PVP 23

Code: 23ES1103

I B.Tech - I Semester – Regular Examinations - JANUARY 2024

BASIC ELECTRICAL & ELECTRONICS ENGINEERING

(Common for CE, ME, IT, AIML, DS)

Duration: 3 hours Max. Marks: 70

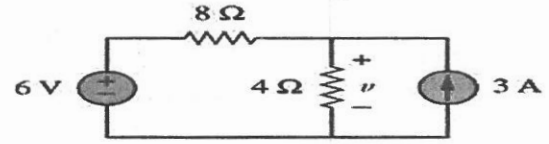
Note: 1. This question paper contains two Parts: Part-A and Part-B.
2. Each Part contains:
- 5 short answer questions. Each Question carries 1 Mark and
- 3 essay questions with an internal choice from each unit. Each question carries 10 marks.

3. All parts of Question paper must be answered in one place.

BL – Blooms Level CO – Course Outcome

PART – A

		BL	CO
1.a)	Can superposition theorem be applied to AC and DC circuits?	L2	CO2
1.b)	Define Apparent power and Power factor.	L2	CO2
1.c)	Why is scale of MI instrument calibrated non-linearly?	L2	CO1
1.d)	List the applications of dc motor.	L2	CO1
1.e)	Calculate the electricity bill amount for a month of 31 days, if 3 bulbs of 30 watts for 5 hours are used. Given the rate of electricity is 2 Rs. per unit.	L3	CO3

			BL	CO	Max. Marks
		UNIT-I			
2	a)	Use the superposition theorem to find v in the circuit shown in Fig. 	L4	CO3	5 M

	b)	In a series circuit containing pure resistance, a pure inductance and a pure capacitance. Obtain the Voltage and current relationship with phasor diagram and explain how to calculate the average power drawn by the circuit and power factor?	L3	CO2	5 M
		OR			
3	a)	An alternating voltage is given by V=230sin314t. Calculate i) frequency, ii) maximum value, iii) average value, iv) RMS value.	L4	CO3	5 M
	b)	State KCL, KVL and illustrate with an example how to calculate the currents and voltage.	L3	CO2	5 M
		UNIT-II			
4	a)	Outline the construction of DC machine.	L3	CO2	5 M
	b)	Describe the construction and working principle of PMMC.	L3	CO2	5 M
		OR			
5	a)	Illustrate the construction and working of an alternator (or) synchronous generator.	L3	CO2	5 M
	b)	Describe the working principle of DC generator with a neat sketch.	L3	CO2	5 M
		UNIT-III			
6	a)	Explain the working principle of Miniature circuit breaker (MCB), its merits and demerits.	L3	CO3	5 M

	b)	Describe the wind power generation.	L3	CO2	5 M
		OR			
7	a)	Outline the Electric Shock, Causes, Symptoms and safety Precautions to avoid shock.	L3	CO3	5 M
	b)	Illustrate the working of hydel power plant with a neat sketch.	L3	CO2	5 M

PART – B

		BL	CO
1.f)	How depletion region is formed in a PN diode?	L3	CO4
1.g)	Covert the binary code 100110 to $(\ )_{10}$.	L3	CO4
1.h)	Explain the necessity of capacitor in Bridge Rectifier.	L3	CO4
1.i)	Mention the difference between Half wave and Full wave Rectifier.	L2	CO5
1.j)	What is a universal gate?	L2	CO4

			BL	CO	Max. Marks
		UNIT-I			
8	a)	Outline the CB configuration of BJT with the help of input and output characteristics.	L4	CO5	5 M
	b)	What is PN junction diode? Explain the characteristics of PN junction diode in forward and reverse bias mode.	L3	CO4	5 M
		OR			
9	a)	Explain the characteristics of zener diode in forward and reverse bias modes.	L3	CO4	5 M
	b)	Distinguish between avalanche breakdown and zener breakdown.	L4	CO5	5 M

		UNIT-II			
10	a)	Describe the working of Public Address system.	L3	CO4	5 M
	b)	Analyze the working of common emitter (RC coupled) amplifier with its frequency response.	L4	CO5	5 M
		OR			
11	a)	Analyze the output waveforms of full wave bridge rectifier with capacitive filter.	L4	CO5	5 M
	b)	Describe the working of Zener voltage regulator with neat sketch.	L3	CO4	5 M
		UNIT-III			
12	a)	Discuss the various number system conversions with the following examples. $(10110)_2 = (\ )_{10}$, $(71263)_8 = (\ )_{10}$, $(5A8)_{16} = (\ )_8$	L4	CO5	5 M
	b)	Covert the following into Excess-3 code. i) 38 ii) 1111 iii) 1011.	L4	CO5	5 M
		OR			
13	a)	Explain the operation of JK and D-Flip flops with truth table.	L3	CO4	5 M
	b)	Outline the functionality of XOR and XNOR gates and mention its applications.	L3	CO4	5 M

Code No:**23ES11003**

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SCHEME OF VALUATION

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Part - A

1.a) superposition theorem be applied to AC and DC circuits	1M
1.b) Definition of Apparent power and Power factor.	1M
1.c) Why is scale of MI instrument calibrated non- linearly - reason	1M
1.d) List the applications of dc motor.	1M
1.e) Calculate the electricity bill amount for a month of 31 days, if 3 bulbs of 30 watts for 5 hours are used. Given the rate of electricity is 2 Rs. per unit. solution	1M
2.(a) Solution	4M
Answer	1M
2.(b) Explanation	5M
3.a) Solution	4M
Answer	1M
3.b) Statement and illustration	5M
4.a) Figure	3M
Explanation	2M
4.b) Figure	3M
Explanation	2M
5.a) Figure	3M
Explanation	2M
5.b) Figure	3M
Explanation	2M
6.a) Figure	3M
Explanation	2M
6.b) Figure	3M
Explanation	2M
7.a) Electric Shock	2M
Causes	2M
Symptoms and safety Precautions to avoid shock.	1M
7.b) Figure	3M
Explanation	2M

Part - B

1.f) Formation of depletion region	1M
1.g) Conversion binary code 100110 to $(\ )_{10}$.	1M
1.h) Explanation	1M
1.i) Differences	1M
1.j) universal gate	1M
8.a) CB configuration	2M
Input and output characteristics.	3M
8.b) PN junction diode	1M
Characteristics of PN junction diode in forward and reverse bias mode.	4M
9.a) characteristics of zener diode in forward and reverse bias modes.	5M
9.b) Distinguish between avalanche breakdown and zener breakdown.	5M
10.a) Working of Public Address system.	2.5M
Figure	2.5M
10.b) Working of common emitter (RC coupled) amplifier with its frequency response.	5M
11.a) Output waveforms of full wave bridge rectifier with capacitive filter.	3M
Explanation	2M
11.b) Working of Zener voltage regulator with neat sketch.	5M
12.a) Conversions with answers	5M
12.b) Conversions with answers	5M
13.a) the operation of JK and D-Flip flops with truth table and explanation.	5M
13.b) functionality of XOR and XNOR gates applications. and its applications.	5M

(2)

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Part – A

1.a) Can superposition theorem be applied to AC and DC circuits? **(1M)**

It can be applied to both AC and DC circuits

1.b) Define Apparent power and Power factor. **(1M)**

Power factor is defined as the ratio of Active Power (kW) to Apparent Power (kVA).
P.F = Active Power(kW) / Apparent Power (kVA)
The combination of Active Power and Reactive Power is known as Apparent Power.

1.c) Why is scale of MI instrument calibrated non- linearly? **(1M)**

Moving Iron Instrument is proportional to square of operating current, therefore the instrument has basically square law response.

1.d) List the applications of de motor. **(1M)**

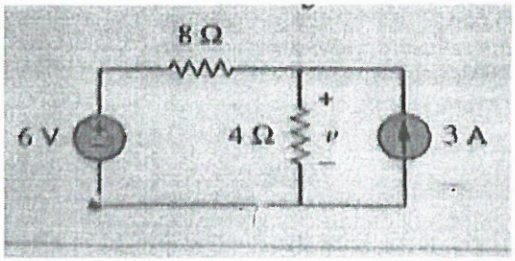
Cranes, Air compressor, Lifts, Elevators, Winching system, Electric traction (Any two)

1.e) Calculate the electricity bill amount for a month of 31 days, if 3 bulbs of 30 watts for 5 hours are used. Given the rate of electricity is 2 Rs. per unit. **(1M)**

Number of bulbs = 3
Wattage per bulb = 30 watts
Hours of usage per day per bulb = 5 hours
Rate of electricity = Rs. 2 per unit
Energy consumed by 3 bulbs for 31 days (in kWh) = (Wattage * Hours of usage)*3*31 / 1000
= (30 watts * 5 hours)*3*31 / 1000
= 13.95 kWh
Electricity bill amount = Total energy consumption * Rate per unit
= 13.95 kWh * Rs. 2/kWh
= Rs. 27.9

UNIT-I

2.(a) Use the superposition theorem to find V' in the circuit shown in Fig **(5M)**



When 6V acting alone

$$V' = 6 \times \frac{4}{8+4} = 6 \times \frac{4}{12} = 2 \text{ volts}$$

when 3A acting alone

$$I_2 = 3 \times \frac{8}{8+4}$$

$$= 3 \times \frac{8}{12} = 2A$$

$$V'' = 2 \times 4 = 8 \text{ volts}$$

according to superposition theorem

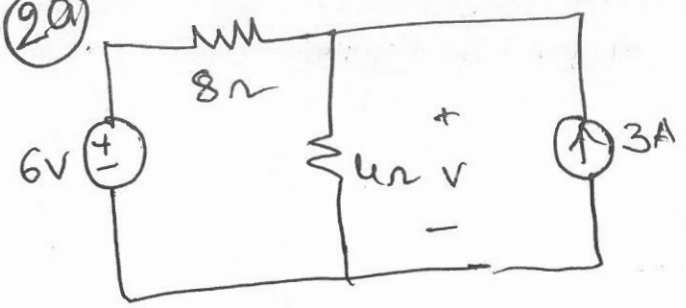
$$V = V' + V''$$

$$= 2 + 8 = 10 \text{ volts}$$

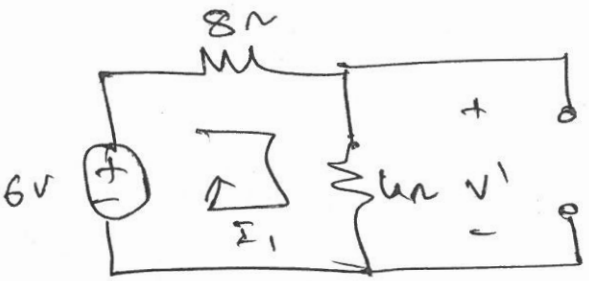
Note : Please consider any method solved by student

2 (a) use the superposition theorem to find V in the circuit shown in figure (3)

(2a)



A. when '6V' source acting alone



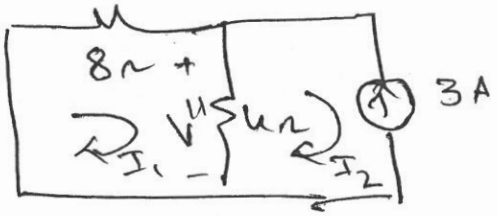
$$8I_1 + 4I_1 - 6 = 0$$

$$12I_1 = 6$$

$$I_1 = 0.5\,A$$

$$V_1 = 4I_1 = 4 \times 0.5 = 2V$$

when '3A' acting alone



$$8I_1 + 4(I_1 - I_2) = 0$$

$$12I_1 - 4I_2 = 0 \rightarrow (1)$$

$$I_2 = -3\,A \Rightarrow 12I_1 - 4(-3) = 0$$

$$12I_1 = -12$$

$$I_1 = -1\,A$$

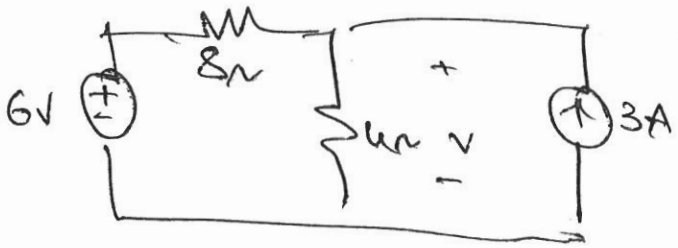
$$V'' = 4(I_1 - I_2)$$

$$= 4(-1 - (-3)) = 4(2) = 8\ Volts$$

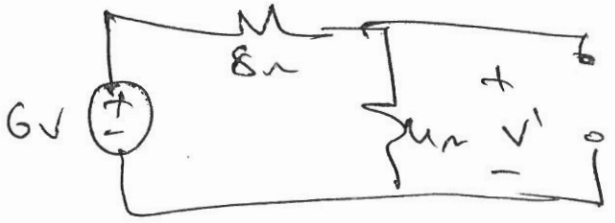
∴ By using superposition theorem $V = V' + V''$

$= 2 + 8 = 10V$

9. By using Superposition theorem (OR). to find V in the circuit shown in figure

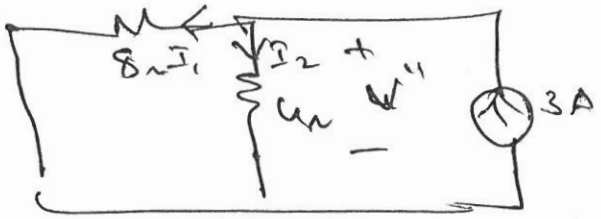


A. when '6V' acting alone



$$V' = 6 \times \frac{4}{8+4} = 6 \times \frac{4}{12_2} = 2 \text{ volts.}$$

when '3A' acting alone



$$I_2 = 3 \times \frac{8}{8+4}$$

$$= 3 \times \frac{8^2}{12_4} = 2A$$

$$V'' = 2 \times 4 = 8 \text{ volts}$$

according to superposition theorem

$$\therefore V = V' + V''$$

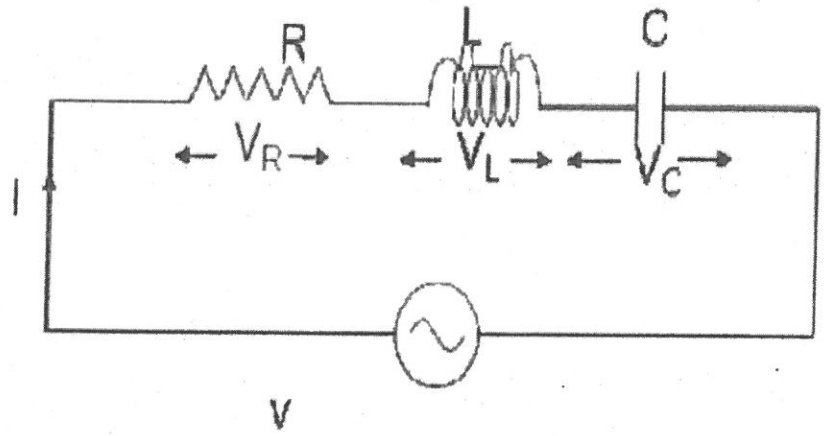
$$= 2 + 8 = 10 \text{ volts}$$

(4)

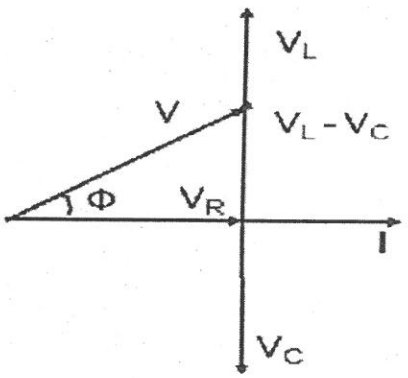
2.(b) In a series circuit containing pure resistance, a pure inductance and a pure capacitance.

Obtain the Voltage and current relationship with phasor diagram and explain how to calculate the average power drawn by the circuit and power factor? (5M)

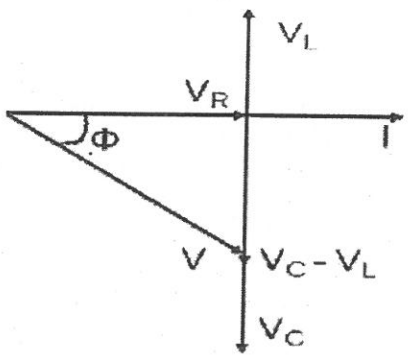
Series Circuit



Voltage and current relationship with phasor diagram



$V_L > V_C$



$V_L < V_C$

Consider an AC circuit with a resistance R, an inductance L and a capacitance C connected in series as shown in the figure. The alternating voltage v is given by

$$v = V_m \sin \quad t$$

The current flowing in the circuit is i. The voltage across the resistor is V_R, the voltage across the inductor is V_L and that across the capacitor is V_C.

$$V = \sqrt{V_R^2 + (V_L - V_C)^2}$$

$$V = \sqrt{(IR)^2 + (IX_L - IX_C)^2}$$

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

$$V = IZ$$

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

Phase angle

$$\Phi = \tan^{-1}\left(\frac{V_L - V_C}{V_R}\right)$$

$$\Phi = \tan^{-1}\left(\frac{IX_L - IX_C}{IR}\right)$$

$$\Phi = \tan^{-1}\left(\frac{X_L - X_C}{R}\right)$$

From the expression for phase angle, we can derive the following three cases

(5)

Case (i): When $X_L > X_C$

The phase angle Φ is positive and the circuit is inductive. The circuit behaves like a series RL circuit.

Case (ii): When XL<XC

The phase angle Φ is negative and the circuit is capacitive. The circuit behaves like a series RC circuit.

Case (iii): When XL=XC

The phase angle Φ = 0 and the circuit is purely resistive. The circuit behaves like a pure resistive circuit.

The voltage and the current can be represented by the following equations. The angle Φ is positive or negative depending on the circuit elements.

$$V = V_m \sin \omega t$$

$$I = I_m \sin(\omega t \pm \Phi)$$

Average power

$$P = VI \cos\phi$$

$$P = (IZ) \times I \times \frac{R}{Z}$$

$$P = I^2 R$$

Hence the power in an RLC series circuit is consumed only in the resistance. The inductance and the capacitance do not consume any power.

(OR)

3.a) An alternating voltage is given by V=230sin314t. Calculate
i) frequency, ii) maximum value,
iii) average value, iv) RMS value. (5M)

i) Frequency:
The equation of the alternating voltage is given as $V = 230 \sin(314t)$.
The coefficient of t inside the sine function represents the angular frequency, which is equal to 2π times the frequency (f).
So, $\omega = 314$ radians per second.
The frequency (f) is then calculated as:
$f = \omega / (2\pi) = 314 / (2\pi) \approx 50$ Hz.

ii) Maximum Value:
The maximum value of a sine function is 1. So, the maximum value of V is the coefficient of the sine function, which is 230.

iii) Average Value:
The average value of a sinusoidal waveform over one complete cycle is zero because the positive and negative areas cancel each other out. However, if we consider over a half cycle (0 to π), the average value can be calculated as:
Average value = $(2 / \pi) * V_{max}$
$= (2 / \pi) * 230$
≈ 146.34 volts.

iv) RMS Value:
The RMS (Root Mean Square) value of an AC voltage is given by the formula:
$V_{rms} = V_{max} / \sqrt{2}$

Given that $V_{max} = 230$ volts,
$V_{rms} = 230 / \sqrt{2}$
≈ 162.65 volts.

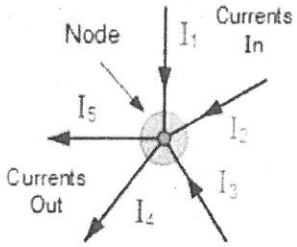
So, to summarize:
i) Frequency ≈ 50 Hz,
ii) Maximum Value = 230 volts,
iii) Average Value ≈ 146.34 volts,
iv) RMS Value ≈ 162.65 volts.

3.b) State KCL, KVL and illustrate with an example how to calculate the currents and voltage. **(5M)**

KCL:

Kirchhoff's Current Law (KCL) states that "The algebraic sum of all currents entering and leaving a node is equal to zero."

Currents Entering the Node
Equals
Currents Leaving the Node

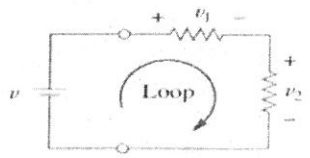


$$I_1 + I_2 + I_3 + (-I_4 + -I_5) = 0$$

KVL:

Kirchhoff's Voltage Law (KVL) states that the sum of all the voltages around a closed loop is equal to zero.

$$v_1+v_2-v=0$$

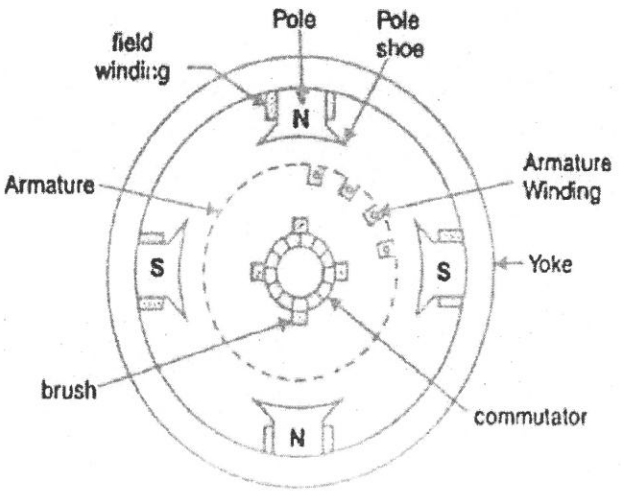


UNIT-II

4.a) Outline the construction of DC machine. **(5M)**

A DC machine is a device that deals with the conversion of electrical energy to mechanical energy and vice versa and which consist of following essential parts.

1) Magnetic frame or YOKE
2) Pole cores and pole shoes
3) Field coils or pole coils or field winding
4) Armature core
5) Armature winding
6) Commutator
7) Brushes and bearings



Yoke:

- The magnetic frame or the yoke of DC machine made up of cast iron or cast steel.
- Its main function is to form a protective covering over the inner sophisticated parts of the motor and provide support to the poles.

Pole cores and pole shoes:

- The construction of magnetic poles basically comprises of two parts namely, the pole core and the pole shoe stacked together under hydraulic pressure and then attached to the yoke.
- Field winding is placed on the pole core. The pole core function is to just hold the pole shoe over the yoke.
- Whereas the pole shoe spreads the flux produced over the air gap between the stator and rotor.

Field Winding:

- The field winding of DC machine is made up of copper wire.
- When the field current flows through these coils, they electro magnetize the poles which produce the necessary flux.

Armature core:

- It houses the armature conductors or coils and causes them to rotate and hence cut the magnetic flux of the field magnets.
- It consists of slotted soft-iron laminations that are stacked to form a cylindrical core.
- The purpose of laminating the core is to reduce the eddy-current losses.

Armature Winding:

- The slots of the armature core hold insulated conductors that are connected in a suitable manner. This is known as "Armature winding".
- The construction of armature winding of DC machine can be of two types:-
  a. Lap winding b. Wave winding.

Commutator:

- The Commutator of DC machine is a cylindrical structure made up of copper segments stacked together, but insulated from each other by mica.
- Commutator reverses the current direction between the rotor and the external circuit.

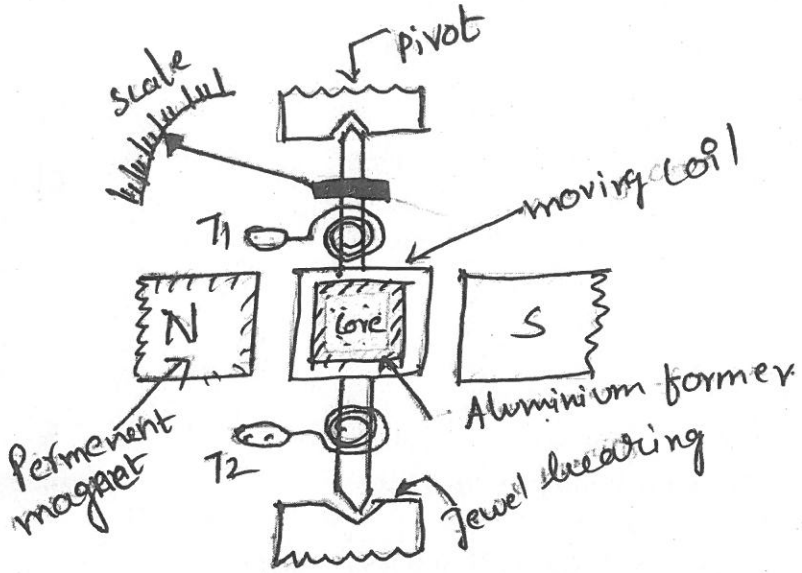
Brushes of DC Machine:

- The brushes of DC machine are made with carbon or graphite structures, making sliding contact over the rotating commutator.
- The brushes are used to transfer the current from external circuit to the rotating commutator from where it flows into the armature winding.

Note: Please consider any four parts explanation

4.b) Describe the construction and working principle of PMMC. **(5M)**

Construction: A permanent magnet is used in this type instrument. Aluminum formeris provided in the cylindrical in between two poles of the permanent magnet . Coils are wound on



the aluminum former which is connected with the spindle. This spindle is supported with jeweled bearing. Two springs are attached on either end of the spindle. The terminals of the moving coils are connected to the spring. Therefore the current flows through spring 1, moving coil and spring 2.Damping: Eddy current damping is used. This is produced by aluminum former.Control: Spring control is used.

Principle of operation

When D.C. supply is given to the moving coil, D.C. current flows through it. When the current carrying coil is kept in the magnetic field, it experiences a force. This force producesa torque and the former rotates. The pointer is attached with the spindle. When the former rotates, the pointer moves over the calibrated scale. When the polarity is reversed a torque is produced in the opposite direction. The mechanical stopper does not allow the deflection in the opposite direction. Therefore, the polarity should be maintained with PMMC instrument. If A.C. is supplied, a reversing torque is produced. This cannot produce a continuous deflection. Therefore this instrument cannot be used in A.C.

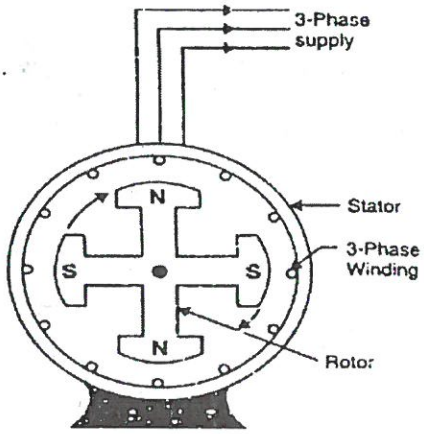
(OR)

5.a) Illustrate the construction and working of an alternator (or) synchronous generator (5M)

Construction of Alternator

An alternator has 3-phase winding on the stator and a d.c. field winding on the rotor.

1. Stator



It is the stationary part of the machine and is built up of sheet-steel laminations having slots on its inner periphery. A 3-phase winding is placed in these slots and serves as the armature winding of the alternator. The armature winding is always connected in star and the neutral is connected to ground.

2. Rotor

The rotor carries a field winding which is supplied withdirect current through two slip rings by a separate d.c. source.

This d.c. source (called exciter) is generally a small d.c. shunt or compound generator mounted on the shaft of the alternator. Rotor construction is of two types,namely;

(i) Salient (or projecting) pole type

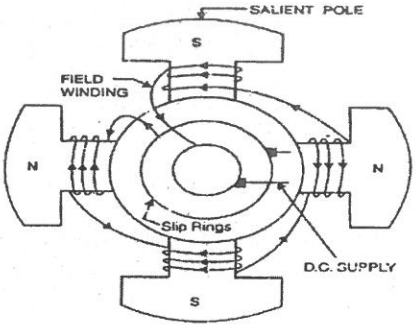
(ii) Non-salient (or cylindrical) pole type

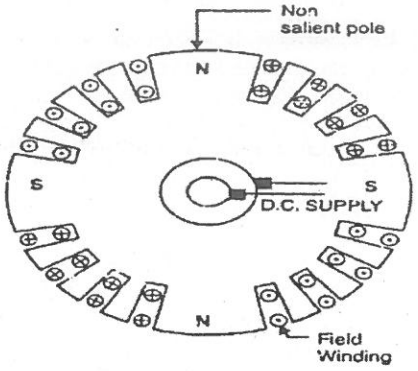
(i) Salient pole type

In this type, salient or projecting poles are mounted on a large circular steel frame which is fixed to the shaft of the alternator. The individual field pole windings are connected in series in such a way that when the field winding is energized by the d.c. exciter, adjacent poles have opposite polarities. Low-speed rotors always possess a large diameter to provide the necessary space for the poles. Consequently, salient-pole type rotors have large diameters and short axial lengths.

(ii) Non-salient pole type

In this type, the rotor is made of smooth solid forged-steel radial cylinder having a number of slotsalong the outer periphery. The field windings are embedded in these slots and are connected in series to the slip rings through which they are energized by the d.c. exciter. The regions forming the poles are usually left unslotted. It is clear that the polesformed are non-salient i.e., they do not project out from the rotor surface.

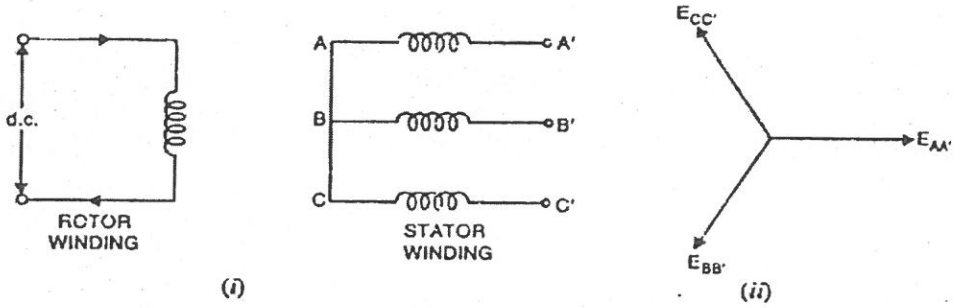




Salient Pole Non Salient PolePrinciple of operation of Alternator:

The rotor winding is energized from the d.c. exciter and alternate N and S poles are developed on the rotor. When the rotor is rotated in anti-clockwise direction by a prime mover, the stator or armature conductors are cut by the magnetic flux of rotor poles. Consequently, e.m.f. is induced in the armature conductors due to electromagnetic induction. The induced e.m.f. is alternating since N and S poles of rotor alternately pass the armature conductors. The direction of induced e.m.f. can be found

The magnitude of the voltage induced in each phase depends upon the rotor flux, the number andposition of the conductors in the phase and the speed of the rotor.



The above figure shows star-connected armature winding and d.c. field winding. When the rotor is rotated, a 3-phase voltage is induced in the armature winding. The magnitude of induced e.m.f. depends upon the speed of rotation and the d.c. exciting current. The magnitude of e.m.f. in each phase of the armature winding is the same. However, they differ in phase by 120° electrical as shown in the phasor diagram.

5.b) Describe the working principle of DC generator with a neat sketch. **(5M)**

Generator: Generator is a device which converts mechanical energy into electrical energy.

Principle of operation of Generator:

An electric generator works based on the principle that whenever flux is cut by an armature conductor,an EMF is induced which will cause a current to flow if the circuit is closed.

The direction of induced EMF (and hence current) is given by Fleming"s right hand rule.

Therefore,the essential components of a generator are:

(a) A magnetic field

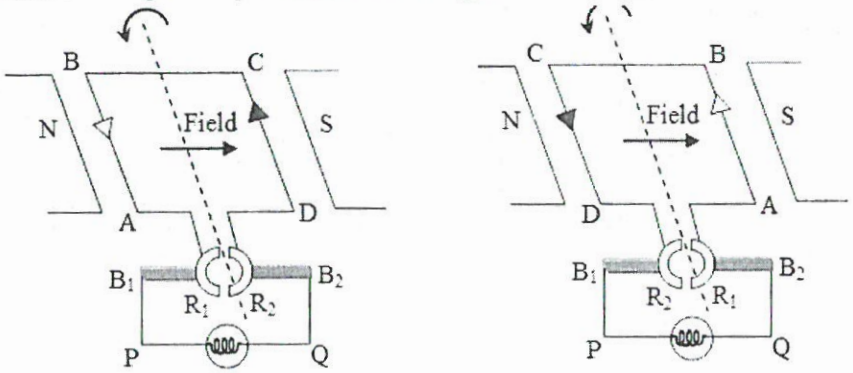
(b) Conductor or a group of conductors

(c) Motion of conductor w.r.t. magnetic field.

Simple Loop Generator

Consider a single turn loop ABCD rotating clockwise in a uniform magnetic field with a constant speedas shown in Figure. As the loop rotates, the flux linking the coil sides AB and CD changes continuously. Hence the e.m.f. induced in these coil sides also changes but the e.m.f. induced in one coil side adds to that induced in the other.

(i) When the loop is in position no. 1 the generated e.m.f. is zero because the coil sides



(AB and CD) are cutting no flux but are moving parallel to it.

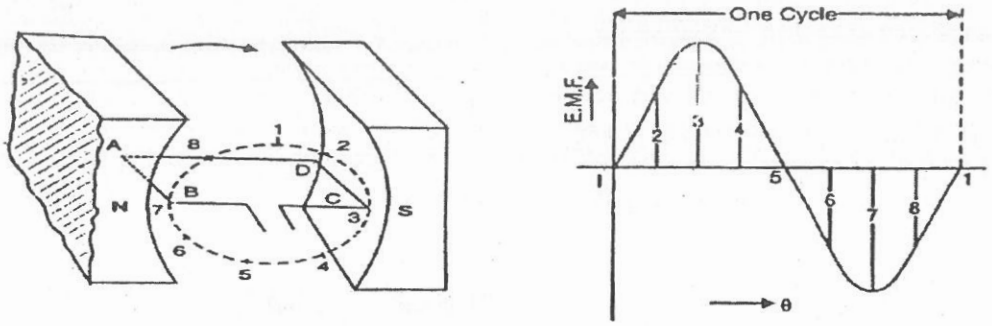
(ii) When the loop is in position no. 2, the coil sides are moving at an angle to the flux and,therefore, a low e.m.f. is generated as indicated by point 2 in Fig. (1.2).

(iii) When the loop is in position no. 3, the coil sides (AB and CD) are at right angle to the fluxand are, therefore, cutting the flux at a maximum rate. Hence at this instant, the generated e.m.f. is maximum as indicated by point 3 in Fig. (1.2).

(iv) At position 4, the generated e.m.f. is less because the coil sides are cutting the flux at anangle.

(v) At position 5, no magnetic lines are cut and hence induced e.m.f. is zero as indicated by point 5.

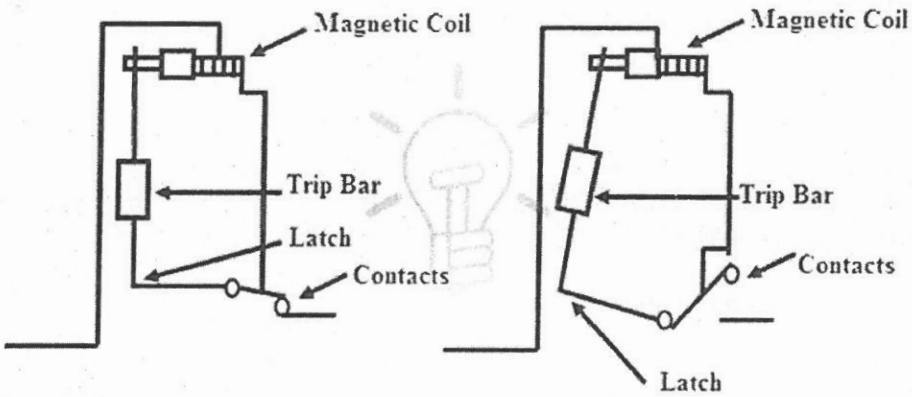
(vi) At position 6, the coil sides move under a pole of opposite polarity and hence the direction of generated e.m.f. is reversed. The maximum e.m.f. in this direction (i.e., reverse direction, See Fig. will be when the loop is at position 7 and zero when at position 1. This cycle repeats with each revolution of the coil.



Note that EMF generated in the loop is alternating one. It is because any coil side; say AB has EMFin one direction when under the influence of N-pole and in the other direction when under the influence of S-pole. If a load is connected across the ends of the loop, then alternating current will flow through the load. The alternating voltage generated in the loop can be converted intodirect voltage by a device called commutator. We then have the D.C. generator. In fact, a commutator is a mechanical rectifier.

UNIT-III

6.a) Explain the working principle Miniature circuit breaker (MCB), its merits and demerits. **(5M)**



The working principle of the MCB is based on two effects-
Electromagnetic Effect.
Thermal Effect
Also, there are essentially three different mechanisms that provide overload and short circuit protection.

Bimetallic Strip:
Thermal effect takes place whenever the condition of overload occurs in the electrical circuit. This bimetallic strip arrangement is used in situations where a constant overload condition prevails over a long time in the connected circuit thus resulting in heating of the bimetallic strip. Overheating of the bi-metallic strip results in the deformation of the strip i.e. the bimetallic strip bends further than the predefined level due to which latch mechanism is released and contacts get open. Themoving contact of the MCB is arranged by means of spring pressure. The displacement of the latch point causes the attached spring to get released and the moving contactor opens the circuit.
Magnetic Trip Coil:
This mechanism comes in force in case of a short circuit event. This mechanism works on the **Electromagnetic effect**. A short circuit event is associated with a sudden surge of a heavy short

circuit current that tends to flow through the circuit. When this sudden surge of short circuit current flows through a very sensitive magnetic trip coil inside MCB i.e. through the solenoids, a sudden change in magneticflux occurs and it activates the trip coil unit. Due to this, the plunger inside the coil deflects and attracts upwards which in turn releases the latch mechanism. The magneto-motive force (MMF) of the coil causes its plunger to hit the same latch pointand to displace the latch point. The displacement of the latch point causes the attachedspring to get released and the moving contactor opens the circuit.

Manual Switching:

MCB also has an external ON/OFF switching option to manually break the circuit. This is used in cases of any maintenance or repair activities or for resetting of MCB incase of an already occurred trip event. It may be due to deformation of a bi-metallic strip, or increased MMF of a trip coil, or maybe a manual operation, but every time the same latch point is displaced and the same deformed spring is released, which ultimately responsible for the movement of the moving contact. When the moving contact is separated from fixed contact, there may be a high chance of arc. Again, when we switch it on, we reset the displaced operating latch to its previous position
i.e on position and the MCB is ready for another trip operation.

Under **normal working condition** the current flow through the incoming terminal, fixed & moving contacts, solenoid, bimetallic strip and then the outgoing terminals.

Merits

- Restoration of power supply quickly is possible with MCBs.
- During abnormal conditions such as overload and fault conditions, automaticallyswitches off the electrical circuit.
- Power restoration can be done quickly.
- It is easier to identify when they have tripped.

Demerits

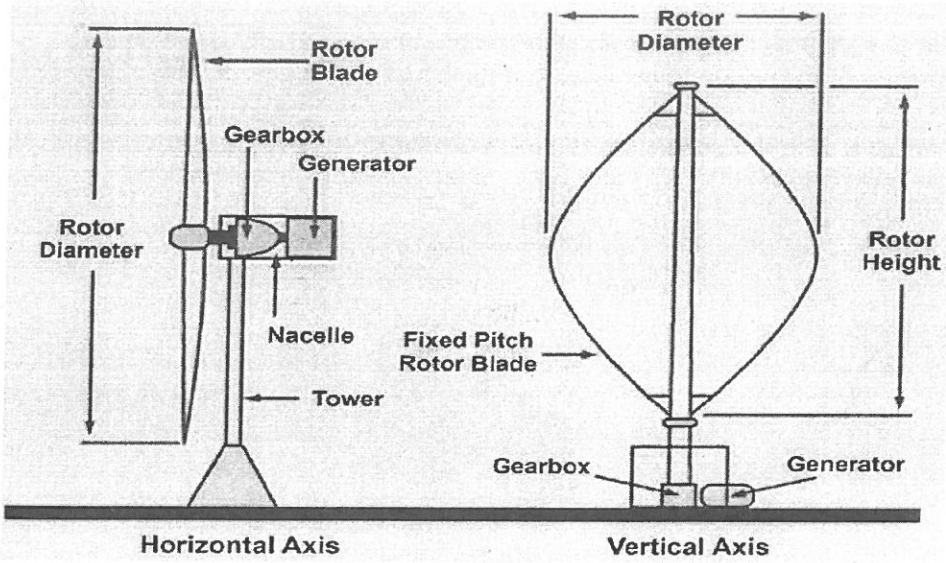
- Slow tripping
- Aging and wear
- They are more expensive than fused switches.
- Can not protect against earth faults.

6.b) Describe the wind power generation. **(5M)**

Working of Wind Power Plant, the wind turbines or wind generators use the power of the wind which they turn into electricity. The speed of the wind turns the blades of a rotor (between 10 and 25 turns per minute), a source of mechanical energy. The rotor then turns on a generator that converts mechanical energy into electricity.

As the wind blows, a wind turbine converts the kinetic energy of the wind's motion into mechanical energy by the rotation of the rotor, and this mechanical energy is transmitted by the shaft to the generator through the gear train. The generator converts this mechanical energy into electrical energy, thereby generating electricity. A wind turbine is connected to the electricity network via a transformer located at the base of the structure

(10)



Note: Please consider any one figure drawn by students

(OR)

7.a) Outline the Electric Shock, Causes, Symptoms and safety Precautions to avoid shock. **(5M)**

What causes electric shock?

Some causes of electric shock include:

- faulty appliances
- damaged or frayed cords or extension leads
- electrical appliances in contact with water
- incorrect, damaged or deteriorated household wiring
- downed power lines
- lightning strike.

If it is safe to do so, disconnect the power supply before trying to help someone with electricshock.

Symptoms of electric shock

Typical symptoms of an electric shock include:

- unconsciousness
- difficulties in breathing or no breathing at all
- a weak, erratic pulse or no pulse at all
- burns, particularly at the place where the electricity entered and left the body(entrance and exit burns)
- cardiac arrest.

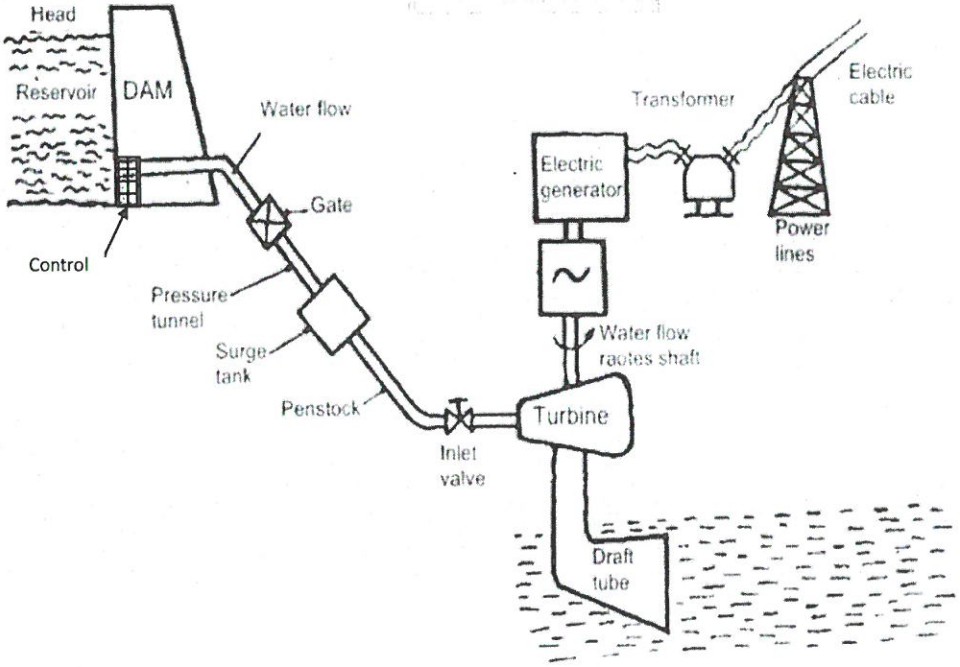
Although someone who has had an electric shock may appear unharmed, they should still receive medical attention. Some injuries and complications may not be obvious initially. A medical examination is important after any electric shock.

safety measures when working with electricity:

1. Always turn off the power source before starting any electrical work. This includesturning off the circuit breaker or unplugging the device.
2. Wear personal protective equipment (PPE) such as safety glasses, rubber gloves, andnon-conductive shoes.
3. Use tools that are specifically designed for electrical work and ensure they are in good condition.
4. Avoid working in wet or damp conditions or with wet hands.
5. Do not touch electrical parts or wires with bare hands, use tools or gloves instead.
6. Keep your work area clean and free from any flammable or combustible materials.

7. Always follow proper wiring procedures, and use proper insulation techniques.
8. Do not work on live circuits, even if you are experienced.
9. Make sure that any electrical work is done according to local codes and regulations.
10. If you are unsure of what to do, consult with a qualified electrician or seek professional advice.

7.b) Illustrate the working of hydel power plant with a neat sketch(5M)



Working Principle:

- Kinetic energy in falling water from a height is converted into mechanical energy by a turbine.
- It is then converted into electrical energy by a generator. Thus, the power is known as hydroelectric power.

Working of hydroelectric power plant

The dam is constructed across a river or lake and water from the catchment area collects at the back of the dam to form a reservoir. A pressure tunnel is taken off from the reservoir and water brought to the valve house at the start of the penstock. The valve house contains main sluice valves and automatic isolating valves. The former controls the water flow to the power house and the lattercuts off supply of water when the penstock bursts. From the valve house, water is taken to water turbine through a huge steel pipe known as penstock. The water turbine converts hydraulic energy into mechanical energy. The turbine drives the alternator which converts mechanical energy into electrical energy.

A surge tank (open from top) is built just before the valve house and protects the penstock from bursting in case the turbine gates suddenly close due to electrical load being thrown off. When the gates close, there is a sudden stopping of water at the lower end of the penstock and consequently the penstock can burst like a paper log. The surge tank absorbs this pressure swing by increase in its level of water.

Part - B

1.f) How depletion region is formed in a PN diode? **(1M)**

Movement of electrons to the p-type side exposes positive ion cores in the n-type side while movement of holes to the n-type side exposes negative ion cores in the p-type side, resulting in an electron field at the junction and forming the depletion region.

1.g) Covert the binary code 100110 to ( )10. **(1M)**

1 * 2^5 + 0 * 2^4 + 0 * 2^3 + 1 * 2^2 + 1 * 2^1 + 0 * 2^0

Now, calculate each term:

1 * 32 + 0 * 16 + 0 * 8 + 1 * 4 + 1 * 2 + 0 * 1

= 32 + 0 + 0 + 4 + 2 + 0

= 38

1.h) Explain the necessity of capacitor in Bridge Rectifier. **(1M)**

A capacitor is included in the rectifier circuit to act as a filter to reduce ripple voltage. The important property of the capacitor is that it passes the AC signal but blocks the DC signal and hence capacitor is used in the rectifier circuit.

1.i) Mention the difference between Half wave and Full wave Rectifier. **(1M)**

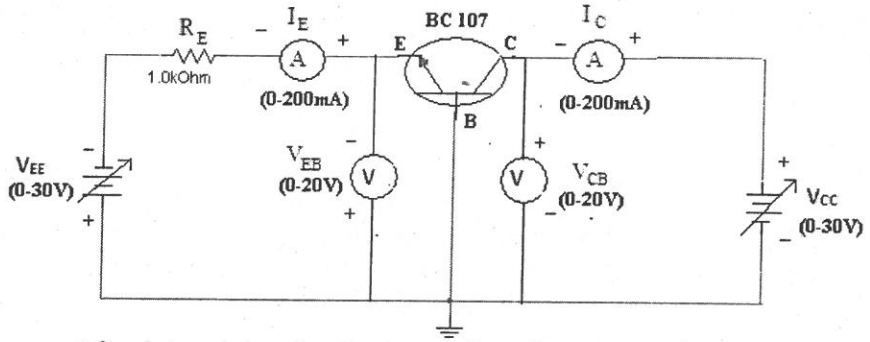
Half-Wave Rectifier: Uses only one half-cycle of the input AC waveform.

Full-Wave Rectifier: Utilizes both halves of the input AC waveform.

1.j) What is a universal gate? **(1M)**

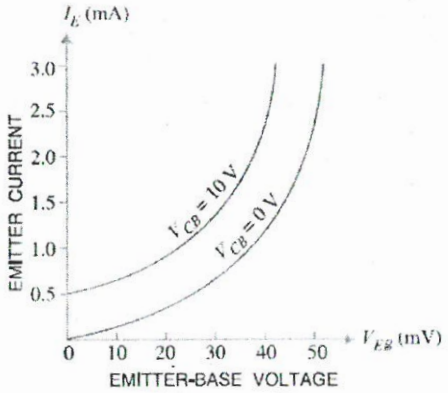
A universal gate is a type of logic gate that can be used to implement any other type of logic gate

8.a) Outline the CB configuration of with the help of input and output characteristics. **(5M)**



The circuit arrangement for determining the characteristics of a common base NPN transistor is shown in fig. In this circuit, the collector to base voltage (V_{CB}), emitter to base voltage (V_{BE}) can be varied using V_{CC} and V_{EE} values The DC voltmeters and DC milli ammeters are connected in the emitter and collector circuits to measure the voltages and currents.

Input characteristics:



The curve plotted between the emitter current (I_E) and the emitter to base voltage (V_{BE}) at constant collector to base voltage (V_{CB}) are known as input characteristics of a transistor in common base configuration.

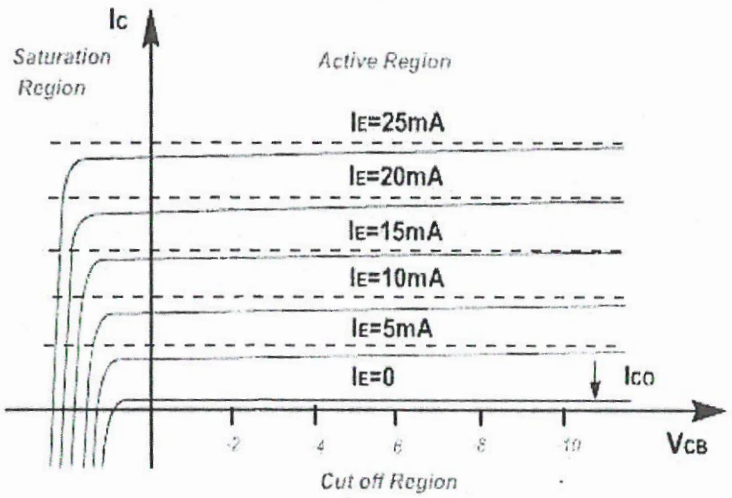
(i) The emitter current I_E increases rapidly with small increase in emitter-base voltage V_{EB}. It means that input resistance is very small.

Input resistance, $r_i = \frac{\Delta V_{BE}}{\Delta I_E}$ at constant V_{CB}

(ii) The emitter current is almost independent of collector-base voltage V_{CB}. This leads to the conclusion that emitter current (and hence collector current) is almost independent of collector voltage.

Output characteristics:

The emitter current I_E is held constant at each of several fixed levels. For each fixed level of I_E, the output voltage V_{CB} is adjusted in convenient steps, and the corresponding levels of collector current I_C are recorded. In this way a table of values is obtained from which a family of output characteristics may be plotted. In the figure the corresponding I_C and V_{CB} values obtained when I_E was held constant are plotted.



1. The common base output characteristics in fig. show that for each fixed level of I_E, I_C is almost equal to I_E and appears to remain constant when V_{CB} is increased.
2. This characteristic may be used to find the output resistance (r_o).

$$\text{Output resistance, } r_o = \frac{\Delta V_{CB}}{\Delta I_C} \text{ at constant } I_E$$

3. A very large change in collector-base voltage produces small change in collector current. It means that the output resistance is very high.

4. The collector is constant above certain values of collector-base voltage. It means that I_C is independent of V_{CB} and depends upon I_E only.

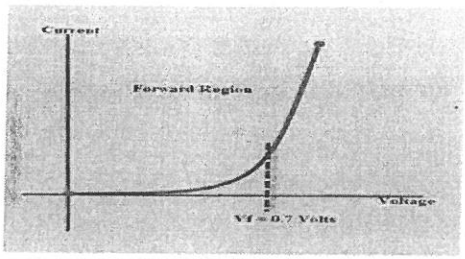
(12)

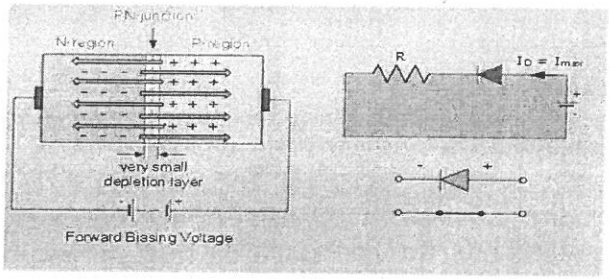
8.b) What is PN junction diode? Explain the characteristics of PN junction diode in forward and reverse bias mode. **(5M)**

P-N Junction Diode:

In a piece of a semiconductor, if one half of is doped by p-type and the other half is doped by n-type impurities, P-N junction (diode) is formed. The n- type has high concentration of free electrons. The p-type has high concentration of holes.

Forward Bias





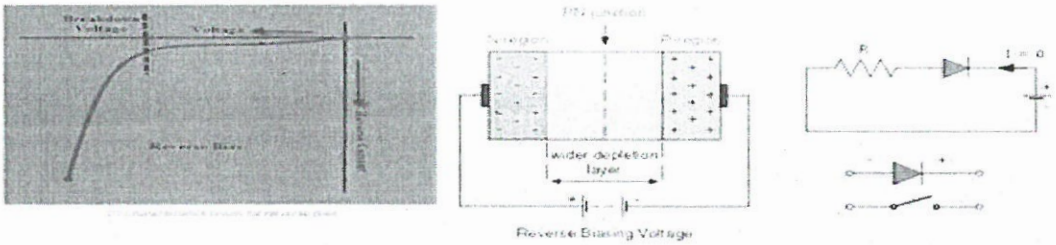
When a diode is connected in a **Forward Bias** condition, a negative voltage is applied to the N-type material and a positive voltage is applied to the P-type material. If this external voltage becomes greater than the value of the potential barrier, approx. 0.7 volts for silicon and 0.3 volts for germanium, the potential barriers opposition will be overcome and current will start to flow. This is because the negative voltage pushes or repels electrons towards the junction giving them the energy to cross over and combine withthe holes being pushed in the opposite direction towards the junction by the positive voltage. This results in a characteristics curve of zero current flowing up to this voltage point, called the "knee" on the static curves and then a high current flow through the diode with little increase in the external voltage as shown above.

The application of a forward biasing voltage on the junction diode results in the depletion layer becoming very thin and narrow which represents a low impedance path through the junction thereby allowing high currents to flow. The point at which this sudden increase in current takes place is represented on the static I-V characteristics curve above as the "knee" point.

Reverse Bias:

When a diode is connected in a **Reverse Bias** condition, a positive voltage is applied to the N-type material and a negative voltage is applied to the P-type material. The positive voltage

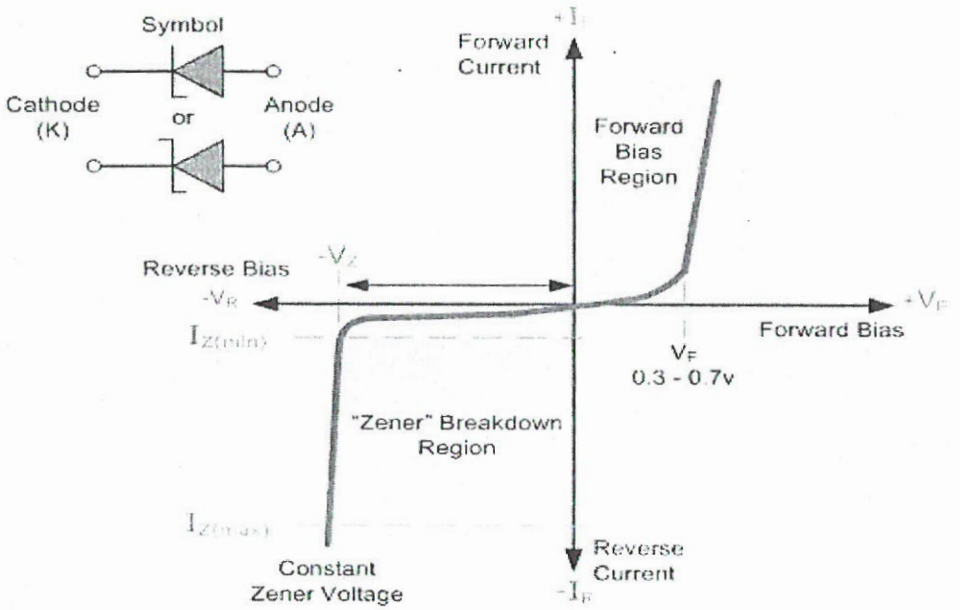
applied to the N-type material attracts electrons towards the positive electrode and away fromthe junction, while the holes in the P-type end are also attracted away from the junction towards the negative electrode. The net result is that the depletion layer grows wider due to a lack of electrons and holes and presents a high impedance path, almost an insulator. The result is that a high potential barrier is created thus preventing current from flowing through the semiconductor material.



(OR)

9.a) Explain the characteristics of zener diode in forward and reverse bias modes. (5M)

A graph of current through vs the voltage across the device is called the **characteristic of Zener diode**. The first quadrant is the forward biased region. Here the Zener diode acts like an ordinary diode. When a forward voltage is applied, current flows through it. But due to higher doping concentration, higher current flows through the Zener diode.



In the third quadrant, the magic happens. The graph shows the current vs voltage curve when we apply a reverse bias to the diode. The Zener breakdown voltage is the reverse bias voltage after which a significant amount of current starts flowing through the Zener diode. Here in the diagram, V_Z refers to the Zener breakdown voltage. Until the voltage reaches Zener breakdown level, tiny amount of current flows through the diode.

Once the reverse bias voltage becomes more than the Zener breakdown voltage, a significant amount of current starts flowing through the diode due to Zener breakdown. The voltage remains at the Zener breakdown voltage value, but the current through the diode increases when the input

voltage gets increased. Due to the unique property of Zener diode, the depletion region regains its original position when the reverse voltage gets removed. The Zener diode doesn't get damaged despite this massive amount of current flowing through it. This unique functionality makes it very useful for many applications.

13

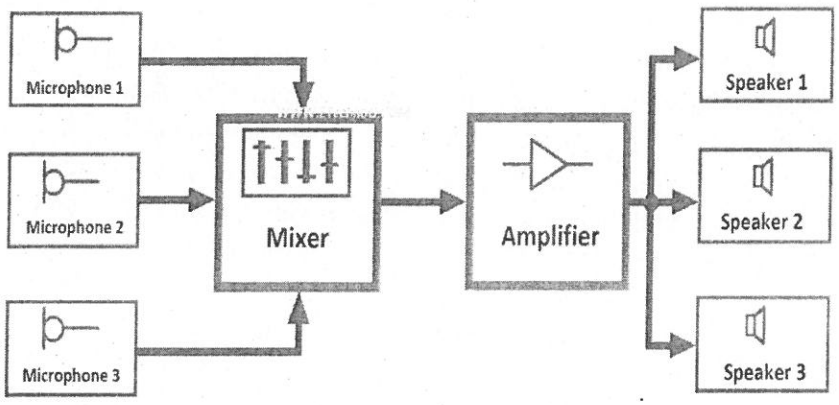
9.b) Distinguish between avalanche breakdown and zener breakdown. **(5M)**

S.No	Zener break down	Avalanche break down
1	Occurs in a heavily doped p-n junction	Occurs in a normally doped p-n junction
2	Occurs in low reverse voltage	Occurs in large reverse voltage
3	Because of high electric field , direct rupture of co-valent bonds takes place	Due to thermally generated carriers , ionization by collision takes place
4	Normally , the junction rebuilds again	Normally , the junction does not rebuild again

10.a) Describe the working of Public Address system. **(5M)**

Basic Block Diagram of PA System

Here, you can see the public address system block diagram and its important blocks.



There are so many devices or components are used in PA system that depends upon their applications and other factors. But the main three components of any public address system are explained below.

1. Microphone

The microphone is a very important part or component of a PA system. The microphone basically is a transducer that converts acoustic energy or sound energy into electrical energy. It continuously generates the pulsating electrical voltage according to the frequency of the sound energy applied to it. Various types of microphones are used in the PA system. The main basic two types of microphones are,

1. Handheld Microphone
2. Lapel Microphone

Other different types of microphones are,

- Wired Microphone
- Wireless Microphone

A wired microphone can be connected by a wire to the mixer or amplifier. It is very simple. But the wireless microphone needs a battery and the frequency of its signal is also a very important factor. The wireless microphone cannot be connected directly to the mixer or amplifier. A receiver is required that can receive the signals sent by the microphone. This receiver is to be connected to the amplifier.

2. Amplifier

The amplifier is the second part of a PA system. The main function of the amplifier is to amplify or increase the volume level of the audio signal that can drive a loudspeaker. The requirement or size of the amplifier depends upon the number and size of the loudspeaker. If the size of the loudspeaker is very large or so many loudspeakers are to be connected then a very powerful amplifier is required. The output of the amplifier is measured in watts or kilowatts.

3. Loud Speaker

Loudspeakers play a very important role in the PA system. It converts electrical energy into acoustic energy or sound energy. The loudspeakers are generally connected to theamplifier and it generates sound according to the audio signal provided by the amplifier.

4. Mixer

A mixer is not a necessary part of a PA system. But if there are multiple audio sourcesor multiple microphones used in the PA system then a mixer is must required. The mixer isan electronic device that can control multiple sound sources simultaneously. It can mix all thesound sources together and play with a single loudspeaker with the help of an amplifier. So the mixer is generally connected before the amplifier. Nowadays, there are so many amplifiers are available in the market that already have an inbuilt mixer. So there is no need for an external additional mixer. All the microphones or sound sources can be connected directly to the amplifier.

10.b) Analyze the working of common emitter (RC coupled) amplifier with its frequency response. (5M)

A **Resistance Capacitance (RC) Coupled Amplifier** is basically a multi-stage amplifier circuit extensively used in electronic circuits. Here the individual stages of the amplifier are connected together using a resistor–capacitor combination due to which it bears its name as RC Coupled.

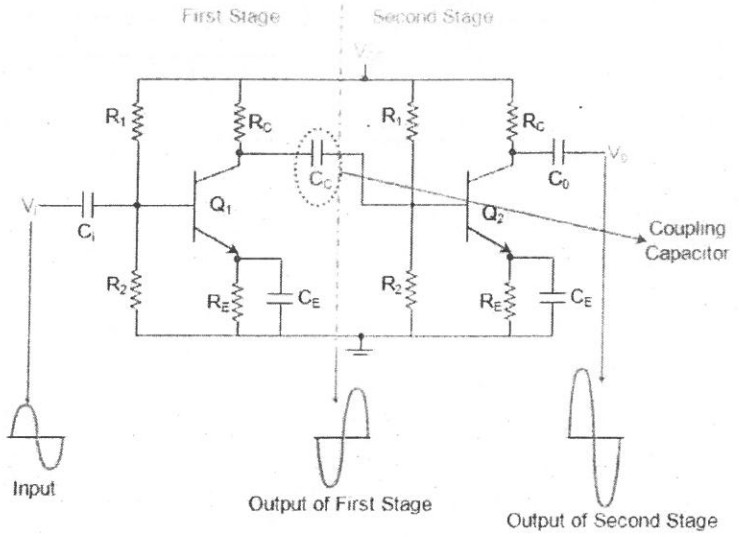


Figure 1 Two-Stage RC Coupled Amplifier

Figure 1 shows such a two-stage amplifier whose individual stages are nothing but thecommon emitter amplifiers. Hence the design of individual stages of the **RC coupled amplifiers** is similar to that in the case of common emitter amplifiers in which the resistors R_1 and R_2 form the biasing network while the emitter resistor RE form the stabilization network.

Here the C_E is also called bypass capacitor which passes only AC while restrictingDC, which causes only DC voltage to drop across R_E while the entire AC voltage will be coupled to the next stage.

Further, the coupling capacitor C_C also increases the stability of the network as it blocks the DC while offers a low resistance path to the AC signals, thereby preventing the DC bias conditions of one stage affecting the other. In addition, in this circuit, the voltage drop across the collector-emitter terminal is chosen to be 50% of the supply voltage V_{CC} in order to ensure appropriate biasing point.

In this kind of amplifier, the input signal applied at the base of the transistor in stage 1(Q_1) is amplified and appears at its collector terminal with a phase-shift of 180°.

The AC component of this signal is coupled to the second stage of the **RC coupled amplifier** through the coupling capacitor C_C and thus appears as an input at the base of the second transistor Q_2. This is further amplified and is passed-on as an output of the second stage and is available at the collector terminal of Q_2 after being shift by 180° in its phase.

Frequency Response:

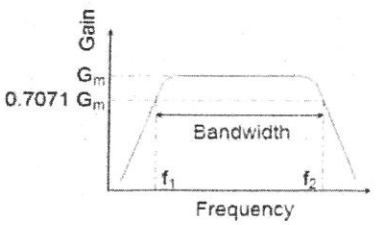
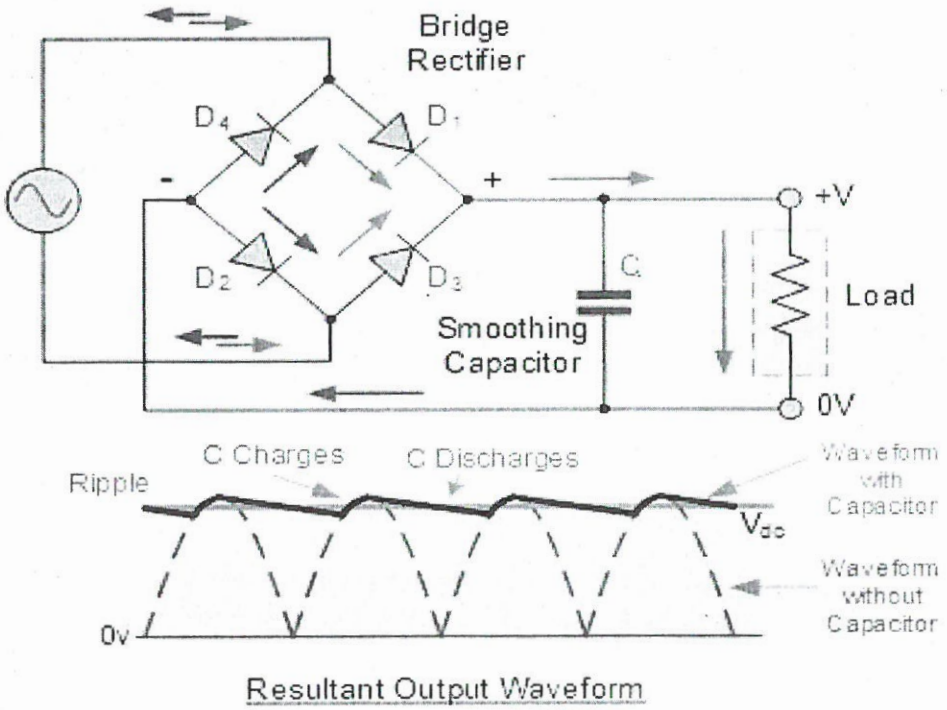


Figure 2 Frequency Response Curve of a RC Coupled Amplifier

(OR)

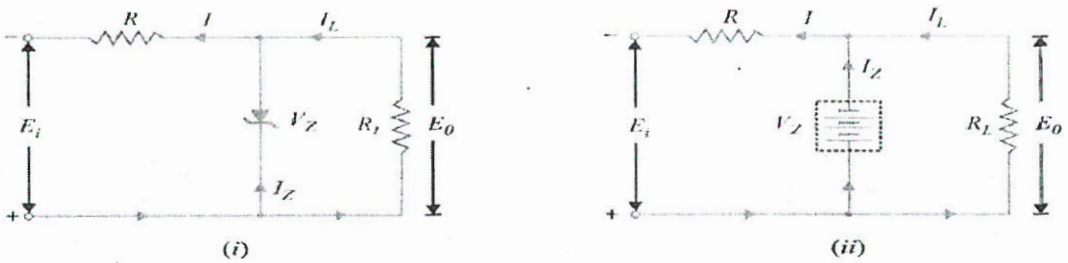
11.a) Analyze the output waveforms of full wave bridge rectifier with capacitive filter. (5M)



Resultant Output Waveform

During the positive quarter cycle of the ac input signal, the diodes D_1 ,D_2 are forward biased, the capacitor C gets charges through forward bias diodes D_1 ,D_2 to the peak value of input voltage V_m. In the next quarter cycle from $\pi/2$ to π the capacitor starts discharging through load resistance R_L , because once capacitor gets maximum value diodes D_1 ,D_2 will be reverse biased and stops conducting, so during this period from $\pi/2$ to π capacitor C supplies load current.
In the next quarter cycle from π to $3\pi/2$ of the rectified output voltage, if the input voltage exceeds the capacitor voltage, making diodes D_3, D4 forward biased, this charges the capacitor back to V_m. In In the next quarter cycle that is from $3\pi/2$ to 2 , the diodes D_3 , D4 gets reverse biased and the capacitor supplies load current.
Next again diodes D_1, D2 are forward biased and the cycle of capacitor charging and discharging continuous, hence load current becomes continuous in nature.

11.b) Describe the working of Zener voltage regulator with neat sketch. (5M)
Working of Zener diode as a voltage regulator:



A Zener diode can be used as a voltage regulator to provide a constant voltage from a source whose voltage may vary over sufficient range. The circuit arrangement is as shown in figure (i).

The Zener diode of Zener voltage V_z is reverse connected across the load R_L across which constant output is desired. The series resistance R absorbs the output voltage fluctuations so as to maintain constant voltage across the load. It may be noted that the Zener will maintain a constant voltage V_z (=E_O) across the load so long as the input voltage does not fall below V_z.

(13)

When the circuit is properly designed, the load voltage E_O remains essentially constant even though the input voltage E_i and load resistance R_L may vary over a wide range.

(i) Suppose the input voltage increases. It is clear that output voltage remains constant at V_Z. The excess voltage is dropped across the series resistance R. This will cause increase in the value of total current I. The Zener will conduct the increase of current in I while the load current remains constant. Hence, output voltage E_O remains constant irrespective of the changes in the input voltage E_i.

(ii) Now suppose that input voltage is constant (supply current I is constant) but the load resistance R_L decreases. This will cause an increase in load current. The additional current will come from a decrease in Zener current I_Z by maintain supply current I constant. Similarly if load R_L increases then load current I_L will be decreases, absorbed by the Zener diode by increasing its Zener current I_Z by maintain supply current I constant. Consequently, the output voltage stays at constant value if load resistance varies.

12.a) Discuss the various number system conversions with the following examples.
$(10110)_2$=( )$_{10}$, $(71263)_8$= ( )$_{10}$, $(5A8)_{16}$ =( )$_8$ **(5M)**

$(10110)_2$ = ( )$_{10}$

$(10110)_2$: $(1 * 2^4) + (0 * 2^3) + (1 * 2^2) + (1 * 2^1) + (0 * 2^0) = 16 + 0 + 4 + 2 + 0 = 22$

Therefore, $(10110)_2 = (22)_{10}$

$(71263)_8$ = ( )$_{10}$

$(71263)_8$: $(7 * 8^4) + (1 * 8^3) + (2 * 8^2) + (6 * 8^1) + (3 * 8^0) = 28672 + 512 + 128 + 48 + 3 =$ 29363

Therefore, $(71263)_8 = (29363)_{10}$

$(5A8)_{16}$ = ( )$_8$

$(5A8)_{16} = (0101\ 1010\ 1000)_2$

Now, group the binary digits into sets of three (starting from the right) and convert each set into its octal equivalent: 010 110 101 000

Now convert each group: $010_2 = 2_8$ $110_2 = 6_8$ $101_2 = 5_8$ $000_2 = 0_8$

Combine the results: $(5A8)_{16} = (2650)_8$

Therefore, $(5A8)_{16} = (2650)_8$

12.b) Covert the following into Excess-3 code.

i) 38 ii) 1111 iii) 1011.

Binary equivalent of 3 = 0011

Binary equivalent of 8 = 1000

0011+0011 = 0110

1000+0011=1011

38 in excess3 code = 01101011.

i) 1111: Adding 3 to each digit: 1111 + 0011 = 10010

ii) (1011): Adding 3 to each digit: 1011 + 0011 = 1110

(OR)

13.a) Explain the operation of JK and D-Flip flops with truth table. **(5M)**

JK Flip Flop Truth Table

The JK Flip Flop Truth Table is given below:

Clock	J	K	Qn+1	State
0	X	X	Qn	
1	0	0	Qn	Hold
1	0	1	0	Reset
1	1	1	1	Set
1	1	1	Qn	Toggle

The JK flip-flop is a sequential logic device with two inputs (J and K), one clock input (CLK), and two outputs (Q and Q'). It has two stable states: set (Q = 1) and reset (Q = 0).

The operation of a JK flip-flop is based on the inputs J and K along with the clock signal. Here's a summary of its behaviour:

When J = K = 0, the output state does not change.
When J = 0 and K = 1, the output (Q) is forced to 0 (reset).
When J = 1 and K = 0, the output (Q) is forced to 1 (set).
When J = K = 1, the flip-flop toggles its output, meaning if Q = 0, it becomes 1, and if Q = 1, it becomes 0.

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D Flip Flop Truth Table

The D flip flop truth table is given below:

Clock	D	Q	Q'	Description
Low	X	Q	Q'	Memory No Change
High	0	0	1	Reset Q >> 0
High	1	1	0	Set Q >> 1

The D flip-flop (Data flip-flop) is a simple sequential logic device with a single input (D), one clock input (CLK), and two outputs (Q and Q'). It has one stable state determined by the input data D.

The operation of a D flip-flop is straightforward:

When the clock input (CLK) transitions from low to high (rising edge), the D input value is transferred to the output Q.

13.b) Outline the functionality of XOR and XNOR gates applications. and mention its applications. (5M)

XOR (Exclusive OR) Gate:

- Functionality: The XOR gate outputs a true (1) value only when the number of true inputs is odd. If the number of true inputs is even or if all inputs are false, the output is false (0).
- Applications:
  1. Data Encryption: XOR gates are fundamental components in encryption algorithms due to their ability to alter the data bitwise, providing a level of security.
  2. Error Detection and Correction: XOR gates are used in error detection and correction codes to identify errors in data transmission.
  3. Arithmetic Operations: XOR gates are used in binary arithmetic operations like addition and subtraction.
  4. Parity Checking: XOR gates are used in parity checking circuits to verify the integrity of transmitted data.

XNOR (Exclusive NOR) Gate:

- Functionality: The XNOR gate outputs a true (1) value only when all inputs are the same (either all true or all false). If the inputs are mixed (some true and some false), the output is false (0).
- Applications:
  1. Comparator Circuits: XNOR gates are used in comparator circuits to compare two binary values and determine if they are equal or not.
  2. BCD to 7-Segment Decoder: XNOR gates are used in BCD to 7-segment decoder circuits to convert binary-coded decimal (BCD) inputs to the corresponding 7-segment display outputs.
  3. Memory Circuits: XNOR gates are used in memory circuits and flip-flops to store and manipulate data.
  4. Parity Generation: XNOR gates are used to generate parity bits in parity checking circuits to ensure data integrity.