PVP 23

Code: 23ES1202

I B.Tech - II Semester – Regular / Supplementary Examinations
JUNE 2026

BASIC ELECTRICAL & ELECTRONICS ENGINEERING

(Common for EEE, ECE, CSE)

Duration: 3 hours Max. Marks: 70

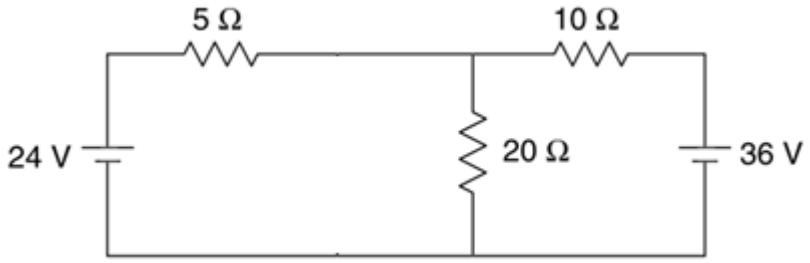
Note: 1. This question paper contains two Parts: Part-A and Part-B.
2. Each Part contains:
- 5 short answer questions. Each Question carries 1 Mark and
- 3 essay questions with an internal choice from each unit. Each question carries 10 marks.

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

BL – Blooms Level CO – Course Outcome

PART – A

		BL	CO
1.a)	Define impedance.	L2	CO1
1.b)	State KVL and formulate loop equations for a simple circuit.	L3	CO1
1.c)	Illustrate working principle of single phase transformer.	L2	CO2
1.d)	Compare MI and PMMC instruments.	L2	CO2
1.e)	Describe electric shock and analyze its causes.	L2	CO3

			BL	CO	Max. Marks
UNIT-I					
2		Find the current through the 5 Ω resistor in Figure solving by using super position theorem. 	L3	CO1	10 M
OR					
3	a)	An sinusoidal alternating current of frequency 60 Hz has a maximum value of 120 A. Calculate i. Average value. ii. RMS value. iii. Peak factor.	L3	CO1	6 M
	b)	A 10 Ω resistor and 400 μF capacitor are connected in series to a 60V, 50Hz sinusoidal supply. Calculate impedance and phase angle between the current and voltage.	L3	CO1	4 M
UNIT-II					
4		Discuss the construction and working of DC generator and list their applications, advantages and limitations.	L2	CO2	10 M
OR					
5		Describe the construction and working of PMMC instrument and analyze list their advantages, limitations and applications.	L3	CO2	10 M

UNIT-III					
6	a)	Explain different types of earthing and justify their importance in electrical safety.	L2	CO3	5 M
	b)	What is two part tariff? Explain the calculation of electricity bill for domestic consumer.	L2	CO3	5 M
OR					
7	a)	Discuss the working of fuse, MCB and list their advantages.	L2	CO3	4 M
	b)	Outline the working and layout of nuclear power plant.	L3	CO2	6 M

PART – B

		BL	CO
1.f)	Define Zener diode and explain its voltage regulation role.	L2	CO4
1.g)	Explain transistor biasing and justify its importance.	L2	CO4
1.h)	Describe capacitor filter and analyze its ripple reduction role.	L3	CO5
1.i)	Explain the block diagram of public addressing system.	L3	CO5
1.j)	What is flip-flop? Classify its types.	L2	CO6

			BL	CO	Max. Marks
UNIT-IV					
8	Explain in detail the CB configuration of transistor with the help of input output characteristics and discuss it applications.		L3	CO4	10 M

OR					
9		Describe the construction and working of Zener diode and plot its V-I characteristics.	L3	CO4	10 M
UNIT-V					
10		Explain the operation of a full-wave bridge rectifier with neat wave forms.	L3	CO5	10 M
OR					
11	a)	Explain the working of capacitor filter and analyze its effectiveness in reducing ripple.	L3	CO5	5 M
	b)	Discuss the working of Zener diode as voltage regulator.	L2	CO5	5 M
UNIT-VI					
12	a)	Describe the construction and operation of a full adder and write its Boolean expressions for sum and carry outputs.	L3	CO6	6 M
	b)	Explain the functionality of NAND and NOR gates with truth tables.	L3	CO6	4 M
OR					
13	a)	Explain the working of an SR flip-flop and analyze its truth table, advantages and limitations.	L3	CO6	6 M
	b)	Convert the binary number $(11011011)_2$ into decimal, Gray code and Excess-3 code.	L3	CO6	4 M

Code No:23ES1003

I B.TECH - II SEMESTER - REGULAR EXAMINATIONS - JUNE 2026

BASIC ELECTRICAL & ELECTRONICS ENGINEERING

(Common for EEE, ECE, CSE)

SCHEME OF VALUATION

Duration: 3 Hours **Max. Marks: 70**

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PART A

1a) Define impedance.
Definition 1M

1b) State KVL and formulate loop equations
Statement and loop equations 1M

1c) Illustrate working principle of a single-phase transformer
Working principle of a single-phase transformer 1M

1d) Compare MI and PMMC instruments
Any two comparisons 1M

1e) Describe electric shock and analyze its causes.
Electric shock and causes 1M

UNIT-I

2) Find the current through the 5 Ω resistor in Figure solving by using super position theorem.
For source I
Loop equations 2M
Answer 2M
For source II
Loop equations 2M
Answer 2M
Final answer 2M

3 a) A sinusoidal alternating current of frequency 60 Hz has a maximum value of 120 A. Calculate
i. Average value.
ii. RMS value.
iii. Peak factor.

Average value
Formula and answer 2M
RMS value
Formula and answer 2M
Peak factor.
Formula and answer 2M

3 b) A 10 Ω resistor and 400μF capacitor are connected in series to a 60 V, 50 Hz sinusoidal supply. Calculate impedance and phase angle between the current and voltage.
Impedance calculation 2M
Phase angle calculation 2M

UNIT-II

4) Discuss the construction and working of DC generator and list their applications, advantages and limitations

Construction of DC machine

Figure and parts 2M

Working of DC generator 5M

Applications, advantages & limitations 3M

5. Describe the construction and working of PMMC instrument and analyze list their advantages, limitations and applications.

Construction and working of PMMC instrument

Figure and explanation 7M

Advantages, limitations and applications 3M

UNIT-III

6 a) Explain different types of earthing and justify their importance in electrical safety

Different types of earthing explanation 4M

Importance 1M

6 b) What is two part tariff? Explain the calculation of electricity bill for domestic consumer.

Two part tariff 1M

Calculation of electricity bill for Domestic consumer 4M

7a) Discuss the working of fuse, MCB and list their advantages.

Working of fuse 2M

Working of MCB & advantages 2M

7b)Outline the working and layout of nuclear power plant.

Working and layout of nuclear power plant 6M

PART-B

1f)Define Zener diode and explain its voltage regulation role.

Definition and voltage regulation 1M

1g) Explain transistor biasing and justify its importance.

Transistor biasing and importance 1M

1h) Describe capacitor filter and analyze its ripple reduction role.

Capacitor filter and ripple reduction 1M

1i) Explain the block diagram of a public addressing (PA) system.

Block diagram 1M

1j) What is a flip-flop? Classify its types.

flip-flop and types 1M

UNIT-IV

8) Explain in detail the CB configuration of transistor with the help of input–output characteristics and discuss its applications.

Detail the CB configuration of transistor

Figure and explanation 5M

Input –output characteristics 4M

Applications 1M

9) Describe the construction and working of Zener diode and plot its V-I characteristics.

Construction and working of zener diode 5M

V-I characteristics of zener diode 5M

UNIT-V

10) Explain the operation of a full-wave bridge rectifier with neat waveforms.

The operation of a full-wave bridge rectifier	8M
Waveforms	2M

11 a) Explain the working of capacitor filter and analyze its effectiveness in reducing ripple.

Working of capacitor filter	4M
Reducing ripple	1M

11 b) Discuss the working of Zener diode as a voltage regulator.

Working of Zener diode as a voltage regulator	5M

UNIT-VI

12 a) Describe the construction and operation of a full adder and write its Boolean expressions for sum and carry outputs.

Construction and operation of a full adder	4M
Boolean expressions for sum and carry outputs	2M

12 b) Explain the functionality of NAND and NOR gates with truth tables.

Functionality of NAND	2M
Functionality of NOR	2 M

13 a) Explain the working of an SR flip-flop and analyze its truth table, advantages and limitations.

Working of an SR flip-flop	4M
Truth table, advantages and limitations	2M

13 b) Convert the binary number $(11011011)_2$ into decimal, Gray code and Excess-3 code.

Decimal, Gray code and Excess-3 code conversions	4M

Code No: 23ES11002

I B. TECH - II SEMESTER - REGULAR EXAMINATIONS - JUNE 2026

BASIC ELECTRICAL & ELECTRONICS ENGINEERING

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KEY

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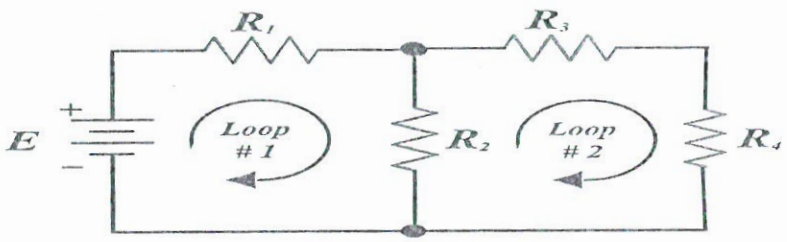
PART A

1a) Define impedance. **1M**

Impedance (Z) is the total opposition offered by a circuit to the flow of alternating current, combining resistance (R) and reactance (X), measured in ohms (Ω).

1b) State KVL and formulate loop equations **1M**

Kirchhoff's Voltage Law (KVL): In any closed loop, the algebraic sum of all voltage drops is zero that is $\sum V=0$



Two loop network

For two loops with mesh currents I_1 and I_2:

Loop 1:

$$E = I_1R_1 + (I_1 - I_2)R_2$$

Loop 2:

$$0 = I_2R_3 + I_2R_4 + (I_2 - I_1)R_2$$

1c) Illustrate working principle of a single-phase transformer **1M**

A single-phase transformer works on **mutual electromagnetic induction** (Faraday's law). AC applied to the primary winding produces an alternating flux in the core; this flux links the secondary winding and induces an EMF in it

1d) Compare MI and PMMC instruments **1M**

PMMC	MI
Works on DC only	Works on both AC and DC
Uniform (linear) scale	Non-uniform scale

Note: Any one comparison can be considered.

1e) Describe electric shock and analyze its causes. **1M**

Our bodies conduct electricity. If any part of your body meets live electricity an electric current flows through the tissues, which causes an electric shock. People sometimes call it electrocution.

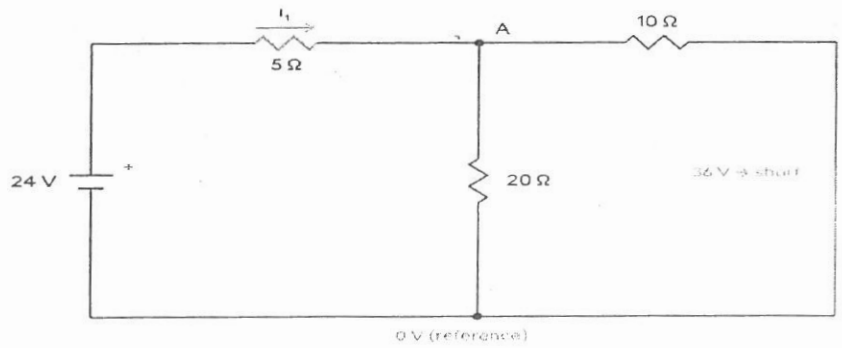
What causes electric shock?

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.

UNIT-I

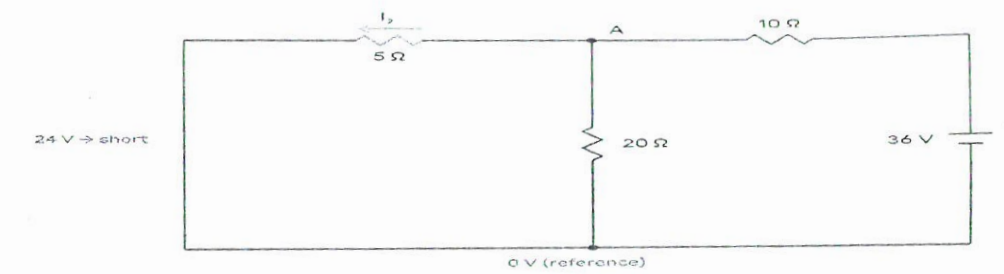
2) Find the current through the 5 Ω resistor in Figure solving by using super position theorem. **10M**



With the 36 V shorted, the 20 Ω and 10 Ω hang in parallel from node A:

$$R_p = 20 \parallel 10 = 6.667\ \Omega, \qquad R_T = 5 + 6.667 = 11.667\ \Omega$$

$$I_1 = \frac{24}{11.667} = 2.057\ \text{A} \quad (\text{into node A, direction} \rightarrow)$$



With the 24 V shorted, the 5 Ω and 20 Ω hang in parallel from node A:

$$R_p = 5 \parallel 20 = 4\ \Omega, \qquad R_T = 10 + 4 = 14\ \Omega$$

$$I_{total} = \frac{36}{14} = 2.571\ \text{A}$$

Current-divider into the 5 Ω branch:

$$I_2 = 2.571 \times \frac{20}{5 + 20} = 2.057\ \text{A} \quad \text{(out of node A, direction } -\text{)}$$

Final combination

Notice the arrows: in Case 1 the current I_1 flows **into** node A through the 5 Ω, while in Case 2 the current I_2 flows **out of** node A — they are in **opposite directions.** So they subtract:

$$I_{5\Omega} = I_1 - I_2 = 2.057 - 2.057 = \boxed{0\ \text{A}}$$

(OR)

3 a) A sinusoidal alternating current of frequency 60 Hz has a maximum value of 120 A. Calculate

i. Average value.
ii. RMS value.
iii. Peak factor. **6 M**

Given: frequency $f = 60$ Hz, maximum (peak) value $I_m = 120$ A

Step 1 — Write down the standard relations

For a pure sinusoidal wave:

- Average value (over half cycle): $I_{avg} = \frac{2}{\pi} I_m = 0.637\, I_m$
- RMS value: $I_{rms} = \frac{I_m}{\sqrt{2}} = 0.707\, I_m$
- Peak (crest) factor: $K_p = \frac{I_m}{I_{rms}}$

Step 2 — i. Average value

$$I_{avg} = 0.637 \times I_m = 0.637 \times 120$$

$$\boxed{I_{avg} = 76.4\ \text{A}}$$

Step 3 — ii. RMS value

$$I_{rms} = \frac{I_m}{\sqrt{2}} = \frac{120}{1.414} = 0.707 \times 120$$

$$\boxed{I_{rms} = 84.85 \text{ A}}$$

Step 4 — iii. Peak factor

$$K_p = \frac{I_m}{I_{rms}} = \frac{120}{84.85}$$

$$\boxed{K_p = 1.414 \ (= \sqrt{2})}$$

3 b) A 10 Ω resistor and 400μF capacitor are connected in series to a 60 V, 50 Hz sinusoidal supply. Calculate impedance and phase angle between the current and voltage. 4M

Given: $R = 10\ \Omega, C = 400\ \mu\text{F} = 400 \times 10^{-6}\ \text{F}, V = 60\ \text{V}, f = 50\ \text{Hz}$

Find: impedance Z and phase angle ϕ

Step 1 — Capacitive reactance

$$X_C = \frac{1}{2\pi fC} = \frac{1}{2\pi \times 50 \times 400 \times 10^{-6}}$$

$$X_C = \frac{1}{2\pi \times 0.02} = \frac{1}{0.12566}$$

$$\boxed{X_C = 7.96\ \Omega}$$

Step 2 — Impedance

For a series R-C circuit, R and X_C are at 90°, so add them as a right triangle:

$$Z = \sqrt{R^2 + X_C^2} = \sqrt{(10)^2 + (7.96)^2}$$

$$Z = \sqrt{100 + 63.36} = \sqrt{163.36}$$

$$\boxed{Z = 12.78\ \Omega}$$

Step 3 — Phase angle

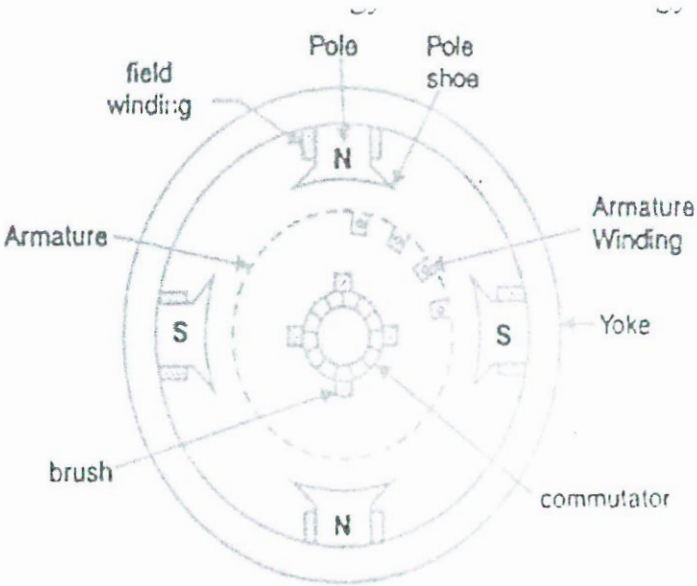
$$\phi = \tan^{-1}\left(\frac{X_C}{R}\right) = \tan^{-1}\left(\frac{7.96}{10}\right) = \tan^{-1}(0.796)$$

$$\boxed{\phi = 38.5^\circ}$$

UNIT-II

4. Discuss the construction and working of DC generator and list their applications, advantages and limitations. 10M

Constructional details of the DC Machine:



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 & Bearings

. Working of DC generator

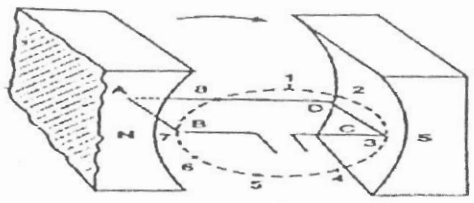
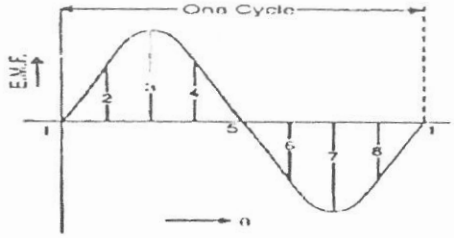


Fig. (1.1)



Fig(1.2)

(i) When the loop is in position no. 1 [See Fig. 1.1], 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 flux and 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 an angle.

(v) At position 5, no magnetic lines are cut and hence induced e.m.f. is zero as indicated by point 5 in Fig. (1.2).

(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.
1.2) will be when the loop is at position 7 and zero when at position 1. This cycle repeats with each revolution of the coil.

DC Motors Applications:

Cranes, Air compressor, Lifts, Elevators, Winching system, Electric traction, Hair drier.

DC Generators Applications:

Testing Purpose in laboratory, speed control of motors, Battery charging, lighting, excitation to alternators, portable power supply.

Note: Any two applications can be considered.

Advantages

1. Provides a steady, ripple-free DC output.
2. Output voltage is easily controlled by varying the field current.
3. Fairly high efficiency and available in a wide range of ratings.
4. Simple and robust construction.

Limitations

1. The commutator and brushes need regular maintenance and periodic replacement.
2. Brush sparking limits its use at high voltages and in explosive/dusty environments.
3. Bulkier and costlier than an equivalent AC machine of the same rating.
4. Commutation problems and losses increase at high speeds and large capacities.

Note: Any two Advantages and Limitations can be considered.

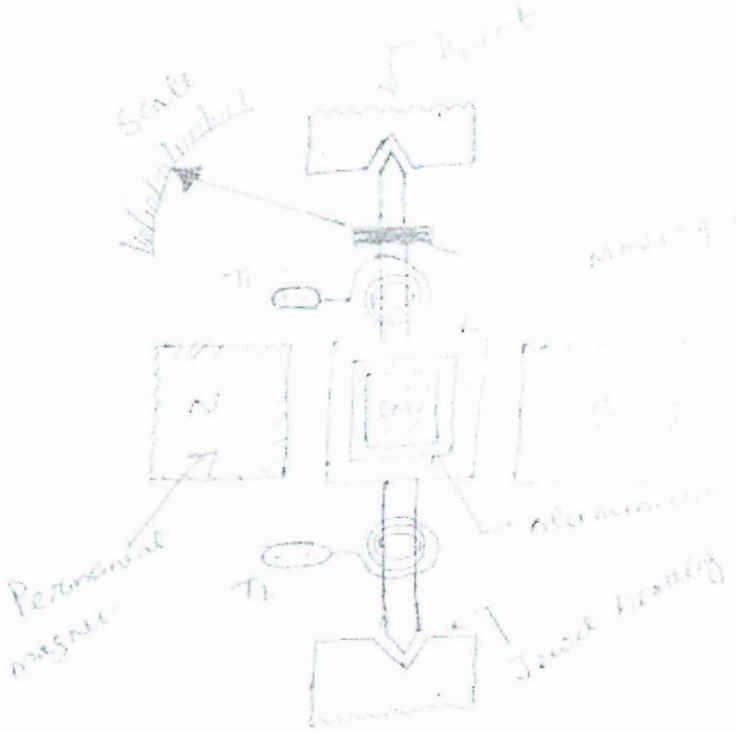
(OR)

5. Describe the construction and working of PMMC instrument and analyze list their advantages, limitations and applications. **10M**

One of the most accurate type of instrument used for D.C. measurements is PMMC instrument.

Construction: A permanent magnet is used in this type instrument. Aluminum former is 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 produces a 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.

Advantages

- Torque/weight is high
- Power consumption is less
- Scale is uniform
- Damping is very effective
- Since operating field is very strong, the effect of stray field is negligible
- Range of instrument can be extended

Disadvantages

- Use only for D.C.
- Cost is high
- Error is produced due to ageing effect of PMMC
  Friction and temperature error are present

Limitations

- ✓ It can measure only DC; not suitable for AC unless a rectifier is used.
- ✓ Costlier due to the permanent magnet and delicate moving coil.
- ✓ Ageing of the magnet and control springs causes calibration errors.
- ✓ Easily damaged by overloads as the coil and springs are delicate.

Note: Any two Advantages and Limitations can be considered.

UNIT-III

6 a) Explain different types of earthing and justify their importance in electrical safety.

5M

Types of Earthing

There are three types of earthing, they are:

- Pipe earthing
- Plate earthing
- Strip earthing

Pipe earthing is the best and most efficient way of earthing and is also easily affordable. Pipe earthing uses 38mm diameter and 2 meters length pipe vertically embedded in the ground to work as earth electrodes.
In plate earthing, an earthing plate made of copper or G.I. is buried into the ground at a depth more than 3 meters from the ground level. This earthing plate is embedded in an alternative layer of coke and salts.
Strip earthing is used in transmission processes. Strip electrodes of cross section not less than 25mm X 1.6mm of copper or 25 mm X 4mm of G.I. or steel are buried in horizontal trenches of a minimum depth of 0.5m.

Importance

- Earthing is the safe and the best method of offering safety. We know that the earth's potential is zero and is treated as Neutral. Since low equipment is connected to earth using low resistance wire, balancing is achieved.
- Metal can be used in electrical installations without looking for its conductivity, proper earthing ensures that metal does not transfer current.
- A sudden surge in voltage or overload does not harm the device and person if proper earthing measures are done.
- It prevents the risk of fire hazards that could otherwise be caused by the current leakage.

NOTE: Any two importance can be considered.

6 b) What is two part tariff? Explain the calculation of electricity bill for domestic consumer.

5M

Two-part tariff: When the rate of electrical energy is charged on the basis of maximum demand of the consumer and the units consumed, it is called a two-part tariff.

Calculation of electricity bill for domestic consumer

The electricity bill for a domestic consumer is calculated based on the electrical energy consumed during the billing period. The energy consumed is measured in kilowatt-hours (kWh), commonly called units.

(OR)

Formula for Energy Consumption:

$$\text{Energy Consumption (kWh)} = \frac{\text{Wattage (W)} \times \text{Operating Hours per Day} \times \text{Number of Days}}{1000}$$

For a billing period of 30 days,

$$\text{Monthly Energy Consumption (kWh)} = \frac{\text{Wattage} \times \text{Hours per Day} \times 30}{1000}$$

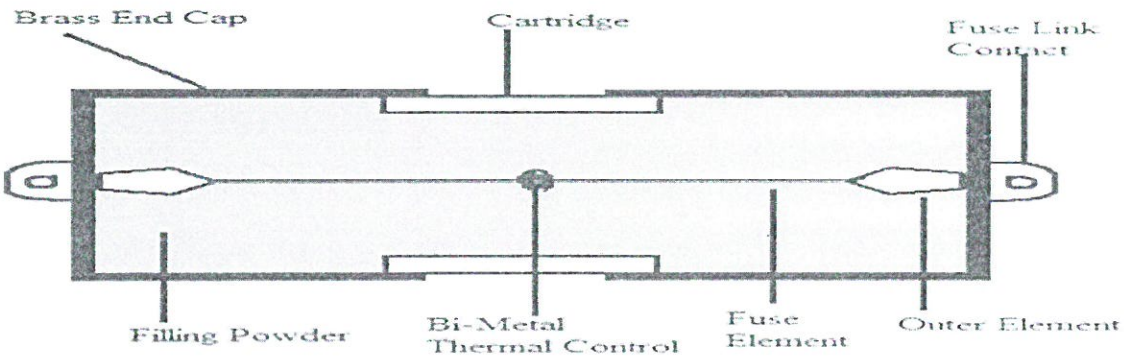
The electricity bill is then calculated as:

$$\text{Electricity Bill (₹)} = \text{Energy Consumption (kWh)} \times \text{Tariff Rate (₹/kWh)}$$

(OR)

7a) Discuss the working of fuse, MCB and list their advantages. **4M**

Working of fuse:



An Electric Fuse is a protective device which interrupts the flow of excessive current in an Electric circuit. This works on the principle of heating effect of the Electric Current .

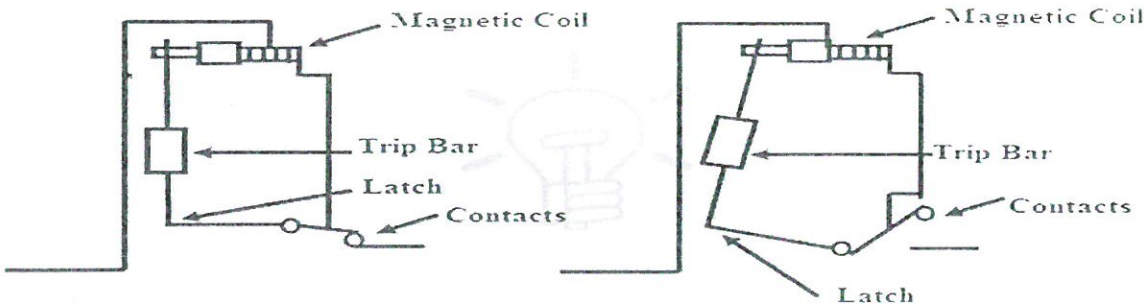
A Fuse consists of conducting wire, which has high resistivity and low melting point. The thickness of the Fuse wire is determined based on the amount of current flow in the circuit. If a fault causes a flow of excess Current then a Conductor break the Circuit by melting or separating it, the thin Conductor used is known as an Electric Fuse. The wire inside the Fuse melts if there is an occurrence of high Current due to a short Circuit or an overloaded Circuit. As a result of which the Current stops flowing since the wire has broken. In order to stop the flow of Electricity. Once a Fuse melts, it can be changed or replaced with a new Fuse. A Fuse is normally made up of elements like zinc, copper, aluminum and silver.

Advantages of Fuse

- It is an economical device used for protecting electrical circuits.
- A fuse melts quickly under fault conditions, preventing damage to electrical equipment.
- It requires very little maintenance since it has no moving parts.

MCB

An MCB – miniature circuit breaker is an electromagnetic device that embodies complete enclosure in a molded insulating material.



Miniature circuit breaker (MCB) :

The main function of an MCB is to open the circuit automatically when the current passing through MCB exceeds the value for which it is set. It can be manually switched ON and OFF as similar to normal switch if necessary. An MCB is a simple, easily operable device and is maintenance-free too. It can be easily replaced. The trip unit is the key part of the MCB on which the unit operates. The bi-metal present in the MCB circuit protects against overload current and the electromagnet in the circuit protects against short-circuit current.

Working Principle of MCB

MCBs is a compact cased device and they have two different tripping mechanisms, the delayed thermal tripping mechanism for overload protection and the magnetic tripping mechanism for short circuit protection .

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.

Advantages of MCB

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

7b)Outline the working and layout of nuclear power plant. 5M

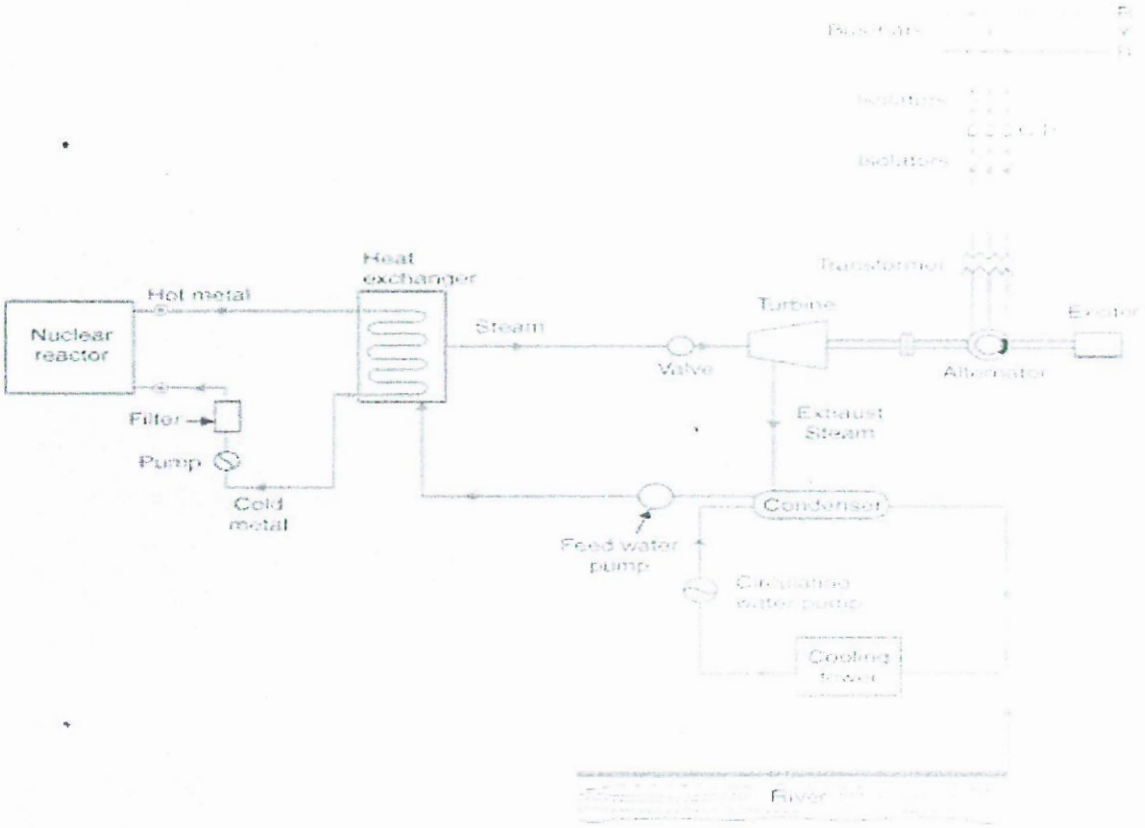
The schematic arrangement of a nuclear power station is shown in Fig. The whole arrangement can be divided into the following main stages :

(i) Nuclear reactor ***(ii)*** Heat exchanger ***(iii)*** Steam turbine ***(iv)*** Alternator.

Nuclear reactor:

It is an apparatus in which nuclear fuel (U_{235}) is subjected to nuclear fission. It controls the *chain reaction* that starts once the fission is done. If the chain reaction is not controlled, the result will be an explosion due to the fast increase in the energy released.

A nuclear reactor is a cylindrical stout pressure vessel and houses fuel rods of Uranium, moderator and control rods .The fuel rods constitute the fission material and release huge amount of energy when bombarded with slow moving neutrons. The moderator consists of graphite rods which enclose the fuel rods. The moderator slows down the neutrons before they bombard the fuel rods. The control rods are of cadmium and are inserted into the reactor. Cadmium is strong neutron absorber and thus regulates the supply of neutrons for fission. When the control rods are pushed in deep enough, they absorb most of fission neutrons and hence few are available for chain reaction which, therefore, stops. However, as they are being withdrawn, more and more of these fission neutrons cause fission and hence the *intensity* of chain reaction (or heat produced) is increased. Therefore, by pulling out the control rods, power of the nuclear reactor is increased, whereas by pushing them in, it is reduced. In actual practice, the lowering or raising of control rods is accomplished automatically according to the requirement of load. The heat produced in the reactor is removed by the coolant, generally a sodium metal. The coolant carries the heat to the heat exchanger.



Schematic arrangement of Nuclear Power Station

PART-B

1f)Define Zener diode and explain its voltage regulation role. **1M**

- A Zener diode is a heavily doped diode designed to operate in reverse breakdown.
- Where it maintains a nearly constant voltage (V_Z) across itself despite changes in current. This property lets it act as a voltage regulator, keeping the output voltage steady against variations in supply voltage or load current.

1g) Explain transistor biasing and justify its importance. **1M**

- In order to have a normal function of transistor it is necessary to apply voltage of a correct polarity across its two junctions. This is called biasing.
- Biasing ensures that the transistor remains in the active region, where it can amplify input signals faithfully without distortion.

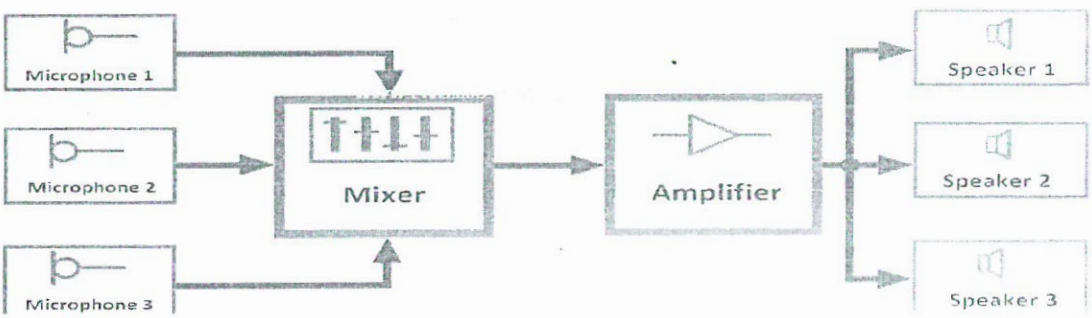
1h) Describe capacitor filter and analyze its ripple reduction role. **1M**

A capacitor filter is a capacitor connected in parallel with the load after a rectifier. It charges to the peak voltage during conduction and discharges slowly through the load between peaks, smoothing the pulsating DC.

1i) Explain the block diagram of a public addressing (PA) system. **1M**

Public Address (PA) System:

A Public Address (PA) system is an electronic sound amplification system used to amplify speech or music so that it can be heard clearly by a large audience.

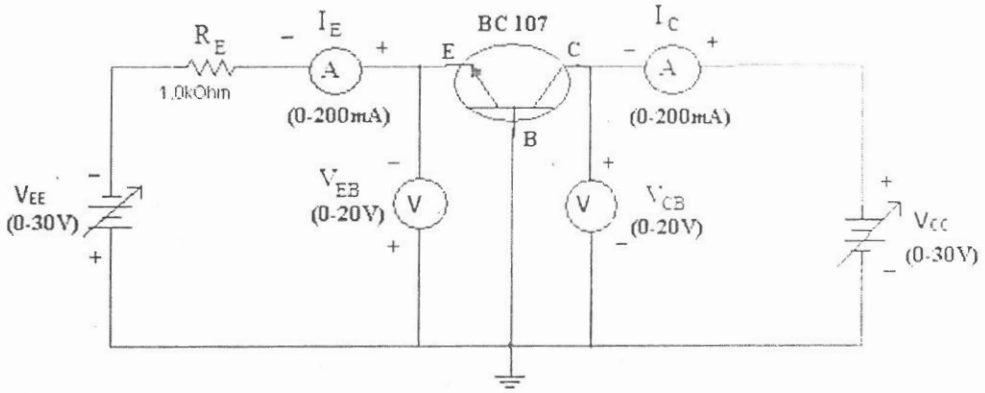


1j) What is a flip-flop? Classify its types. **1M**

It is the basic memory element in sequential circuits. Types: SR, JK, D, and T flip-flops.

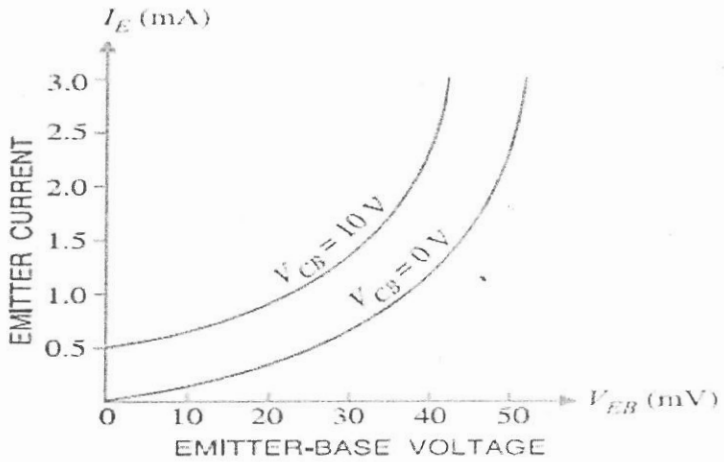
UNIT-IV

8) Explain in detail the CB configuration of transistor with the help of input–output characteristics and discuss its applications. **10 M**



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:



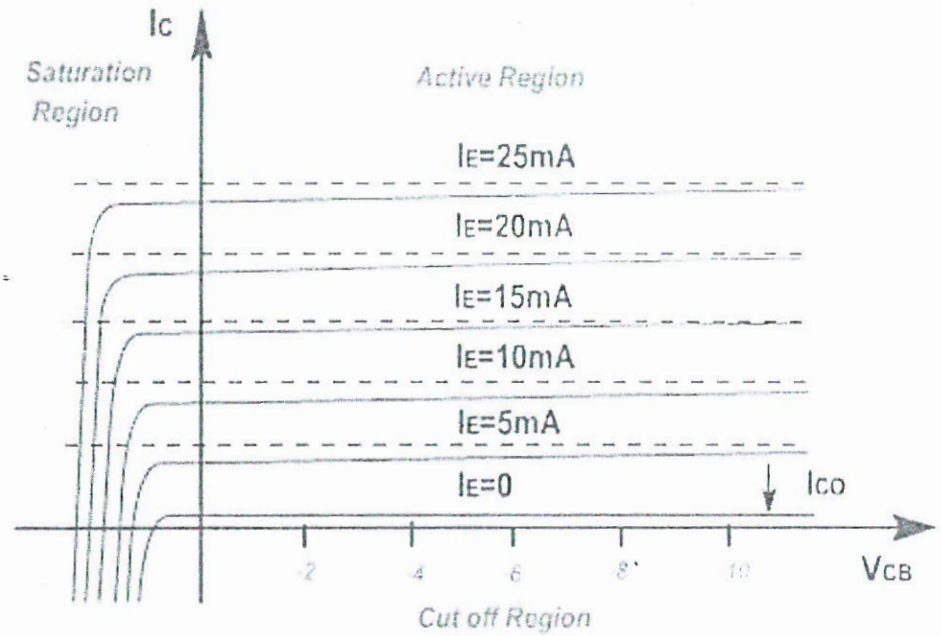
The curve plotted between the emitter current (I_E) and the emitter to base voltage (V_{BE}) at constant collector to base voltage (V_{CB}) are known as input characteristics of a transistor in common base configuration.

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

(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.
(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.

The output characteristics may be divided into three regions and these regions are plotted in the fig.

1. The active region
2. Cut-off region
3. Saturation region

Active region:
In this region the collector junction is reverse biased and the emitter junction is forward biased. In this region when $I_E = 0$, $I_C = I_{CO}$. This reverse saturation current remains constant and is independent of collector voltage V_{CB} as long as V_{CD} is below the breakdown potential.

Saturation region:
The region to the left of ordinate $V_{CB} = 0$ is called the saturation region. In this region both junction are forward biased.

Cut-off region:
The region below the $I_E = 0$ characteristics, for which the emitter and collector junction both reverse biased is called cut-off region.

Applications :
- High-frequency amplifiers
- RF (Radio Frequency) amplifiers

(OR)

9) Describe the construction and working of Zener diode and plot its V-I characteristics. 10M

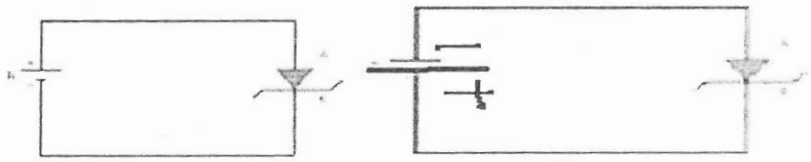
Construction: A Zener diode is a PN-junction diode with heavily doped P and N regions. Heavy doping makes the depletion region very thin, which produces a strong electric field even at low reverse voltage.

Working: There are three biasing conditions for Zener junction diode and this is based on the voltage applied:

Zero bias: There is no external voltage applied to the Zener junction diode.

Forward bias: The positive terminal of the voltage potential is connected to the p-type while the negative terminal is connected to the n-type.

Reverse bias: The negative terminal of the voltage potential is connected to the p-type and the positive is connected to the n-type.

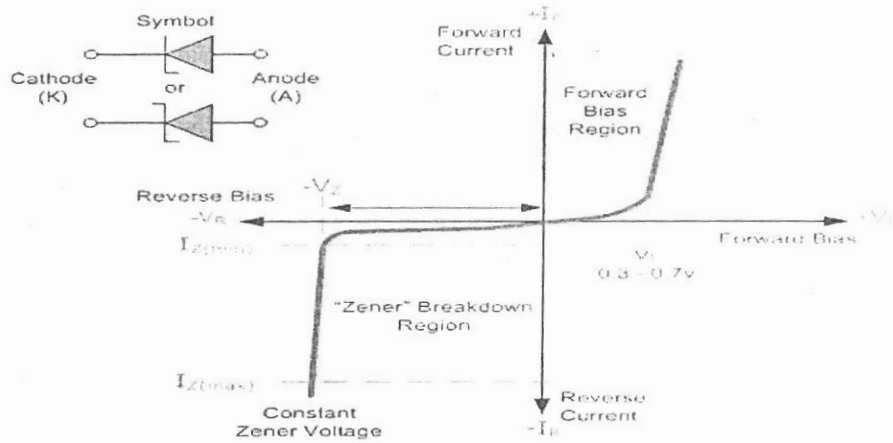


Forward bias of Zener Diode

Reverse biased zener diode

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

Zener Diode I-V Characteristics

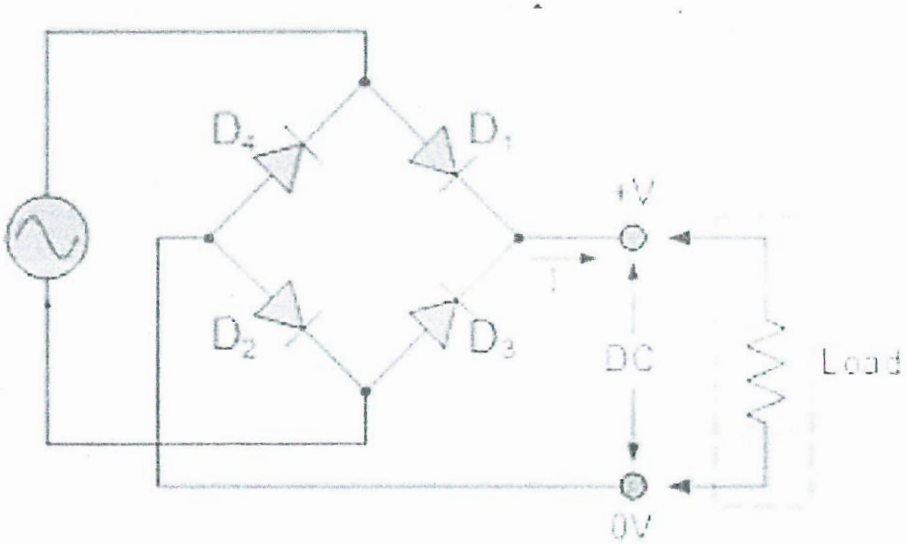


In the third quadrant, the magic happens. The graph shows the current vs voltage curve when we apply a reverse bias to the diode. The Zener breakdown voltage is the reverse bias voltage after which a significant amount of current starts flowing through the Zener diode. Here in the diagram, Vz refers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

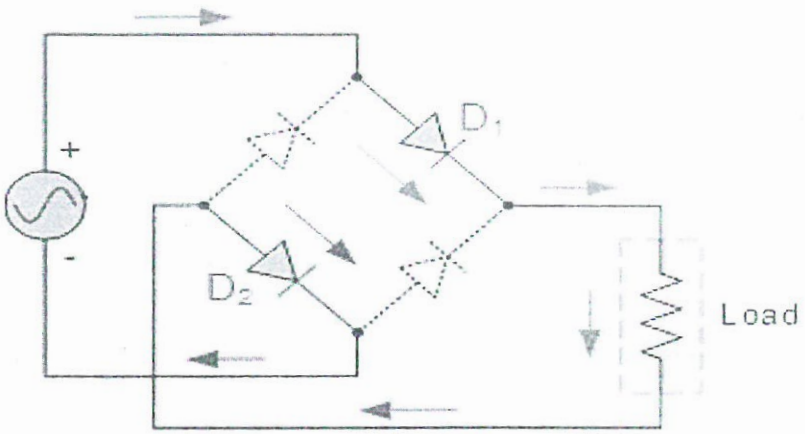
Once the reverse bias voltage becomes more than the Zener breakdown voltage, a significant amount of current starts flowing through the diode due to Zener breakdown. The voltage remains at the Zener breakdown voltage value, but the current through the diode increases when the input voltage gets increased.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

UNIT-V

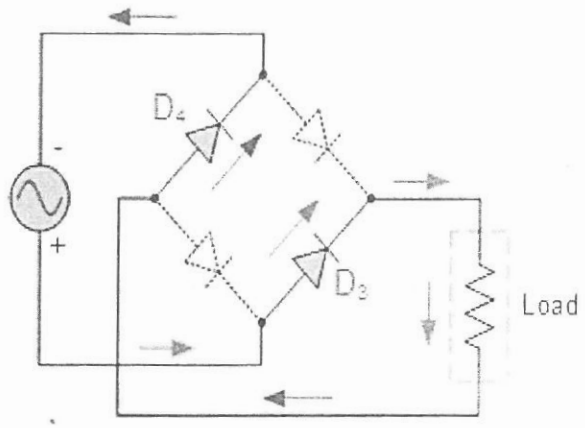
10) Explain the operation of a full-wave bridge rectifier with neat waveforms. 10M



The four diodes labeled D1 to D4 are arranged in "series pairs" with only two diodes conducting current during each half cycle.

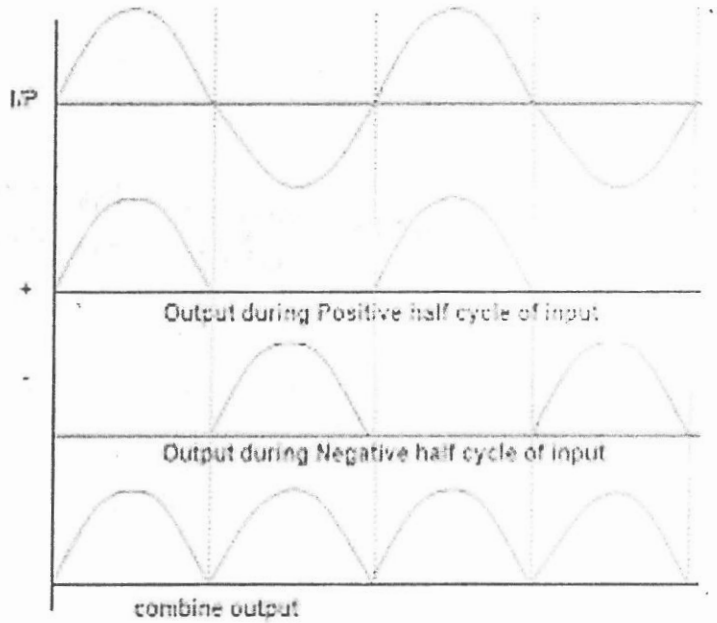


During the positive half cycle of the supply, diodes D1 and D2 conduct in series while diodes D3 and D4 are reverse biased and the current flows through the load as shown below.



During the negative half cycle of the input ac voltage diodes D_3 and D_4 conduct, whereas diodes D_1 and D_2 do not conduct. The conducting diodes D_3 and D_4 will be in series through the load resistance R_L and the current flows through the R_L, in the same direction as in the previous half cycle. Thus a bidirectional wave is converted into a unidirectional wave.

Waveforms:



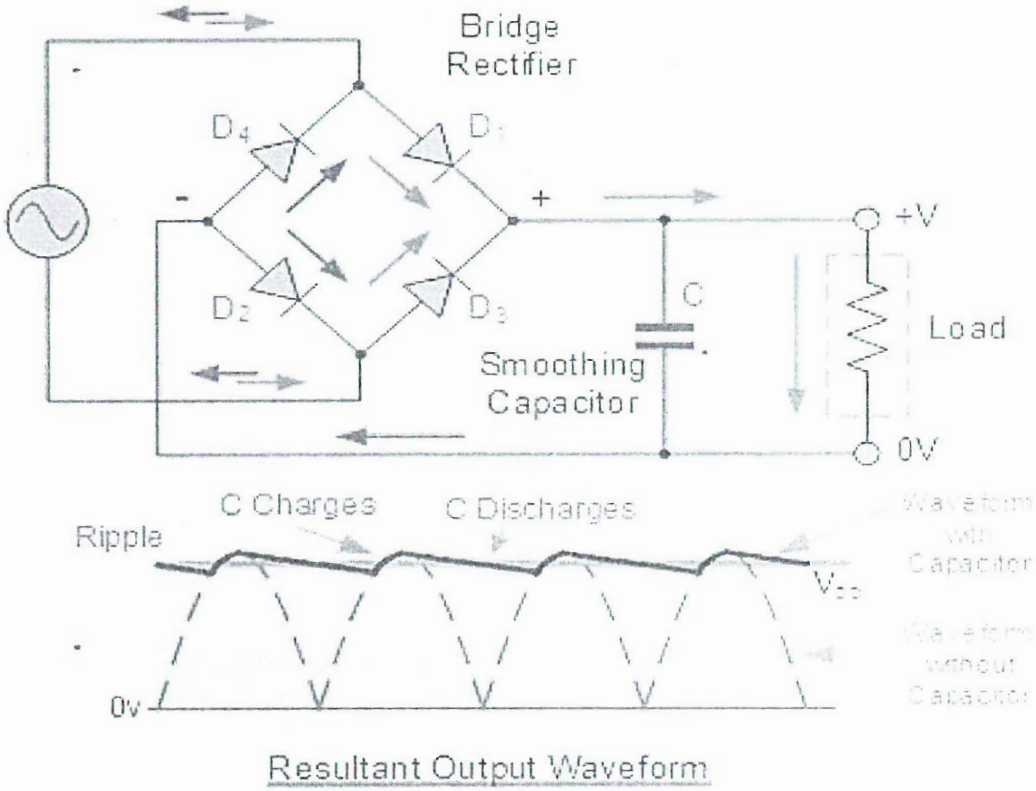
(OR)

11 a) Explain the working of capacitor filter and analyze its effectiveness in reducing ripple. **5M**

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

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.



Resultant Output Waveform

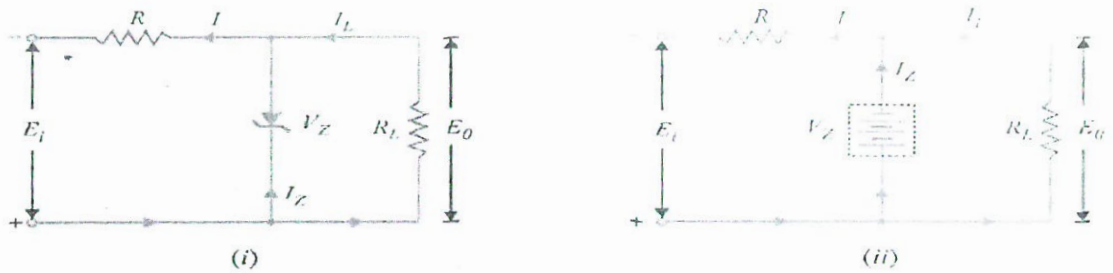
Effectiveness in Reducing Ripple

NOTE:- Any two Effectiveness can be considered.

A capacitor filter is effective because:

- It stores energy during the charging period.
- It releases energy during the discharging period.
- It maintains a nearly constant output voltage.
- Larger capacitor values provide better smoothing and lower ripple.

11 b) Discuss the working of Zener diode as a voltage regulator. **5M**



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

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

(i) Suppose the input voltage increases. It is clear that output voltage remains constant at Vz. 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 Eo remains constant irrespective of the changes in the input voltage Ei.

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

UNIT-VI

12 a) Describe the construction and operation of a full adder and write its Boolean expressions for sum and carry outputs. **5M**

A Full-adder is a combinational circuit that adds two bits and a carry and outputs a sum bit and a carry bit. The full-adder adds the bits A and B and the carry from the previous column called the carry-in Cin and outputs the sum bit S and the carry bit called the carry-out Cout. The variable S gives the value of the least significant bit of the sum. The variable Cout gives the output carry.

The block diagram and truth table of full adder are shown in the following fig. The eight rows under the input variables designate all possible combinations of 1s and 0s that these variables may have. The 1s and 0s for the output variables are determined from the arithmetic sum of the input bits. When all the bits are 0s, the output is 0. The S output is equal to 1 when only 1 input is equal to 1 or when all the inputs are equal to 1. The Cout has a carry of 1 if two or three inputs are equal to 1.

Inputs			Sum	Carry
A	B	C_{in}	S	C_{out}
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

(a) Truth table

(b) Block diagram

From the truth table, a circuit that will produce the correct sum and carry bits in response to every possible combination of A, B and Cin is described by

$$S = \bar{A}\bar{B}C_{in} + \bar{A}B\bar{C}_{in} + A\bar{B}\bar{C}_{in} + ABC_{in}$$
$$= (A\bar{B} + \bar{A}B)\bar{C}_{in} + (AB + \bar{A}\bar{B})C_{in} = (A \oplus B)\bar{C}_{in} + (\overline{A \oplus B})C_{in} = A \oplus B \oplus C_{in}$$

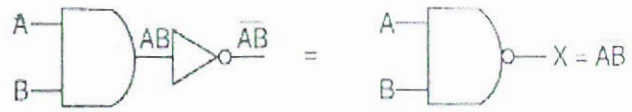
$$C_{out} = \bar{A}BC_{in} + A\bar{B}C_{in} + AB\bar{C}_{in} + ABC_{in} = AB + (A \oplus B)C_{in} = AB + AC_{in} + BC_{in}$$

12 b) Explain the functionality of NAND and NOR gates with truth tables. **5M**

NAND GATE:

NAND gate means NOT AND i.e, AND output is NOTed. So NAND gate is a combination of AND & NOT gates. The little invert bubble (small circle) on the right end of the symbol means to invert the output of AND.

The logic symbol and truth table of NAND gate are shown in the fig.



An AND gate followed by a NOT gate

A two-input NAND gate (Logic symbol)

(a)

Truth table

Inputs		Output
A	B	X
0	0	1
0	1	1
1	0	1
1	1	0

(b)

NAND assumes Logic 0 when each of inputs assumes logic 1. Otherwise the output is logic 1.

NOR GATE:

NOR gate is NOT gate with OR gate. i.e, OR gate is NOTed or an inverted OR function. The standard logic symbol and truth table for the NOR gate are shown in Fig.

An OR gate followed by a NOT gate

A two-input NOR gate (logic symbol)

(a)

Inputs		Output
A	B	X
0	0	1
0	1	0
1	0	0
1	1	0

(b) Truth table

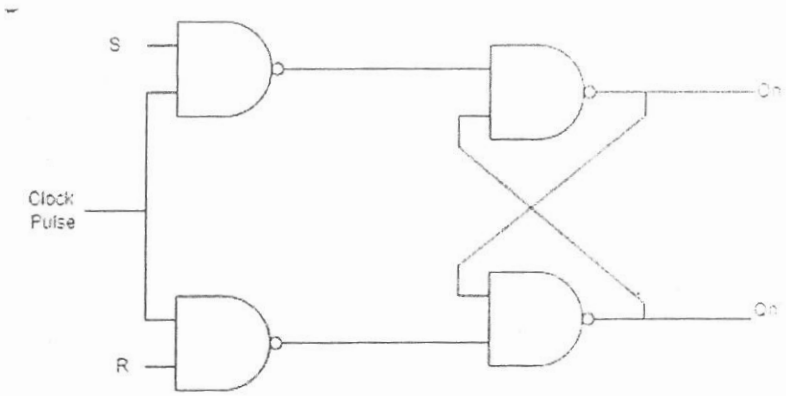
The unique property of NOR gate is that it produces an output of logic '1' if and only if all its inputs are logic '0'.

(OR)

13 a) Explain the working of an SR flip-flop and analyze its truth table, advantages and limitations. **5M**

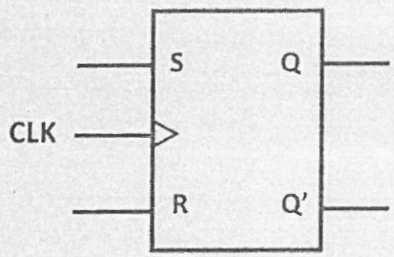
It is a Flip Flop with two inputs, one is S and the other is R. S here stands for Set and R here stands for Reset. Set basically indicates set the flip flop which means output 1 and reset indicates resetting the flip flop which means output 0. Here, a clock pulse is supplied to operate this flip-flop, hence it is a clocked flip-flop.

SR Flip Flop



SR Flip-Flop Truth Table

Symbol



S	R	Q n+1
0	0	Q n
0	1	0
1	0	1
1	1	Indeterminate (invalid)

Advantages: Simplest flip-flop, basic building block for memory and registers, easy to construct.

Limitations: The S=R=1 condition is forbidden (race/indeterminate output).
(invalid)

13 b) Convert the binary number $(11011011)_2$ into decimal, Gray code and Excess-3 code. **5M**

Binary to Decimal Conversion

$$= (1 \times 2^7) + (1 \times 2^6) + (0 \times 2^5) + (1 \times 2^4)$$
$$+(1 \times 2^3) + (0 \times 2^2) + (1 \times 2^1) + (1 \times 2^0)$$

Now substitute the values of powers of 2:

$$= (1 \times 128) + (1 \times 64) + (0 \times 32) + (1 \times 16)$$
$$+(1 \times 8) + (0 \times 4) + (1 \times 2) + (1 \times 1)$$
$$= 128 + 64 + 0 + 16 + 8 + 0 + 2 + 1$$
$$= 219$$

Therefore,

$$\boxed{(11011011)_2 = (219)_{10}}$$

Gray code:

Binary : 1 —⊕—► 1 —⊕—► 0 —⊕—► 1 —⊕—► 1 —⊕—► 0 —⊕—► 1 —⊕—► 1

Gray : 1 0 1 1 0 1 1 0

Excess-3 code:

Step 1: Convert Binary to Decimal

$$(11011011)_2 = (219)_{10}$$

Decimal Digit BCD (8421)

2	0010
1	0001
9	1001

	2	1	9
BCD	0010	0001	1001
	+ 0011	+ 0011	+0011
	0101	0100	1100

5 → 0101

4 → 0100

12 → 1100

Excess-3 Code = 0101 0100 1100