thermally produced electrons so that drain current is zero. E-MOSFET is normally OFF when VGS=0V.



2.When gate is made positive, it attracts free electron into p-region. The free electrons combine with holes next to sio2 layer.



If V_G is positive through all holes touching the sio_2 layer are filled and free electrons begin to flow from source to drain. This effect create thin layer of n-type material adjacent to sio_2 layer. Thus E-MOSFET is turned on and current flowing from Source to drain.

UNIT – V
DIGITAL ELECTRONICS

Boolean algebra – Reduction of Boolean expressions - De-Morgan's theorem - Logic gates - Implementation of Boolean expressions - Flip flops - RS, JK, T and D. Combinational logic - Half adder, Full adder and Subtractors. Sequential logic - Ripple counters and shift registers

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2 Marks

1. What is a logic gate?

The elements of performing logic functions are usually called gates. The most common logic gates are OR, AND and NOT gates.

2. What are universal gates?

NAND and NOR gates are known as universal gates because they can be used as the universal building blocks to build any logic circuit.

3. State Boolean algebra.

In simplification of Boolean expression, the redundant term in an expression can be eliminated to form the equivalent expression.

4. Define De Morgan's theorem (APRIL 2011)

Theorem 1: It that the complementary of a sum is equal to the product of complement,

$$\overline{A+B} = \overline{A} \cdot \overline{B}$$

Theorem 2: It says the complementary of a product equals the sum of complements

$$\overline{A.B} = \overline{A} + \overline{B}$$

5. Define half adder and full adder.(JAN 2013)

Half adder: The logic circuit which performs the arithmetic sum of two bits is called half adder

Full adder: The logic circuit which performs the arithmetic sum of 3 bits and carries from the previous addition.

6. Define half substractor and full substractor.

Half substractor: The logic circuit which performs the subtraction between two bits is called half subs tractor

Full substractor: It is combination circuits that perform a subtraction between 2 bits. It is also takes into account borrow of the lower significant stage.

7. Define the flip-flop?

It is a sequential device that samples its input and changes its output only at the time which is determined by the clocking signal.

8. Define counter.(JAN 2010)

A digital circuit used for counting. Counter is divided into synchronous and asynchronous counter. The change of the state of a particular flip flop is depending on the present state of other flip flop.

9. What is difference between Sequential and combination logic?

Sequential logic	**combination logic**
It has memory	No memory
Depends on present as well as previous state	Depends only on present state
Example: shift register , ripple counter	Example: ADDER , SUBTRACTOR

10. Define shift register(APRIL 2010)

A register is a group of flip flop that can be used to store a binary number. Register has a variety of application in digital system including microprocessor.

11. Define J-K Flip-flop. (NOV /DEC 2011)

The input J and K behave like inputs S and R to set and clear the flip flop respectively. The input J is for set and the input K for reset. If J=K=1, then output switched to the complementary state of Q is called toggle state. Example: Q=1 then Q(t+1)=0 and vice versa.

12. Define T Flip Flop.

If J=K=1, then output is the complement of the previous state, so that the J-K flip flop is converted into a T flip flop.

13. Define R-S flip flop.

The most basic type of flip flop is the set/reset flip flop. This can be built using either two NOR gates or two NAND gates.

14. Write the implementation of Boolean expression

Boolean expression also has commutative, associative, and distributive properties as listed below:

- Commutative: A. B = B. A and A + B = B + A
- Associative: (A. B). C = A. (B. C) and (A + B) + C = A + (B + C)
- Distributive: A. (B + C) = A. B + A. C
- De Morgan's laws

15. What are basic gates?

OR, AND and NOT gate

16. What are special gates?

X-OR gate and X-NOR gate

17. What developed gates?

NOR, NAND, X-OR and X-NOR gate

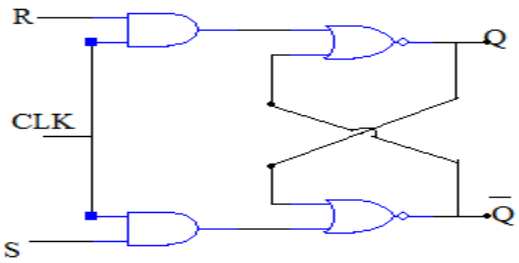
9 Marks

9) **Explain the operation of JK flip flop with logic diagram and truth table. (9)(JAN 2011, JAN 2010,MAY 2012)**

JK FLIP FLOP

A JK flip flop has two inputs, similar to the RS flip flop. JK means Jack Kilby.

The negative edge triggered JK flip flop is illustrated as,



JK Flip Flop

The flip flop is inactive, when the clock input is low or on its positive going edge. The truth table for the JK flip flop is given by,

CLK	J	K	Q
0	0	0	No Change
0	0	1	No Change
0	1	0	No Change
0	1	1	No Change
1	0	0	No Change
1	0	1	0
1	1	0	1
1	1	1	Toggle

Case 1:

When J=0 and K=0, the clock pulse has no effect on the output and the output of the flip flop is the same as its previous value. This is because when both the J and K are 0.

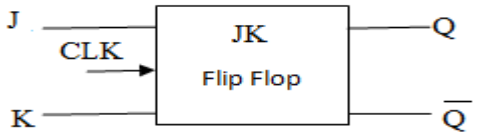
Case 2: When J=0 and K=1 therefore Q becomes 0. The condition will reset the flip flop.This represents the RESET state of flip flop.

Case 3:

When J=1and K=0, therefore Q becomes 1. This condition will set the flip flop. This represents the SET state of Flip flop.

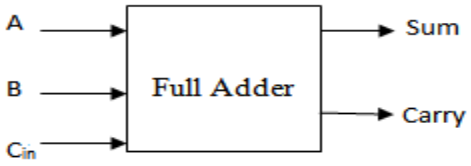
Case 4:

When J=1 and K=1, the outputs Q and $\overline{Q}$ toggles or alternate with each negative going clock edge.



10) **Draw and explain the operation of full adder with truth table.(5)(JAN 2014, MAY 2013, JAN 2010, NOV 2011)**

A **full adder** is a combinational circuit that forms the arithmetic sum of three bits. It consists of three inputs and two outputs.



The Boolean function for sum is given by,

Sum (S) = $\overline{A}\,\overline{B}\,C_{in} + \overline{A}\,B\,\overline{C_{in}} + A\,\overline{B}\,\overline{C_{in}} + ABC_{in}$

$= \overline{A}\,(\overline{B}\,C_{in} + B\,\overline{C_{in}}) + A\,(\overline{B}\,\overline{C_{in}} + BC_{in})$

$= \overline{A}\,(B \oplus C_{in}) + A\,(\overline{B \oplus Cin})$

$= A \oplus B \oplus Cin$

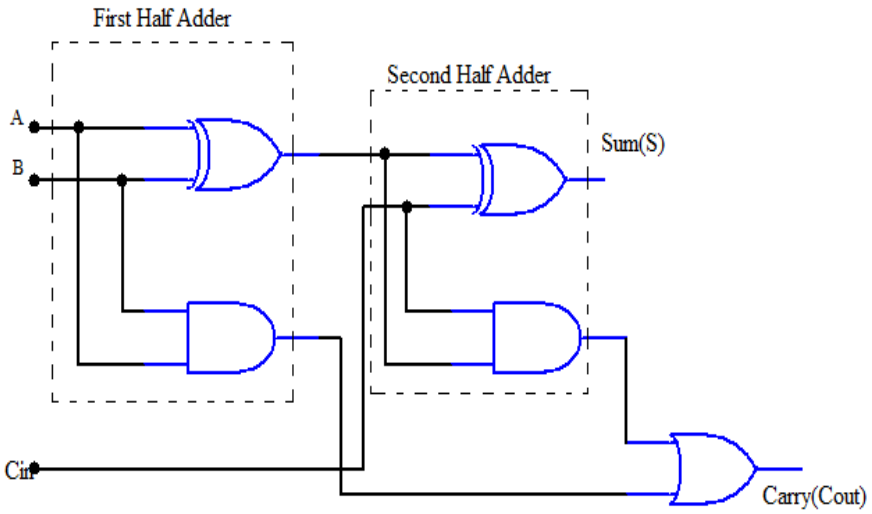
The Boolean function for Carry is given by,

Carry(C_{out})= $\overline{A}\,BC_{in} + A\,\overline{B}\,C_{in} + AB\,\overline{C_{in}} + ABC_{in}$

$= C_{in}(\overline{A}\,B + A\,\overline{B}) + AB(\overline{C_{in}} + C_{in})$

$= C_{in}(A \oplus B) + AB$

A full adder logic circuit can be implemented with two half- adders and one OR gate, as shown in below logic diagram.

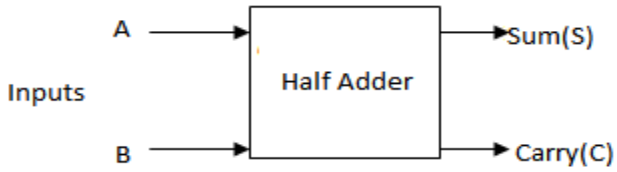


Logic Diagram for Full Adder

INPUTS			OUTPUTS	
A	B	C_{in}	Sum	Carry
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

11) **Draw and explain the operation of half adder with truth table.(5) (APR 2011, JAN 2010)**

HALF ADDER: The half adder operation needs two binary inputs: Augend and Addend bits and two binary outputs: Sum and carry



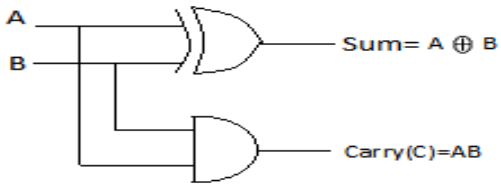
The truth table gives the relation between input and output variables for half adder operation.

Input		Output	
A	B	SUM(S)	CARRY(C)
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

$$Sum(S) = A'B + AB'$$

$$= A \oplus B$$

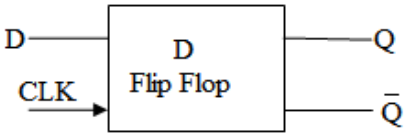
$$Carry(C) = AB$$



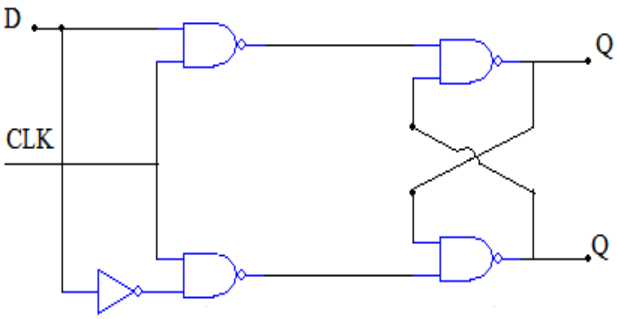
Logic Diagram

12) **Draw the diagram of D flips flop and explains its operation. Write the truth tables of D flip flop.(4) (JAN 2014, MAY 2013)**

D FLIP FLOP



The realization of positive edge triggered D flip flop using NAND gates is illustrated,



Positive Edge Triggered D Flip Flop

The Flip Flop is inactive, when the clock input is low or on its negative going edge.

The outputs Q and $\bar{Q}$ change only on the positive going edge of the incoming clock pulse.

If D=0, when the positive going clock appears, then Q=0 and $\overline{Q}$=1.

If D=1, when the positive going clock edge appears, then Q=1 and $\overline{Q}$=0.

The data input and output are the same after the positive going pulse,(i.e.), the input data D is stored only on the positive going edge of the incoming clock pulse.

Truth table for D flip flop is given by,

CLK	D	Q
0	0	No Change
0	1	No Change
1	0	0
1	1	1

13) **Write detailed notes about the operation of shift register with necessary diagram.(9) (JAN 2014, JAN 2013,MAY 2013,JAN 2011,MAY 2012)**

SHIFT REGISTER

A Register is a group of flip flops that can be used to store a binary information number. If the output of each flip flop is connected to the input of the adjacent flip flop, then the circuit is called a shift register.

In each successive clock pulse, moves or shifts the data bits one flip flop to the left or the right, depending on the flip flops are connected.Register finds a variety of applications in digital systems including microprocessors.

Registers are classified depending upon the way in which data is entered and retrieved.

They are

1. Serial in Serial out(SISO)

2. Serial in Parallel out (SIPO)

3. Parallel in Serial out (PISO)

4. Parallel in Parallel out (PIPO)

SERIAL IN SERIAL OUT (SISO)

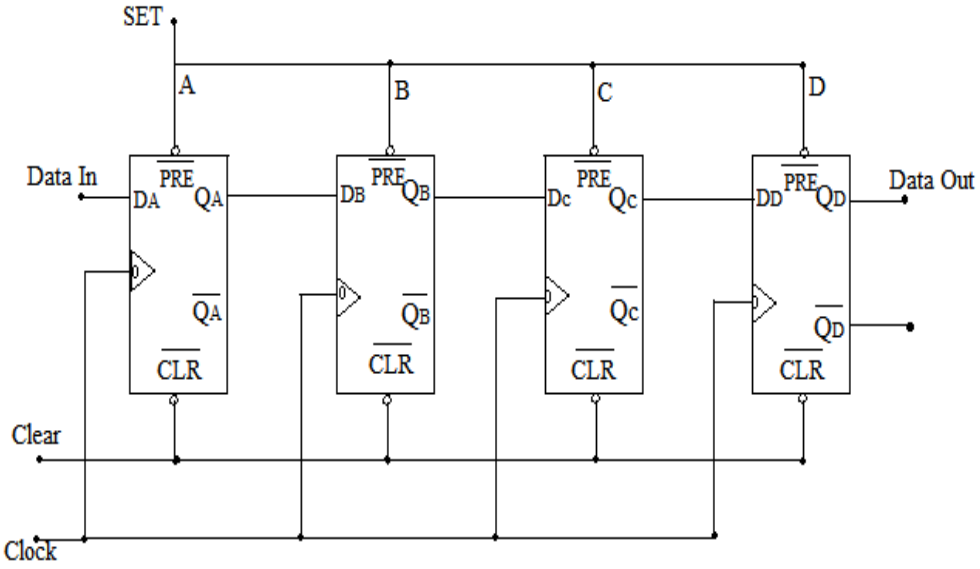
Input data is applied one bit at a time to the first flip flop in a chain and read out from the last flip flop in a chain one bit at a time.

The four D flip flops are connected in serial in serial out fashion is illustrated by,

The output of Q of one flip flop is connected to the D input of the next flip flop.

CLK, PRE' and CLR' signals are connected in parallel to all four flip flops, so that they are all clocked, all set, or all reset at the same time.

This shift operation is known as the shift right register because when the clock pulse is given the data are shifted to the right.



Operation:

Initially register is cleared.

So $Q_A=Q_B=Q_C=Q_D=0$

Next assume that the data signal 1 is given as the input to the flip flop A.

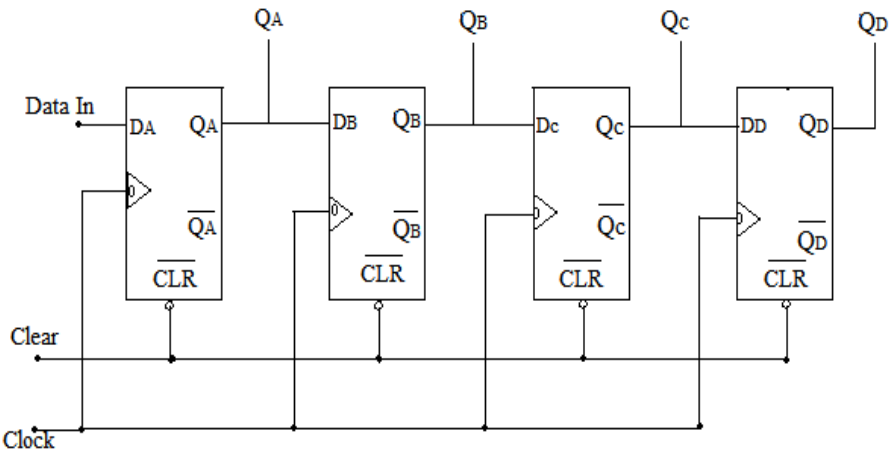
When the next positive edge of the clock pulse occurs, the 1 on the D inputs of the A flip flop will be transferred to the Q_A output.

On the next rising edge of the clock signal, the 1 at Q_A is transferred to QB output. The D input for the flip flop A is 0 and hence the output Q_A is 0.

On the third positive edge of the clock pulse Q_C becomes high and for the 4th positiveedge of the clock pulse Q_D becomes high.

SERIAL IN PARALLEL OUT SHIFT REGISTER

A Serial in parallel out shift register is illustrated as,



Input data is applied one bit at a time to the D input of the first flip flop in a chain and read out from the Q outputs in parallel after a data word is all shifted in.

PARALLEL IN SERIAL OUT (PISO)

In a parallel in serial out shift registers, the bits are entered simultaneously into their respective stages on parallel lines rather than on a bit by bit basis on one line as with serial data inputs.

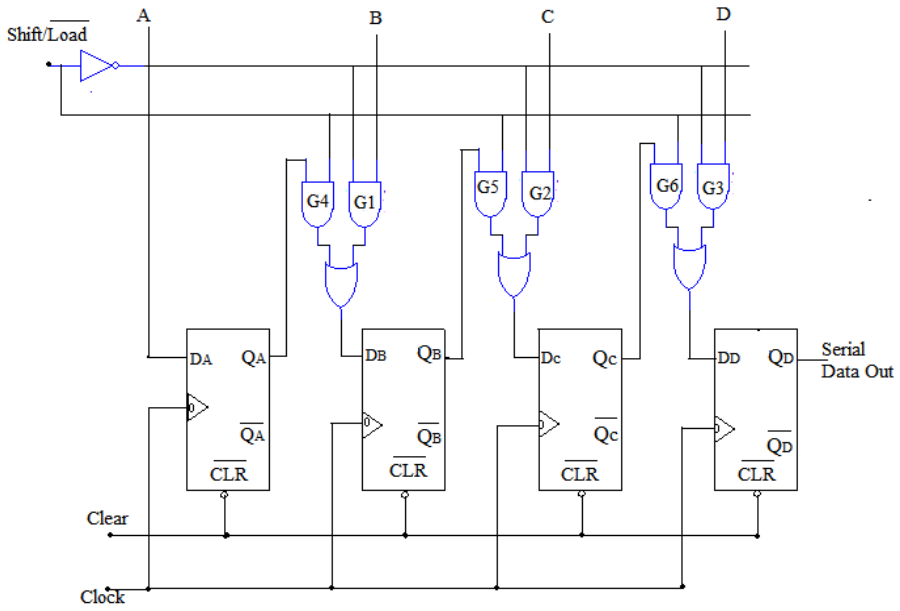
The four bit PISO shift register is illustrated as, shown below.

There are four input data lines A, B, C and D and a shift/ $\overline{load}$ input that allows four bits for data to be entered into the shift register in a parallel fashion.

When shift/ load is low, gates G1, G2 and G3 are enabled, allowing each data bit to be applied to the D input of the respective flip flops.

When clock pulse is applied the flip flops with D=1 will SET and those with D=0 will RESET thereby storing all 4 bits simultaneously.

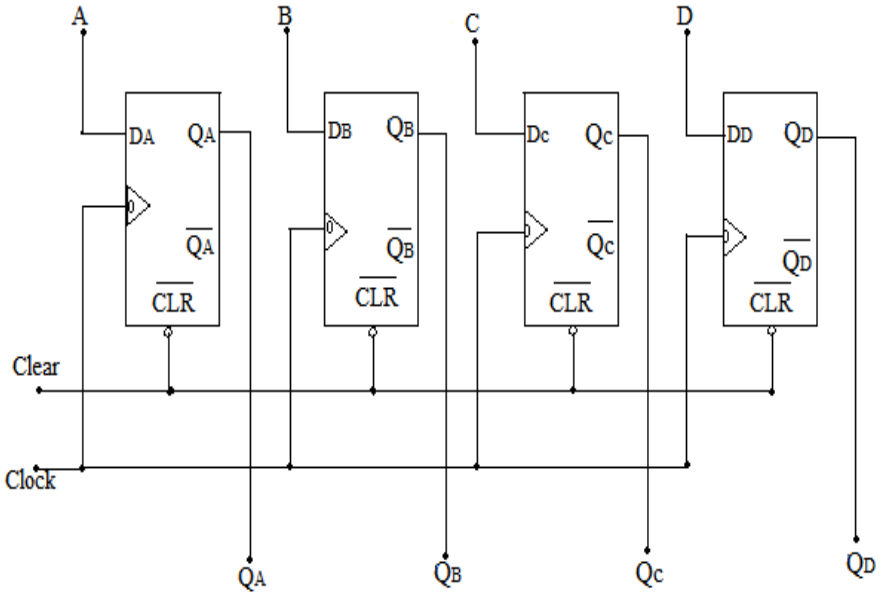
When shift/ $\overline{load}$ is high, gates G4, G5 and G6 are enabled, allowing the data bits to shift right from one state to the next.



The OR gates allow either the normal shifting operation or the parallel data entry operation, depending on which AND gates are enabled by the shift/load' control signal.

PARALLEL IN PARALLEL OUT

Data is entered into the PIPO shift register as in the previous PISO case. The difference is,the outputs are taken only from the Q's of all the flip flops.



14) **Explain the operation of Binary counter. (9)(NOV 2011)**

COUNTERS

It is a digital circuit consisting a set of Flip flop whose states represent the binary number equivalent to the number of clock pulses that have occurred at the input of the counter, i.e. it counts the number of clock pulses.

Counters are of two types:

1. Synchronous counters

2. Asynchronous counters

ASYNCHRONOUS COUNTERS

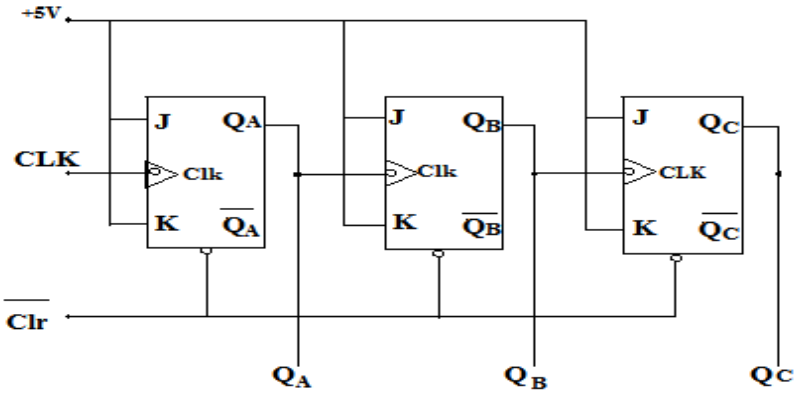
In asynchronous counters, the output of the previous flip flop is connected to the clock input of the following flip flop.

Due to the propagation delay of flip flops, no two flip flops are triggered simultaneously.

They are also called as ripple counter.

A n-bit counter will have n number of flip flops and 2^n states and the binary numbers that can be counted in 2^n-1. Here n=4 i.e. 2^4-1= 15.

Working: Ripple Counter



The fig shows the connection of JK flip flop to act as a binary counter. For each flip flop, the J and K inputs are connected to +5V.

This means that each flip flop will toggle when its clock input receives a negative going clock pulse. The MSB of the counter is Q_D and the LSB of the counter is Q_A.

Initially, the $\overline{CLR}$ inputs of all the flip flops are tied to ground and hence all the Q outputs will be '0'. When the flip flops are counting, the $\overline{CLR}$ input is tired up to +5V, its inactive state.

Fig b represent how the outputs of each flip flop respond to each negative going clock edge. At each negative going clock edge, the count increases by '1'.

Initially the count is 0000. For the first negative edge of the clock input, the LSB flip flop sets, increasing the count to 0001.

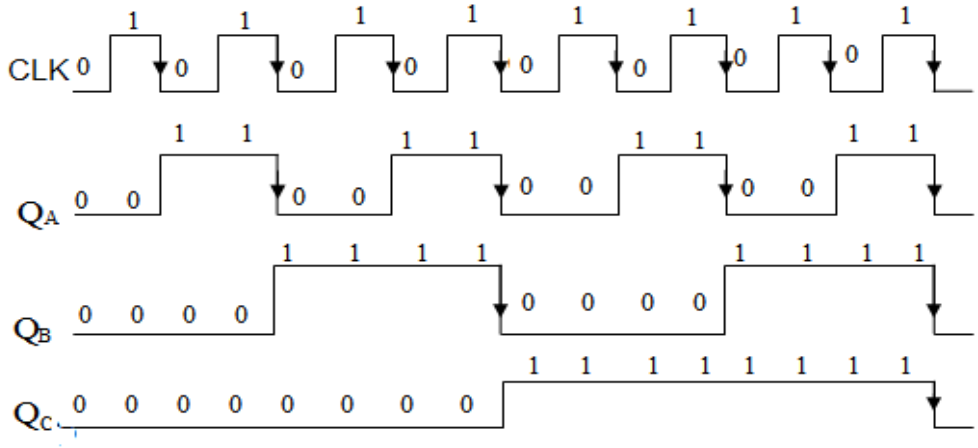
The Q_A output is connected to the clock input of the next most significant flip flop. This high clock pulse does not cause the Q_B output to change.

However, the second negative going clock edge applied to the LSB flip flop causes the Q_A output to toggle from 1 to 0. This negative going clock edge causes the count to 0010. This count continues until 1111 is reached.

Then on the next negative going clock edge, all flip flop outputs toggle back to '0' for a count of 0000.

Truth Table

State	Q_C	Q_B	Q_A
0	0	0	0
1	0	0	1
2	0	1	0
3	0	1	1
4	1	0	0
5	1	0	1
6	1	1	0
7	1	1	1



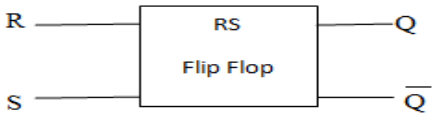
Timing diagram for three bit Asynchronous counter

It illustrates the changes in the state of the flip flop outputs in response to the clock.

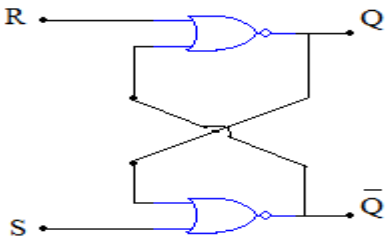
15) **Explain the operation of RS flip flops. (5)(APR 2011, JAN 2010,MAY 2012)**

RS FLIP FLOP

The most basic type of flip flop is the Reset/Set flip flop. This can be built using either two NOR gates or two NAND gates



The realizations of RS flip flop using NOR gate is illustrated as,



Each Flip flop has two outputs, Q and $\overline{Q}$.

When Q=1 and $\overline{Q}$=0, the flip flop is said to be set.

When Q=0and $\overline{Q}$=1, the flip flop is said to be reset.

The truth table for the RS flip flop is given by,

R	S	Q
0	0	No Change
0	1	1(Set)
1	0	0(Reset)
1	1	Indeterminate

CASE 1:

When R=0 and S=0, the flip flop remains in its present state, (i.e.) Q remains unchanged.

CASE 2:

When R=0 and S=1, the outputs Q=1 and $\overline{Q}$=0, therefore the flip flop is Set.

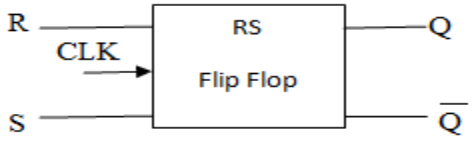
CASE 3:

When R=1 and S=0, the outputs Q=0 and $\overline{Q}$=1, therefore the flip flop is Reset.

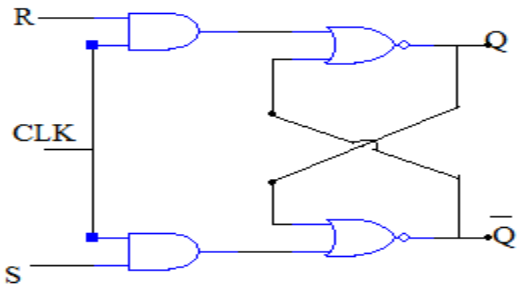
CASE 4:

When R=1 and S=1, Condition is forbidden as it violates the basic definition of a flip flop taking both Q and $\overline{Q}$ to the low state.

CLOCKED RS FLIP FLOP



The RS flip flop that has a clock input illustrated as shown below,



Clocked RS Flip Flop

The truth table of the clocked RS flip flop is givenby,

CLK	R	S	Q
0	0	0	No Change
0	0	1	No Change
0	1	0	No Change
0	1	1	No Change
1	0	0	No Change
1	0	1	0
1	1	0	1
1	1	1	Indeterminate

It is also called as gated RS Flip Flop.

Clocked RS flip flop is designed by adding two AND gates to a basic NOR gate flip flop.

When the clock is low, the outputs will not change regardless of the conditions of the R and s inputs.

When the clock input is high, the flip flop will set, if R=0 and S=1.

When the clock input is high, R=1 and S=0, the flip flop will reset.

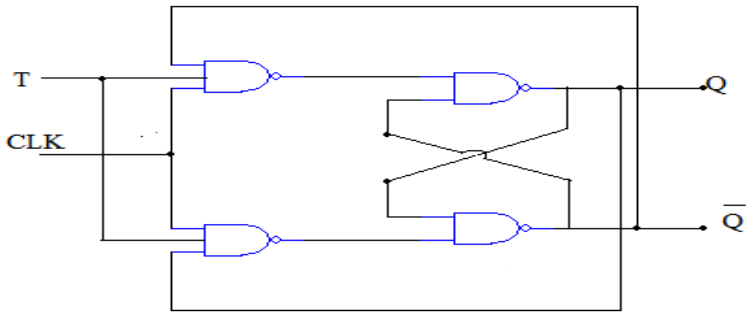
16) **Explain the operation of T flip flop (5) (JAN 2011)**

T FLIP FLOP

T flip flop is also known as “Toggle” flip flop. The T flip flop is a modification of the JK flip flop, by connecting both inputs J and k together.

If J =k=1, then output is the complement of the previous state, so that the JK flip flop is converted into a T flip flop.

The realization of positive edge triggered T flip flop is illustrated as,



Positive edge triggered T flip flop

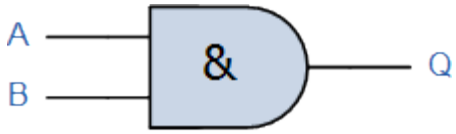
Truth Table for T flip flop is given by,

CLK	T	Q
0	0	No Change
0	1	No Change
1	0	No Change
1	1	Q_{N-1}

17) **Explain with logic symbol and truth table of AND, NOT, OR, NAND, NOR, EXOR gates (9) (APR 2010)**

AND Gate

For a 2-input AND gate, the output Q is true if BOTH input A "AND" input B are both true, giving the Boolean Expression of: (Q = A and B).

Symbol	Truth Table		
 2-input AND Gate	A	B	Q
	0	0	0
	0	1	0
	1	0	0
	1	1	1
Boolean Expression Q = A.B	**Read as A AND B gives Q**		

Note that the Boolean Expression for a two input AND gate can be written as: A.B or just simply ABwithout the decimal point.

OR Gate

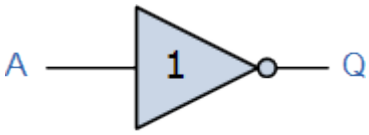
For a 2-input OR gate, the output Q is true if EITHER input A "OR" input B is true, giving the Boolean Expression of: (Q = A or B).

Symbol	Truth Table		
	A	B	Q

	0	0	0
	0	1	1
	1	0	1
	1	1	1
Boolean Expression Q = A+B	**Read as A OR B gives Q**		

NOT Gate

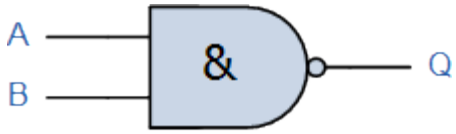
For a single input NOT gate, the output Q is ONLY true when the input is "NOT" true, the output is the inverse or complement of the input giving the Boolean Expression of: (Q = NOT A).

Symbol	Truth Table	
 Inverter or NOT Gate	A	Q
	0	1
	1	0
Boolean Expression Q = NOT A or A	**Read as inversion of A gives Q**	

The NAND and the NOR Gates are a combination of the AND and OR Gates with that of a NOT Gate or inverter.

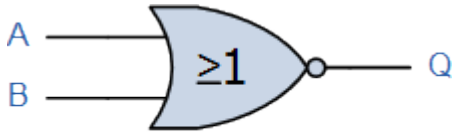
NAND (Not AND) Gate

For a 2-input NAND gate, the output Q is true if BOTH input A and input B are NOT true, giving the Boolean Expression of: (Q = not(A and B)).

Symbol	Truth Table		
 2-input NAND Gate	A	B	Q
	0	0	1
	0	1	1
	1	0	1
	1	1	0
Boolean Expression Q = A .B	**Read as A AND B gives NOT-Q**		

NOR (Not OR) Gate

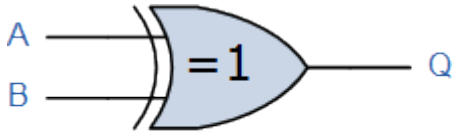
For a 2-input NOR gate, the output Q is true if BOTH input A and input B are NOT true, giving the Boolean Expression of: (Q = not(A or B)).

Symbol	Truth Table		
 2-input NOR Gate	A	B	Q
	0	0	1
	0	1	0
	1	0	0
	1	1	0
Boolean Expression Q = A+B	**Read as A OR B gives NOT-Q**		

As well as the standard logic gates there are also two special types of logic gate function called anExclusive-OR Gate and an Exclusive-NOR Gate..

EX-OR (Exclusive OR) Gate

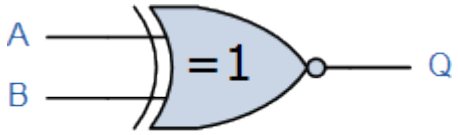
For a 2-input Ex-OR gate, the output Q is true if EITHER input A or if input B is true, but NOT both giving the Boolean Expression of: (Q = (A and NOT B) or (NOT A and B)).

Symbol	Truth Table		
 2-input Ex-OR Gate	A	B	Q
	0	0	0
	0	1	1
	1	0	1
	1	1	0
Boolean Expression Q = A B			

EX-NOR (Exclusive NOR) Gate

For a 2-input Ex-NOR gate, the output Q is true if BOTH input A and input B are the same, either true or false, giving the Boolean Expression of: (Q = (A and B) or (NOT A and NOT B)).

Symbol	Truth Table



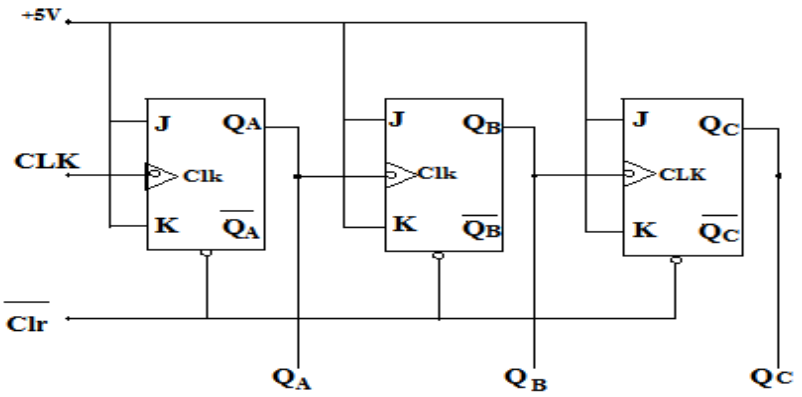
2-input Ex-NOR Gate

A	B	Q
0	0	1
0	1	0
1	0	0
1	1	1

Boolean Expression Q = A B

18) **Explain the operation of ripple counter(9)(APR 2010)**

Ripple Counter



The fig shows the connection of JK flip flop to act as a binary counter. For each flip flop, the J and K inputs are connected to +5V.

This means that each flip flop will toggle when its clock input receives a negative going clock pulse. The MSB of the counter is Q_D and the LSB of the counter is Q_A.

Initially, the $\overline{CLR}$ inputs of all the flip flops are tied to ground and hence all the Q outputs will be '0'. When the flip flops are counting, the $\overline{CLR}$ input is tired up to +5V, its inactive state.

Fig b represent how the outputs of each flip flop respond to each negative going clock edge. At each negative going clock edge, the count increases by '1'.

Initially the count is 0000. For the first negative edge of the clock input, the LSB flip flop sets, increasing the count to 0001.

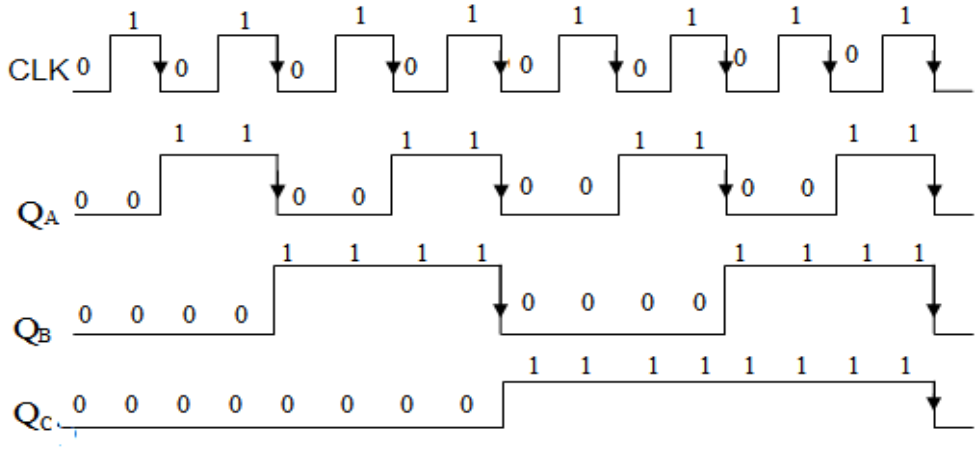
The Q_A output is connected to the clock input of the next most significant flip flop. This high clock pulse does not cause the Q_B output to change.

However, the second negative going clock edge applied to the LSB flip flop causes the Q_A output to toggle from 1 to 0. This negative going clock edge causes the count to 0010. This count continues until 1111 is reached.

Then on the next negative going clock edge, all flip flop outputs toggle back to '0' for a count of 0000.

Truth Table

State	Q_C	Q_B	Q_A
0	0	0	0
1	0	0	1
2	0	1	0
3	0	1	1
4	1	0	0
5	1	0	1
6	1	1	0
7	1	1	1



Timing diagram for three bit Asynchronous counter

It illustrates the changes in the state of the flip flop outputs in response to the clock.

UNIT – VI
COMMUNICATION AND COMPUTER SYSTEMS

Model of communication system - Analog and digital - Wired and wireless channel. Block diagram of various communication systems - Microwave, satellite, optical fiber and cellular mobile system. Network model - PAN, LAN, MAN and WAN - Circuit and packet switching - Overview of ISDN.

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2 Marks

1.Define the communication

Communication is a process of transfer of information bearing signal from one place to another

2. Define digital signal.

A signal define at discrete instant of time is called a discrete time signal or digital signal.

3. What is modulation?

Modulation is the process of changing some parameter of a high frequency carrier signal in accordance with the instantaneous variation of the message signal.

4. What are the types of analog modulation?

- Amplitude modulation
- Angle modulation

5. What are the advantages of FM over AM?

- The amplitude of the frequency modulation wave in FM is independent of the depth of the modulation.
- In AM, when the modulation index increase, the total transmission power is increased. In FM, the total transmitted power is always same but the bandwidth is increased with the increased modulation index.
- By increase frequency deviation, the noise can further be reduced in FM, whereas AM doesn't have this feature.
- As there is a guard band between FM stations, there is less adjacent channel interference in FM then in AM

6. What is transmitter?

A transmitter is advice that transmits information by means of waves.

7. What is microwave communication?

Electromagnetic waves in the frequency range of GHz to 30 GHz are referred to as microwaves.

8. What is satellite communication system?

A satellite communication is a RF repeater station which has made broadband long distance communication feasible and ensures a high quality service.

9. What is advantage of optical fibers over coaxial cable?(JAN 2011)

Optical fibers are used for transmission of optical signal in the same manner of co-axial Cable for radio wave transmission.

10. What are the applications of optical fiber system?

- International communication
- Inter-city communication
- Inter-exchange communication
- Data links
- Domestic communication
- Plant and traffic control etc.

11. Define uplink satellite system

The primary component of the uplink section of a satellite system is the earth station transmitter with uplink frequency of 6 GHz and 14 GHz

12. Define down link of satellite system

The primary component of the down link section of a satellite system is the earth station receiver with down link frequency of 4 GHz and 12 GHz

13. What are the elements of communication system?

Input transducer, transmitter, channel, receiver, and output transducer are element of communication system.

14. What are of type's wireless communication? (JAN 2013,APRIL 2010)

Microwave, satellite, and cellular mobile communication system.

15. What are wired communication?

Parallel wire, coaxial cable and optical fiber communication.

16. Define the network model?

A network consists of two or more computer that is liked in order to share resource, exchange files or allow electronic communication.

17. Define an ISDN?

An ISDN is a network, which provides end to end digital connectivity between user to support a wide range of service including voice and non voice.

18. What is cellular mobile communication?

A cell phone is a portable telephone which has been used for making communication through a cell site or transmitting tower

19. What is optical fiber communication?

Fiber-optic communication is a method of transmitting information from one place to another by sending pulses of light through an optical fiber. The light forms an electromagneticcarrier wave that is modulated to carry information.

20. What is satellite communication?

Satellite receives the signal from transmitting earth station, and then it amplifies and retransmits the signal towards the other location of receiving earth station.

21. Define LAN

A local area network (LAN) is a computer network covering a small physical area, like a home, office, or small groups of buildings, such as a school, or an airport.

22. Define MAN

A metropolitan area network (MAN) is a large computer network that usually spans a city or a large campus. A MAN usually interconnects a number of local area networks (LANs) using a high-capacity backbone technology, such as fiber-optical links, and provides up-link services to wide area networks and the Internet.

23. Define WAN (JAN 2014)

A wide area network (WAN) is a computer network that covers a broad area (i.e., any network whose communications links cross metropolitan, regional, or national boundaries).

24. Define wired channel

Wire Channel is a medium that transmit the information from the transmitter to receiver through coaxial cable or optical fiber.

25. Define wireless channel

Wireless Channel is a medium that transmit the information from the transmitter to receiver through Microwave, satellite, and cellular mobile communication system

26. What are types of communication system? ?(JAN 2013,APRIL 2010)

- Wire communication: Parallel wire, coaxial cable and optical fiber communication.
- Wireless communication: Microwave, satellite, and cellular mobile communication system

10 Marks

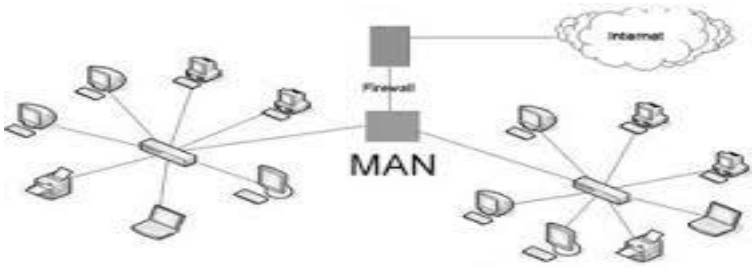
1) **Write short notes on (JAN 2013)**
   a)MAN (5)
   b)WAN (5)

METROPOLITAN AREA NETWORK (MAN)

It is a network that is used to connect the computers over a large geographical area, such as district or city. Two or more interconnected LANs are known as MAN. MAN connects computer resources across an area greater than LAN and smaller than WAN.

A MAN is typically owned an operated by a single entity such as a government body or large corporation. A MAN often acts as a high speed network to allow sharing of regional resources. A MAN typically covers an area of between 5 and 50 km diameter. It Data speed upto34to 155 Mbps.

Examples of MAN: Telephone company network that provides a high speed DSL to customers and cable TV network.



Major Characteristics of MAN

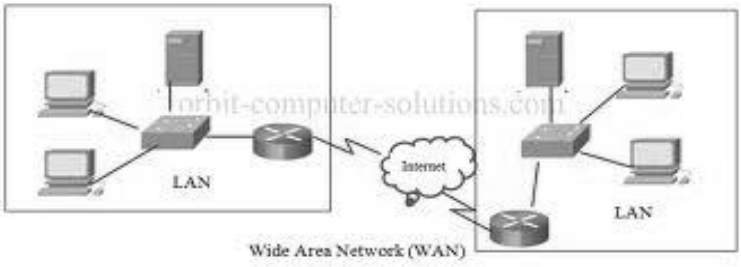
MAN covers much grateer distance than LAN do. Most MAN can recover very quickly from a link or switch/router failure. Some Man topologies are based on a ring. Data is passed around in a ring fashion and also the network routes and switches are interconnected in a ring fashion. Have the ability of a users to dynamically allocate more bandwidth on demand.

WIDE AREA NETWORK (WAN)

WAN covers a large geographic area such as country, continent or even whole of the world. A WAN is two or more LANs connected together. Range: Beyond **100 km.** The LANs can be many miles apart.

To cover great distances, WANs may transmit data over leased high speed phone lines or wireless links such as satellites. It data speed upto 150 Mbps. Multiple LANs can be connected

together using devices such as bridges, routers, or gateways, which enable them to share data. The world's most popular WAN is the Internet.



Wide Area Network (WAN)

Characteristics of WAN

1. Communication facility:

For a big company spanning over different parts of the country the employees can save long distance telephone calls and it overcomes the time lag in overseas communications.

2. Remote data entry:

Remote data entry is possible in WAN. It means that sitting at any location you can enter data, update data and query other information of any computer attached to the WAN but located in other cities.

3. Centralized Information:

In modern computerized environment you will find that big organizations go for centralized data storage. This means if the organization is spared over many cities, they keep their important business data in a single place. As the data are generated at different sites, Wan permits collection of this data from different sites and saves at a single site.

2) **Write detailed notes about the working of LAN with necessary diagram (10) (JAN 2014)**

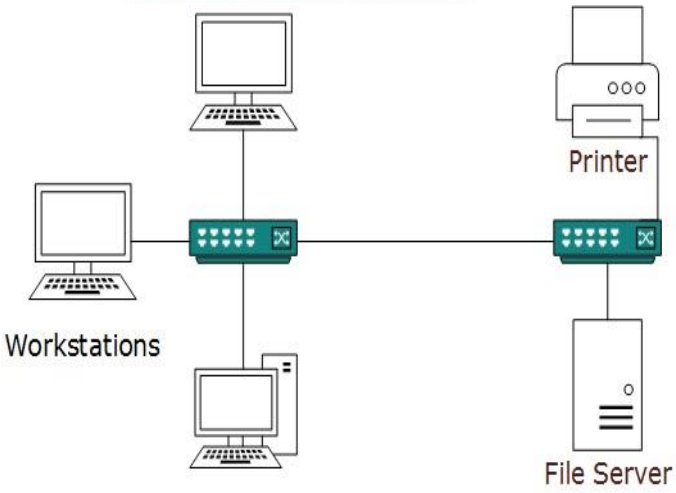
LOCAL AREA NETWORK (LAN)

LAN is a privately owned network and is used to link the devices in an office or a building. It may be connected either minimum two computers with a common printer or it might be extended throughout the office. LAN works at the speed of 100 or 1000 Mbps. Upper limit: 10 km ; Lower limit: 1 km.

The basic idea of designing LAN is to share the resources among the workstations and the personal computers. The size of LAN which is limited to a few kilometers. It is very small network. It can be distinguished from other types of networks on the basis of transmission media and the topology used.

Three main types of transmission media used are

- Twisted pair
- Coaxial cable
- Optical fiber



The most common topologies are

- Bus
- Ring
- Star

Major Characteristics of LAN

- Every computer has the potential to communicates with any other computers of the network
- High degree of interconnection between computers.
- Easy physical connection of computers in a network.
- High data transmission rate.

ADVANTAGES

- The reliability of network is high because the failure of one computer in the network does not affect the functioning for other computer.
- Addition of new computer to network is easy.
- High rate of data transmission is possible.
- Peripheral devices like magnetic disk and printer can be shared by other computers.

DISADVANTAGES

- If the communication line fails, the entire network system breaks down.
- Requires administrative time.

3) **State the advantages and disadvantages of ISDN. (10) (MAY 2012)**

Advantages of an ISDN Line over a standard telephone line

1. Digital service- should have less error
2. Connection is fast- direct Connection with no dialing
3. Higher bandwidth-less time downloading material

4. Able to use ISDN for more than one task e.g. Surf and telephone
5. permits use of newer technologies e.g. video phone
6. Streaming video or audio without disruption
7. Video conferencing-multiple recipients
8. Multiple users
9. Voice, data and video can all be sent over a single ISDN line.

Limitation of ISDN

- ISDN is more expensive to install than a standard telephone
- ISDN is more expensive to rent per month than a standard telephone line
- An engineer has to fit the system in your home.
- Not all Exchanges have ISDN enabled
- If all you require is a telephone service, then the standard analogue service is fine.

4) **Explain circuit switching and packet switching (10) (NOV 2011)**

CIRCUIT SWITCHING:

Circuit switching is used for making standard telephone call on the public telephone network.

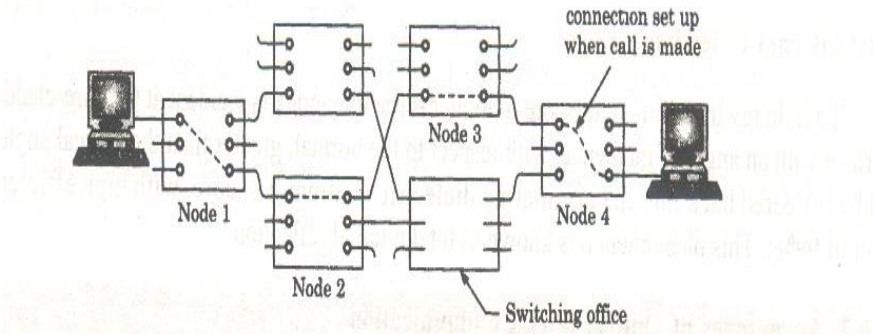
Circuit-switched communication involves three phases:

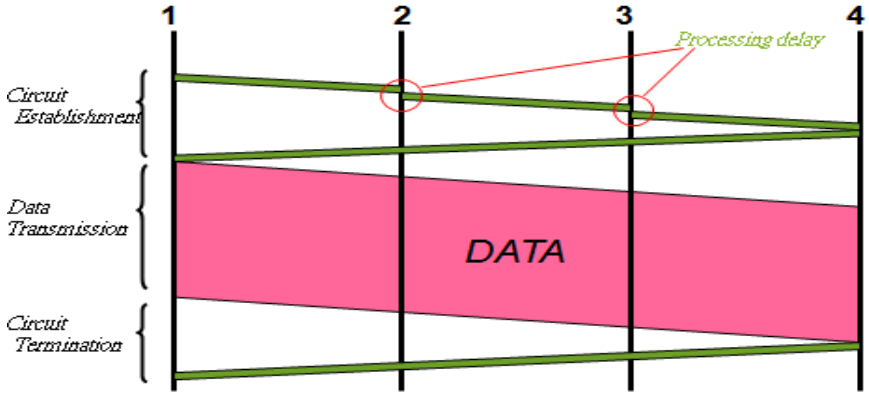
Circuit Establishment → Data Transfer → Circuit Release

The call is established, information is transferred and then call is disconnected. The time required to establish the call is called the setup time.

There are three ways to implement circuits

- Frequency Division Multiplexing (FDM)
- Time Division Multiplexing (TDM)
- Wavelength Division Multiplexing (WDM)





Timing of Circuit Switching

(i) Circuit establishment:

Circuit switchingin a network operates almost the same way as the telephone system works. A complete end-to-end path must exist before communication can take place. The computer initiating the data transfer must ask for a connection to the destination.Once the connection has been initiated and completed to the destination device, the destination device must acknowledge that it is ready and willing to carry on a transfer. Becausethere are a limited number of circuit and switching paths available, blocking can occur. Blocking is the inability to complete a call because there are no facilities or switching path available between source and destination locations.When circuit switching is used for data transfer the terminal equipment at the source and destination must be complete compatible.A circuit switch is a transparent switch, the switch is transparent to the data, it does nothing more than interconnect the source and destination terminal equipment.

(ii) Data transfer

After a call has been established, information is transferred in real time.

(iii) Circuit disconnect

When transfer is complete, one station initiates termination. Terminate connection at end of data transfer.

Advantage

- Fixed bandwidth, guaranteed capacity
- Low variance end to end delay

Disadvantages

- Connection setup and tear down introduces extra overhead
- It is inflexibility in dealing with computer oriented data
- More expensive than any other switching techniques,because a dedicated path is required for each connection
- Inefficient use of the communication channel, because the channel is not used when the connected systems are not using it.

PACKET SWITCHING

Packet switching is often used in computer networks where individual users need the channel at frequent intervals. In packet switching, messages are broken into short blocks and interleaved with other messages.

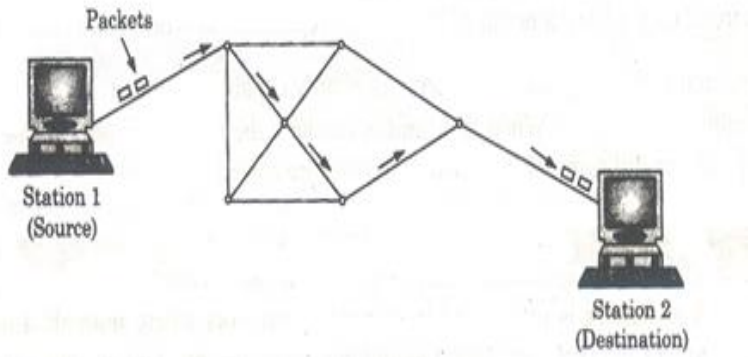
Thus user queue for the channel and share it with one another efficiently. Data is sent in individual packets. Each packet is forwarded from switch to switch, eventually reaching its destination. Each node has a small amount of buffer space to temporarily hold packets. The variation of packet switching exits

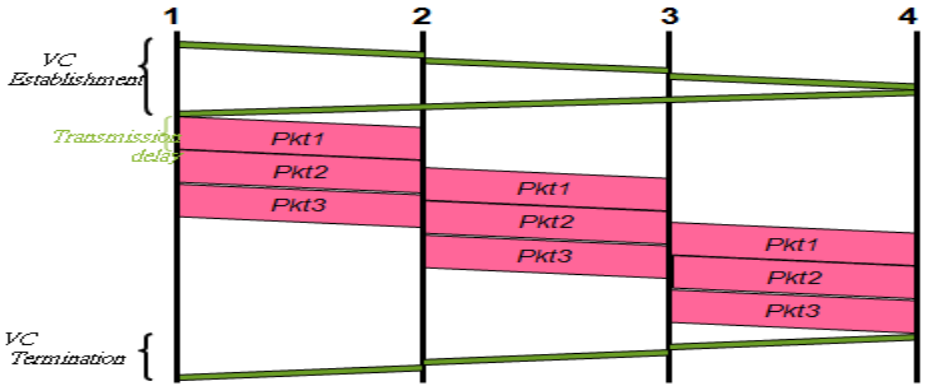
There are two methods of packet switching: Datagram and virtual circuit

Virtual circuit packet switching (connection oriented)

Communication with virtual circuits (VC) takes place in three phases:

- VC Establishment
- Data Transfer
- VC Release





Timing Diagram of VC Packet Switching

The virtual circuit method is closer to circuit switching. Here complete route is worked out prior to sending data packets. The route is established by sending a connection request packet along the route to the destination.

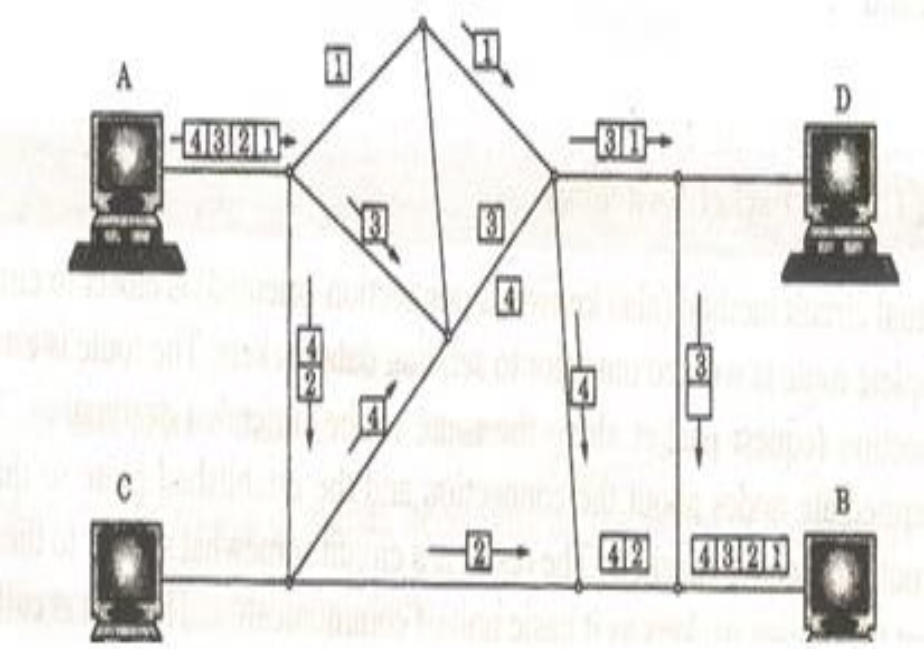
This packet informs the intermediate nodes about the connection and the established route so that they will know how to route subsequent packets. The result is a circuit somewhat similar to those in circuit switching.

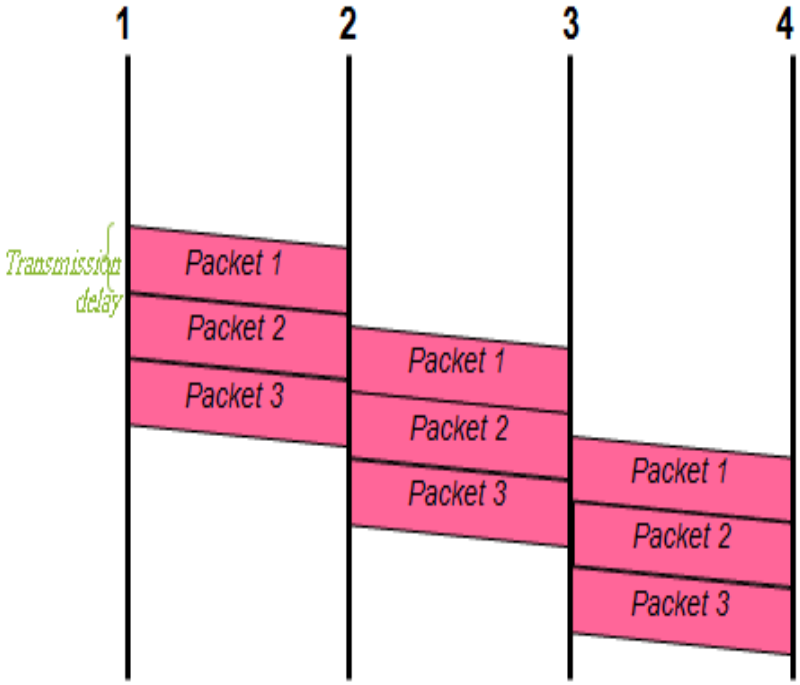
Each packet carries a virtual circuit identifier which enables a node to determine to which virtual circuit it belongs and hence how it should be handled. Because the route is fixed for the duration of the call, nodes spend no effort in determining how to route packets.

When the two hosts initiate a connection, the network layer establishes a virtual circuit which is maintained for duration of connection. When the hosts disconnect, the network layer releases the circuit.

Datagram packet switching(connectionless)

Datagram method does not rely on pre established route, instead each packet is treated independently. It is possible for different packets to travel along different routes in the network to reach the same final destination. As a result, packets may arrive final out of order, or even never arrive (due to node failure).





It is up to the network user to deal with lost packets, and to rearrange packets to their original order.

Because of the absence of pre-establishes circuit each packet must carry enough information in its header to enable the nodes to route it correctly.

Advantages of Packet Switching:

- Uses resources more efficiently
- Very little setup or tear down time
- It is more flexible

Disadvantages of packet switching:

- No guarantee in delay
- Algorithms are more complicated
- Difficult to bill customers
- If a node crashes momentarily all of its queued packets are lost.

5) **Draw the block diagram of optical fiber communication system and explain it. (JAN 2013)**

6) **Describe the channel and services provided by ISDN.(10) (APR 2010, JAN 2011)**

ISDN

Integrated services digital network- "A network that provides end to end digital connectivity, used for supporting a wide range of services which includes

- Telephony (Voice and Music)
- Data (telementry, E-mail and alarm)
- Text (telex, teletex and videotext)
- Image (Facsimile, TV conferencing, Video Phone)

It also Provides Supplementary services like

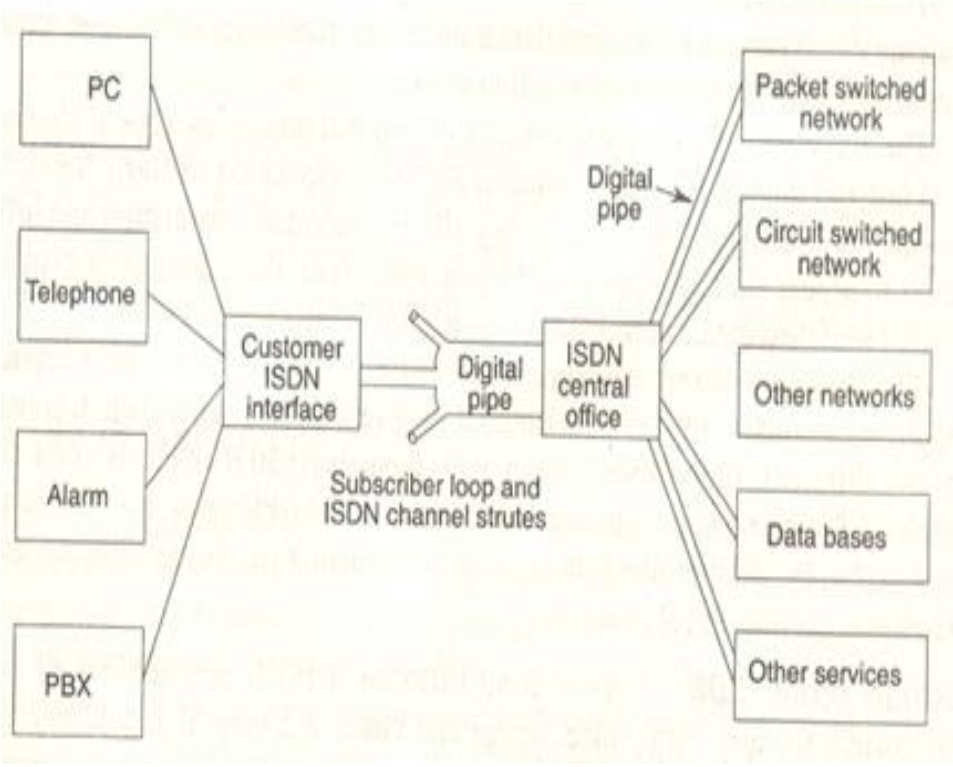
- Direct Dialing in
- Call wait
- Call hold etc..

The evolution of ISDN is based on two important technological developments

(i) Digital transmission

(ii) Digital Switching

Architecture of ISDN



ISDN incorporates all communication connections in a home or building into a single interface

With ISDN all customer services will become digital rather than analog

It consists of

1) Common physical interface

2) ISDN central office

3) Digital subscriber loop

4) ISDN channels

5) Integrated network

Common physical interface

In an ISDN, all devices such as digital telephone, alarm, computer terminal, videotext, facsimile, PBX and even a LAN can be connected to the transmission line using the common physical interface.

It essentially provides DTE-DCE connection, where DTE is data terminal equipment and DCE is data communication equipment.

ISDN central office

It connects the numerous ISDN subscriber loop signals to the ISDN.

It provides subscribers the access to circuit switched networks, packet switched networks, databases and other services.

Digital subscriber loop (DSL) and ISDN Channels

The DSL is the connection between common physical interface and the ISDN central office. In ISDN, this is one or two twisted pairs of copper cable or a fiber optic link that provides full duplex digital transmission.

It has two different ISDN channel structures

1. Basic Channel structure
2. Primary channel structure

Both the channels are constructed from the following channels

1. B-Channel (64kbps)
2. D-Channel (16 or 64 Kbps)
3. H-Channel (384 or 1536 or 1920Kbps)

B channel

- basic user channel
- Can carry any type of digital info in Full-duplex mode
- Carries transmissions end-to-end

D channel

- Primary function is to carry control signaling for the B channel
- Acts like an operator between the user and the network at the network layer

H Channels

- For high data rate applications such as video, teleconferencing and so on