Important suggestions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more importance.
4) While assessing figures, examiner may give credit for principle components indicated in a figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) Some of the questions are not clearly indicative of the exact answer expected. In such cases, credit may be given by judgment of relevant answer based on candidate's understanding.

SECTION- I (Electrical Engg)

Q.1 A) Attempt any Nine of the following:----------18 Marks

a) State Ohm's Law and writes equation for finding current.

(Statement-1 Marks& equation-1 Marks)

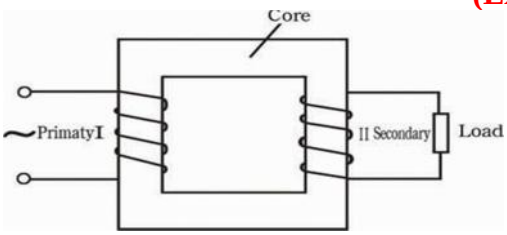
Ohms Law:-

The current flowing through a solid conductor is directly proportional to the difference of potential across the conductor. & inversely proportional to its resistance provided the temperature remains constant.

$$I \equiv \frac{V}{R}$$

b) What is transformer? List any two applications.

(Explanation-1 Marks & application each point 1/2 Marks)



It is static piece of apparatus which transform electrical power in one circuit into electrical power of same frequency in another circuit . **OR**

A Transformer works on the principle of Faradays law of electromagnetic induction. When their primary winding is connected to a.c supply, applied alternating voltage circulates an alternating current through it.

This current flowing through the primary winding produces an alternating magenetic flux (Ø).This flux links with secondary winding through the magenetic core & induces an emf in it. When the load current flows in load. Thus the energy is transferred.

Application:- (Any two application expected)

i) Distribution Transformer
ii) Furnace transformer
iii) Welding transformer
iv) Step up transformer
v) Step down transformer

c) State two application of A.C. motors. **(Any two application expected-1 Mark each)**

Application of AC Motors:- Lathes Machines, Drilling Machine, Grinders, Printing Machine, Fans, Blowers, Compressors , Refrigerators, mixer ,textile industry, food industry, food industry.

d) State the principle of electroplating. **(2 Marks)**

Electroplating can be defined as the deposit of a very thin layer of metal "electrolytically" to a base metal to enhance or change its appearance.

e) What is meant by step-up and step- down transformer?
(Stepup-1 Mark & Stepdown-1 Mark)

- **Step up**- when $N_2 > N_1$ or when $V_2 > V_1$ or when $K > 1$, then it is called as step up transformer.
- **Step down**- when $N_1 > N_2$ or when $V_1 > V2$ or when $K < 1$, then it is called as step down transformer.

f) Write classification of single phase induction motor. **(2 Mark)**
Classification of A.C Motor:

i) 1-phase Induction Motor:-

a) Split phase induction Motor b) Shaded pole induction Motor c) Repulsion type induction Motor etc

ii) 3-Phase Induction Motor:-

a) Squirrel Cage Induction Motor b) Slip-Ring or Wound-Rotor Induction Motor

iii) Synchronous Motor:-

a) Salient Pole Motor b) Cylindrical pole Motor

g) Define i) Amplitude ii) Frequency **(Each Definition- 1 Mark)**

i) Amplitude- The maximum or peak material value of ac quantity is called as amplitude.

ii) Frequency- The number of cycles completed by an alternating quantity in one second.

h) State the Principle of dielectric heating? **(2 Marks)**

Principle-

- For heating any non metallic such as wood, plastic, glass, etc. dielectric heating is used.
- Material to be heated is placed between two metallic plates as shown in figure.
- Across which high voltage (20 to 25 KV) and high frequency (10 to 30 MH_Z) supply is given.
- Material is heated due to dielectric loss taking place inside the job

i) State any four types of commonly used motor enclosure. **(Each type- 1/2 Mark)**

1. Open type enclosure
2. Screen protected enclosure
3. Drip proof enclosure
4. Flame proof enclosure
5. Totally enclosed type enclosure
6. Pipe ventilated totally enclosed enclosure

j) List Classification of DC Motor. **(2 Mark)**

Types of DC Motor :-

i) DC Shunt Motor
ii) DC Series Motor
iii) DC Compound Motor: a) Short Shunt Compound Motor
b) Long short compound Motor

k) Write two advantages of electrical drives. **(Any two expected- 1 Mark each)**

Advantages of Electrical Drives:-

1) Easy Starting. 2) Its operating Characteristics can be easily modified.

3) They are available in wide range of torque, speed & power.

4) High Efficiency. 5) Longer life.

6) Lower Noise. 7) Lower Maintenance.

8) It occupies less space.

9) Do not pollute the environment. 10) Regenerative braking is possible.

11) It is more flexible.

12) It is reliable source of drive.

13) It is more economical.

Q.2 Attempt any Four of the following: ----------16 Marks

a) State and explanation Faraday's Law of electromagnetic induction. **(Each law- 2 Mark)**

Faradays laws of Electromagnetic Induction:-

First Law:-

Whenever change in the magnetic flux linked with a coil or conductor, an emf is induced in it. **OR** Whenever a conductor cuts magnetic flux, an emf is induced in conductor.

Second Law:-

The Magnitude of induced emf is directly proportional to (equal to) the rate of change of flux linkages.

$$e = \frac{-Ndt}{dt} d¤$$

Where, N= Number of turn

$\frac{d¤}{dt}$ = Rate of Change of flux

b) Define an auto-transformer. Write two advantages and applications of an auto-transformer
(Difination-2 Mark & any one advantages – 1 Marks & any one Application- 1 Marks)

Auto Transformer:-

An Auto Transformer is a transformer having only one winding wound on a laminated magnetic core, the part of this winding being common to both the primary & secondary circuits auto transformer is also called as dimmerstat.

Advantages of autotransformer-(Any one accepted)

1. Saving of copper takes place.
2. Voltage regulation of autotransformer is better.
3. Autotransformer is smaller in size.
4. Cost is reduced in autotransformer as compared to conventional two winding transformer.
5. Losses are less in autotransformer.

Autotransformer Applications- (Any one accepted)

1. Autotransformer used as variac (to change the voltage).
2. Autotransformer can be used to start the ac machines such as induction motor.
3. Autotransformer is used to vary the supply voltage of a furnace.
4. Autotransformer can be used as a dimmerstat.
5. To give small boost to a distribution cable to correct the voltage drop.
6. Autotransformer used as interconnecting transformer in 132 kv/220 kv system.
7. Autotransformer used in control equipment for 1 phase and 3- phase electrical locomotives.

c) Why synchronous motor runs at synchronous speed only? Explain it.

(Reason-2 Marks & Explanation- 2 Marks)

Synchronous motor runs on the principal of magnetic locking between stator magnetic flux and rotor flux.

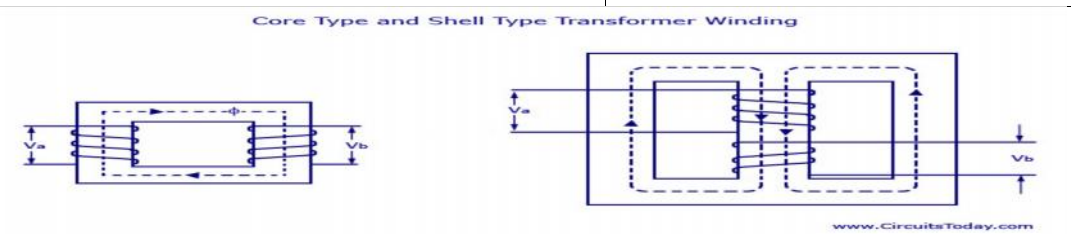
As stator magnet flux runs at synchronous speed only so, rotor as it is locked with this stator magnetic flux which runs at synchronous speed only hence rotor i. e. synchronous motor runs at synchronous speed only.

OR

In an electric motor torque is developed by interaction of the rotor flux and the stator flux. In order to develop a continuous torque the fluxes must be fixed relative to one another as the motor rotates. If they are not fixed, then the torque fluctuates both positive and negative and the net torque is zero.

In a synchronous machine the position rotor flux is fixed relative to the rotor. Therefore, the rotor speed must be the same as the rotational speed of the stator flux.

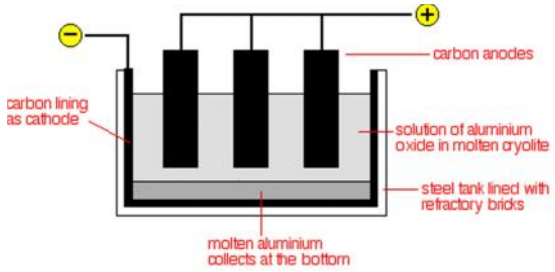
d) Explain with neat sketch the difference between core type and shell type single phase transformer. **(Figure-1 Marks & Difference any three point expected-1 Mark each)**

S.No	Core Type 1-Ph Transformer	Shell Type 1-Ph Transformer
1.		
2.	The Winding surround the core	The core surround the windings
3.	Average length of the core is more	Average length of the core is less
4.	Magnetic Flux has only one continuous path	Magnetic Flux is distributed into 2 paths
5.	Suitable for high voltage & less output	Suitable for less voltage & high output
6.	Easy for repairs	Difficult for repairs
7.	Less in Weight	More in Weight
8.	Leakage flux are more	Leakage flux are less

e) With the help of labeled diagram explain the electro-extraction of Aluminum.

(Explanation 2-Marks and Diagram- 2 Marks)

Neat Diagram & explain Electro-extraction of Aluminum :



or Similar

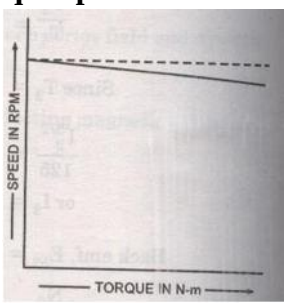
Aluminium is produced from bauxite containing aluminium oxide or alumina,silica & iron oxide.The bauxite are is reduced ,aluminium oxide by chmical treatment & then it isdissolved in fused cryolite. Cryolite is electrolysed & fused.This is accomplished in a large shallow rectangular steel path lined with carbon, carbon anodes projecting downwards intothe bath as shown in above fig.thus bottom of the bath.forms the cathod.This charge will be melted by the electric heating method by current flowing through the charge.The liquid metal deposite at bottom cathod in the form of laddels,fresh alumina is used for decomposition using electric current flow with process.we get 99.5% pure aluminium.**OR**

Following keypoints coverd in above explain:

- Aluminium obtained from bauxite.
- Reduction chemical process.
- Fused cryolite which is electrolysed.
- Large rectangular steel bath with carbon.
- Electric heating method by current flow.

f) Draw and explain following characteristics of DC shunt motor i) Torque speed ii) Torque Armature current **(Each Explanation- 1 Mark & Figure- 1 Mark)**

i) Torque speed:

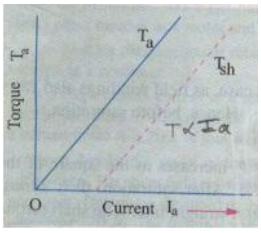


$$Eb = \frac{¤ZNP}{60A}$$

$$N \sim E_b \sim V - I_a R_a \qquad \text{(since all other constant)}$$

From these $N \sim E_b \sim V - I_a R_a$ *it is clear that as load increses* $I_a R_a$ *drop increses hence speed decreses as shown in the graph.*

ii) Torque Armature current



$T = \frac{1}{2®} \times ¤ \, ZI_a \frac{P}{A}$

$T \sim I_a$ (Since all others are constant)

In case of shunt motor ¤ is constant therefore $T \sim I_a$ from this equation it is clear that as armature current increases, torque increases. As shown in graph.

Q.3 Attempt any Four of the following:----------16 Marks

a) A single phase 50 Hz transformer has 20 primary turns and 273 secondary turns. The net cross sectional area of core is 400 cm2. If primary winding is connected to a 220 V AC supply. Find: **(Give stepwise Marks as mention below)**

i) Peak value of flux density in the core
ii) EMF induced in the secondary winding

Solution-

Given Data - f=50 Hz, $N_1 = 20$, $N_2 = 273$, $A = 40\ cm^2$, $V_1 = 220\ V$ $B_m = ?$ $E_2 = ?$

Step – I :- *E.m.f. equation for primary side is given by : –*

$E_1 = 4.44 \times f \times ¤_{max} \times N_1$ ---------- **(1Mark)**

$220 = 4.44 \times 50 \times ¤_{max} \times 20$

$¤_{max} = 0.0495\ wb$

Flux density is given by : –

$B_{max} = \frac{¤_{max}}{A}$ ---------- **(1Mark)**

$B_{max} = \frac{0.0495}{400 \times 10^{-4}}$ ---------- **(1Mark)**

i) Peak value of flux density in the core= $B_{max} = 1.238\ wb/m^2$

Step – II emf on secondary side is given by : –

$E_2 = 4.44 \times f \times ¤_{max} \times N_2$

$E_2 = 4.44 \times 50 \times 0.0495 \times 273$

ii) EMF induced in the secondary winding= $E_2 = 3003\ V$ ---------- **(1Mark)**

b) Write the comparison of 3-phase squirrel cage I.M and Slip ring 3-Ph I.M (Any four points) **(Each point-1 Mark)**

S.No	3-phase squirrel cage I.M	Slip ring 3-Ph I.M
1	Rotor is in the form of bars	Rotor is in the form of 3-ph winding
2	No slip-ring and brushes	Slip-ring and brushes are present
3	External resistance cannot be connected	External resistance can be connected
4	Small or moderate starting torque	High Starting torque
5	Starting torque is of fixed	Starting torque can be adjust
6	Simple construction	Completed construction
7	High efficiency	Low efficiency
8	Less cost	More cost
9	Less maintenance	Frequent maintenance due to slip-ring and brushes.
10	Starting power factor is poor	Starting power factor is adjustable & large
11	Size is compact for same HP	Relatively size is larger
12	Speed control by stator control method only	Speed can be control by stator & rotor control method

c) State and explain any four factor to be considered while selection of electrical drives.

(Any four factor expected, each factor -1 Mark)

Factors to be considered for selection of Electrical Drives:

1) **Nature of Supply:-** Whether supply available is AC, pure DC or rectified DC
2) **Nature of Drive :-**Whether motor is used to drive individual machines or group of M/c
3) **Nature of Load :-** Whether load required light or heavy starting torque or load having high inertia require high starting torque for long duration.
4) **Electric Characteristics of drive: -** Starting, Running, Speed control and braking characteristics of electric drive should be studied and it should be match with load.
5) **Size and rating of motor: -** Whether motor is continuously running, intermittently running or used for variable load cycle.
6) **Mechanical Consideration: -** Types of enclosure, Types of bearings, Transmission of power, Noise level, load equalization
7) **Cost: -** Capital, Running and maintenance cost should be less

d) State two function of motor enclosure also state two types of enclosure along with application? (Function – 2 Marks, Types- 1 Marks & Application- 1 Mark)

Function of motor enclosure:-

1. It protects the operator against the contact with live and moving parts.
2. It provides protection to internal parts of motor against mechanical injury.
3. It gives mechanical support.
4. It provides protection against entry of moisture, dirt, dust particles inside the motor.
5. Main purpose of enclosure is to fold the machines.

Types of commonly used motor enclosure:-

1. Open type enclosure
2. Screen protected enclosure
3. Drip proof enclosure
4. Flame proof enclosure
5. Totally enclosed type enclosure
6. Pipe ventilated totally enclosed enclosure

Application of enclosures-

1. Open type enclosure
   It is used where motor is installed in clean atmosphere and in closed room.
2. Screen protected enclosure
   It is used where motor is installed in clean atmosphere and in closed room.
3. Drip proof enclosure
   It is used where there is damp atmosphere condition such as water pumping station , motor on ship.
4. Flame proof enclosure
   It is used where motor is used in explosive atmosphere such as chemical and plants mines.
5. Totally enclosed type enclosure
   It is used where dusty atmosphere such as stone crushing plant, coal handling plant, saw mill, cotton industry.
6. Pipe ventilated totally enclosed enclosure
   It is used where dusty atmosphere such as saw mill, stone crushing plant.

e) State & explain principal of resistance heating (4 Marks)

Principal of Resistance Heating:-

- When the current is passed through heating element heat is produced due to I^2R loss.
- To produce more amount of heat in less time in case of industrial resistance furnace large amount of current is passed through heating element.
- This heat is utilized to heat the charge directly (conduction) or indirectly (radiation)

- Heating element is made of high resistivity material such as nichrome.
- Heating element may be in the form of wire or strip.

f) Write the procedure to select furnace for heating. **(Each procedure – 1 Mark)**

Procedure to select furnace for heating:

1) Whether material is conducting or not conducting.
2) Material in liquid /solid and powder form.
3) Quantity of Material.
4) Charge is to be heated or to be melted. **(OR any similar point)**

---------- **Section I End**----------

Section –II (Electronics)

Q.4 Attempt any Nine of the following

a) List two application of transistor.

Applications of Transistor **(2 Marks for any 2 applications)**

1. Transistor as a switch
2. Transistor as an amplifier
3. In digital systems (Logic Gates, memory, Microprocessors, etc)
4. In different electronics fields/circuits such as linear integrated circuits, oscillators, etc.

b) Define semiconductor and insulator with example.

Semiconductor :- **(1 Mark)**

A solid substance that has conductivity between that of an insulator and that of most metals and the conductivity can be selectively controlled by doping the material with an impurity. Examples- Silicon, germanium.

Insulator :- **(1 Mark)**

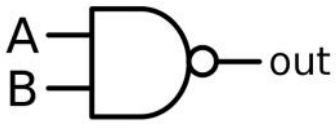
Any material that exhibits high resistivity to electrical current, such as rubber, plastic, or wood

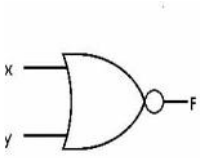
c) What are universal gates? Name them

Universal Gates with their symbols :- **(Marks Allotted –2 Mark)**

Logic NAND and NOR Gates are the Universal Gates. **(1 Mark)**

Symbol of NAND Gate **Symbol of NOR Gate** **(1 Mark)**





d) State two ideal characteristics of operational amplifier.

Characteristics of an Ideal Op-Amp: - **(2 Marks for any 2 applications)**

1. Infinite open-loop gain *A*
2. Zero output impedance
3. Zero common-mode gain, or, infinite common-mode rejection
4. Infinite input impedance
5. Infinite gain-bandwidth product.

e) What is filter? State the function of filter.

Definition of filter – (1 Mark)

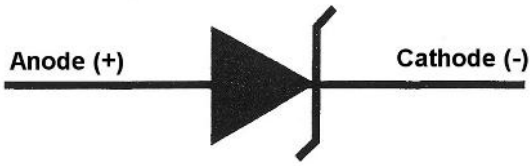
Filters are the electronics circuits used to remove unwanted frequency.

Function :- (1 Marks)

- The output of rectifier circuit is pulsating D.C. and not a pure D.C. It contains some A.C. component along with d.c. component. To filter out these a.c. components from the d.c. and to get pure d.c., filter is connected at the output of the rectifier.
- In high pass filter, low pass filter, Band pass filter and Band reject filter desired frequencies will be filtered out.

f) Draw the symbol of zener diode and give one application of the same.

Symbol of zener diode :- **(1 Mark)**



Applications of the zener diode (any one):- **(1 Mark)**

1. Voltage regulator
2. Regulated power supply
3. In protection circuits of MOSFETs
4. In the clipping circuits
5. In the pulse amplifier

g) State working principle of LCD

Working principle of LCD (Liquid Crystal display) **(Marks Allotted – 2)**

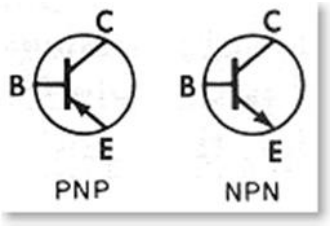
A LCD display consists of many pixels; this is what the resolution stands for, the number of pixels. Each of these pixels is an LCD panel, and it is seen as a multi-layer sandwich supported by a fluorescent backlight. At the two far ends of the LCD panel are non-alkaline, transparent glass substrates with smooth surface and free of surface scratches. The glass substrates are attached to polarizer film that transmits or absorbs a specific component of polarized light. In between the two glass substrates is layer of the nematic phase liquid crystals. There is also a colour filter containing the 3 primary colours. (red, green and blue). Each of the polarized glass is arranged at right angles to each other.

When electric current was passed through the LCD panel, the liquid crystals are aligned with the first polarized glass encountered and will make a 90^{o} twist when approaching the other polarized glass at the end. When this happens, the light from the fluorescent backlight is able to

pass through and thus giving us a lighted pixel on the monitor. When there is no electric current, the liquid crystals will not twist and thus the light will not pass through and a black pixel will be shown. The reason we see the coloured images are due to the colour filter, light passes through the filtered cells creates the colors.

h) Draw the symbol of PNP and NPN transistor and write one application of transistor.

Symbols of NPN & PNP transistors :- **(1/2 Mark for each symbol)**

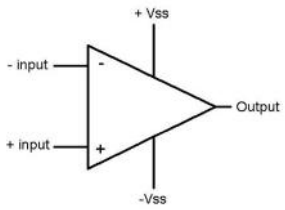


Applications of Transistor:- **(1 Mark for any 1 Application)**

1. Transistor as a switch
2. Transistor as an amplifier
3. In digital systems (Logic Gates, memory, Microprocessors, etc)
4. In different electronics fields/circuits such as linear integrated circuits, oscillators, etc.

i) Draw the labelled symbol of OP-AMP

Labelled symbol of OP-AMP: - **(Marks Allotted – 2)**

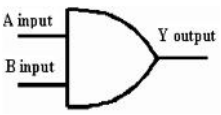


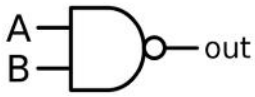
j) What is logic gate? Draw the logic symbol of NAND and OR gate.

Logic Gates: - **(1 Mark)**

A logic gate is an elementary building block of a digital circuit implementing a Boolean function, that is, it performs a logical operation on one or more logic inputs and produces a single logic output.

Symbol of OR Gate: - **Symbol of NAND Gate** **(Each symbol-1Mark)**





k) What is rectifier? What are its types?

Rectifier:- **(1 Mark)**

A rectifier is an electrical circuit that converts alternating current (AC) to direct current (DC).

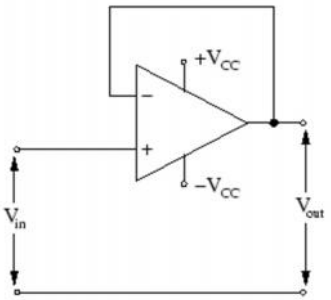
Types of Rectifier :- **(1 Mark)**

1. Half wave rectifier
2. Full wave rectifier:-
   a) Center tapped full wave rectifier
   b) Bridge rectifier.

Q.5 Attempt any Four of the following.

a) Draw the circuit of voltage follower using Op-AMP. State its applications.

Voltage follower using OP-AMP Circuit diagram: **(2 Marks)**



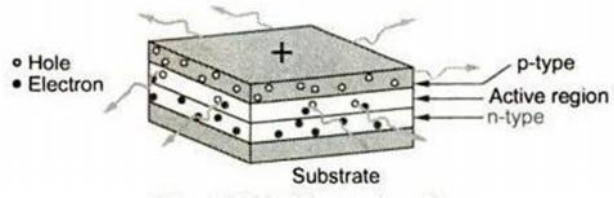
The circuit of voltage follower is the special case of non- inverting amplifier with unity gain. The circuit is also known as unity gain amplifier.

Applications of voltage follower: **(2 Marks)**

1. As a buffer amplifier
2. For impedance matching

b) With the help of a neat diagram explain construction and working of the LED.

Construction of LED :- **(2 Marks)**



One of the methods used for the LED construction is to deposit three semiconductor layers on the substrate. In between p-type and n-type, there exists an active region.

Working of LED :- LED- Light Emitting Diode **(2 Marks)**

- When it is forward bias, it emits visible light. The electrons are in the higher conduction band on the N-side, where holes are are in the lower valence band on p- side.
- When forward biased electrons recombine with the holes. During recombination energy is emitted in form of light.
- G_aA_s , G_aP, G_aA_sP are used to get visible light.(G_aA_S- Infrared radiation, G_aP- Red or green, G_aA_sP- Red or yellow
- Colors of the emitted light depends on the type of material used.

c) Draw and explain block diagram of mobile phone system.

(There are two alternative Answers select any one) **(Marks Allotted –4 Mark)**

Blocks involved in the mobile phone system/ communication- **(2 Marks for Description)**

- SIM: Subscriber Identity Model
- ME /MS: Mobile equipment/set
- BSC: Base Station Controller
- BTS: Base Tran receiver Controller
- EIR: Equipment Identity Register
- HLR: Home Location Register
- VLR : Visitor Location Register
- MSC: Mobile Service Switching Centre
- Au C: Authentication centre

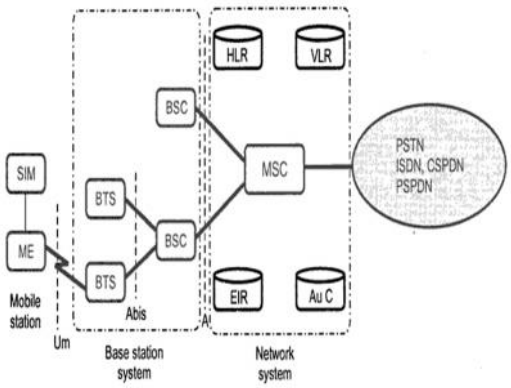
Mobile Station- carried by subscriber

Base station system- controls the radio link with the mobile station

Network System-

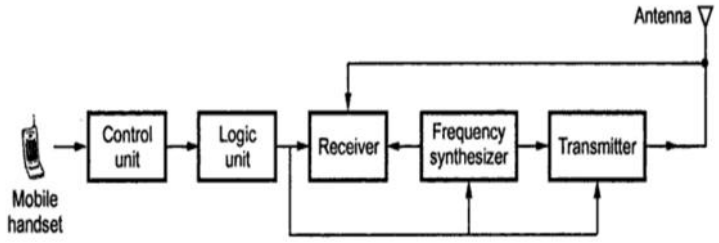
Performs switching of calls between users. Mobile phone communication system provide terminal mobility (ability to locate and identify a mobile terminal as it moves and access communication), personal mobility (to identify end users) and service portability (to provide subscribed services).

Block diagram of mobile phone system :- **(2 Marks)**



OR (Alternative Answer)

Block Diagram of mobile phone handset :- **(2 Marks)**

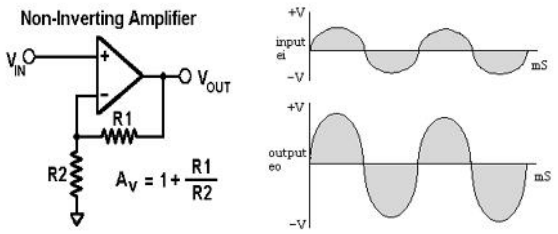


Working :- **(2 Marks)**

- After authentication at mobile terminal and BSC/BTS, the channels are allocated to mobile terminal.
- These channels are accessed by setting frequencies at frequency synthesizer.
- Modulated signal are transmitted and received by allocating different codes to different users, so that the particular user will receive valid signals. This is called as Code Division Multiple Access (CDMA).
- The control and logic units provide required signals for transmission and reception of signal at mobile terminal.

d) Draw and explain non-inverting configuration of an Op-AMP.

Non- inverting amplifier (Circuit):- **(2 Marks)**



Vo = Av X Vin

Where, Av = Closed loop gain of amplifier

$$\mathbf{Av = 1 + \frac{R_1}{R_2}}$$

Explanation- **(2 Marks)**

- The input is applied to non-inverting terminal and inverting terminal is grounded through R1
- R_f = feedback resistor
- Due to closed loop configuration , the gain of the amplifier is adjustable and is given by the equation

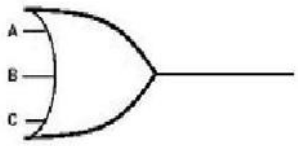
$$\mathbf{Av = 1 + \frac{R_1}{R_2}}$$

By selecting proper values of R_f and R1 we can design the required gain.

- With this circuit the small signal Vin gets amplified as shown in the waveform.
- V_O will be in phase with the input.

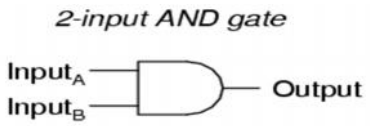
e) Draw the logic symbol and construct the truth table for each of the following: i) Three input OR gate. Ii) Two input AND gate

i) Three input OR gate and Truth Table (1 Mark for logic symbol and 1 Mark for Truth table)



A	B	C	Output
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1

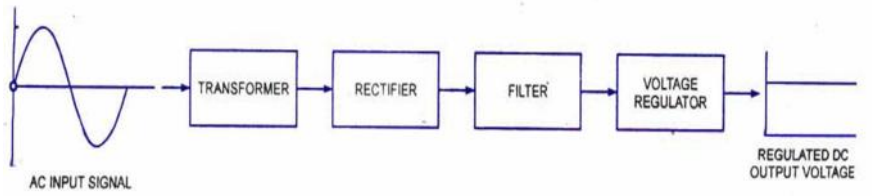
ii) Two input AND Gate and Truth Table- (1 Mark for logic symbol and 1 Mark for Truth table)



A	B	Output
0	0	0
0	1	0
1	0	0
1	1	1

f) Draw and explain Block diagram of a power supply.

Block Diagram of Regulated power supply:- **(2 Marks)**



Block Diagram of a DC Power Supply

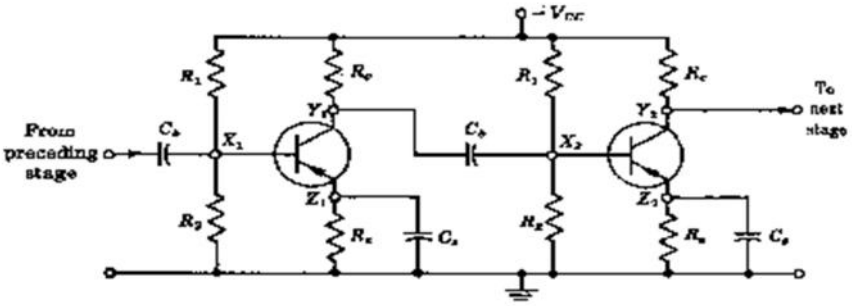
Explanation:- **(2 Marks)**

- **Transformer: -** is used to step-up or step-down (usually to step-down) the-supply voltage as per need of the solid-state electronic devices and circuits to be supplied by the dc power supply. It can provide isolation from the supply line-an important safety consideration.
- **Rectifier***:*-is a device which converts the sinusoidal ac voltage into either positive or negative pulsating dc.
- **Filter:**-The output voltage from a rectifier circuit has a pulsating character i.e., it contains unwanted ac components (components of supply frequency *f* and its harmonics) along with dc component. For most supply purposes, constant direct voltage is required than that furnished by a rectifier. To reduce ac components from the rectifier output voltage a filter circuit is required. Thus filter is a device which passes dc component to the load and blocks ac components of the rectifier output.
- **Regulator:**-The magnitude of output dc voltage may vary with the variation of either the input ac voltage or the magnitude of load current. So at the output of a rectifier filter combination a voltage regulator is required, to provide an almost constant dc voltage at the output of the regulator.

Q.6 Attempt any Four of the following.

a) Draw circuit diagram of two stage RC coupled amplifier.

Two stage RC coupled amplifier- Circuit diagram **(4 Marks)**



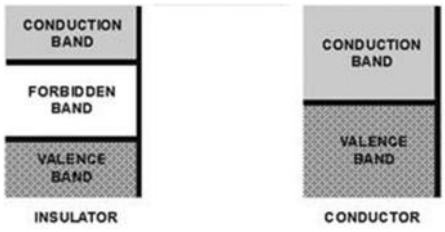
Working:-

Vin is the small a.c. signal which is to be amplified.

- Q1 and Q2 are NPN transistors, therefore + Vcc is applied.
- C1 = input coupling capacitor C2 couples stage1 output with stage2
  C3 = output coupling capacitor
- R1 and R2 form voltage divider bias
- R1, R2 and Re provide steady Q-point and the transistor is operated in active region.
- Total gain of the amplifier = A_1 X A_2,(A1= gain of first stage,A2= gain of second stage)
  180 degree phase shift is provided by each transistor, hence total phase shift = 360 degree. Thus the output is in phase with the input.

b) Draw the energy level diagram of a insulator and conductor and explain the term forbidden energy gap.

The energy level diagram of an insulator and conductor: - **(2 Marks)**

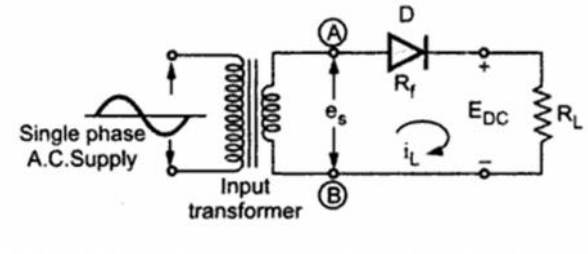


Forbidden energy gap- **(2 Marks)**

It is the separation between conduction band and valence band. It is the energy required to transfer an electron from valence band to conduction band, the external energy which is required is equal to the forbidden energy gap.

c) Draw and explain half wave rectifier.

Half wave Rectifier (Circuit) :- **(2 Marks)**



The rectifier circuit consists of resistive load, rectifying element and the source of a.c. voltage, all connected in series. To obtain the desired d.c. voltage across the load, the a.c. voltage is applied to rectifier circuit using suitable step-up or step-down transformer.

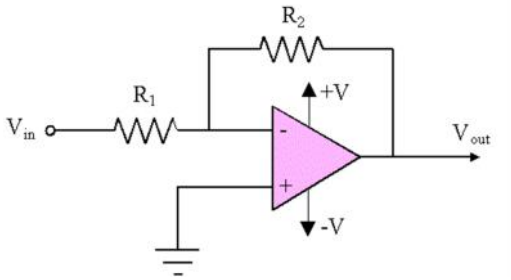
Operation- **(2 Marks)**

During the positive half cycle, terminal (A) becomes positive with respect to terminal (B). The diode is forward biased and the current flows in the circuit. The current will flow in almost full positive half cycle.

During the negative half cycle, terminal (A) becomes negative with respect to terminal (B). The diode is reverse biased and the no current flows in the circuit.

d) Explain inverting amplifier circuit.

Inverting amplifier using Op-amp (Circuit Diagram) :- **(2 Marks)**



Working: **(2 Marks)**

Here the Op-amp is configured in inverting mode. Input signal Vs is applied at inverting terminal through Resistor $\mathbf{R_1}$ & Non-inverting terminal is grounded $\mathbf{R_f}$ is the feedback resistor.

At node V_2, apply Kirchhoff's current law:-

$$Ii = I_b + I_f$$

But Ib = 0 then Ii ≈ If

$$\frac{V_{in}-V_2}{R_1} \equiv \frac{V_2-V_0}{R_f} \ldots\ldots\ldots 1$$

As V1 = 0 (grounded) & Vd = 0 …… Ad = ∞

$V_d = V_1 - V_2 = 0$ Hence

$V_2 = 0$…… Virtual ground

Put V2 = 0 in equation **1**

$$\frac{Vin-0}{R_1} \equiv \frac{0-V_0}{R_f}$$

$$\frac{V_{in}}{R_1} \equiv \frac{-V_O}{R_f}$$

$$\frac{V_{in}}{V_{in}} \equiv \frac{-R_F}{R_1} \equiv Av$$

Thus the gain of inverting Amplifier is :- $\frac{-R_f}{R_1}$ Thus the output gets inverted and amplified.

e) What is transistor? Explain transistor as an amplifier. **(Marks Allotted –4 Mark)**

Transistor :- **(1 Mark)**

A transistor is a semiconductor device used to amplify and switch electronic signals and electrical power. It is composed of semiconductor material with at least three terminals for connection to an external circuit.

Transistor as Amplifier :- Circuit Diagram **(1 Mark)**

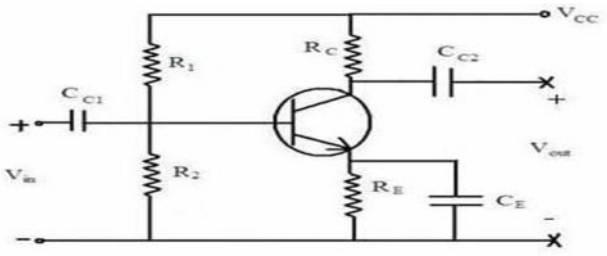


Figure 1 . RC-coupled CE BJT Amplifier

Transistor as Amplifier

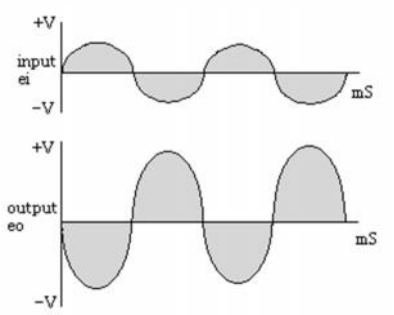
Transistor Q is configured in common emitter mode to design a voltage Amplifier. Small ac input Vin which is to be amplified is applied at the base of Q. Emitter is common(ground) and output is obtained at the collector of Q. As the transistor is NPN, +Vcc supply is applied as the biasing voltage.

Working :- **(2 Marks)**

- Resistors R_1 & R_2 form voltage bias.
- R_1, R_2 & R_E (emitter resistor) are used to bias the transistor in the active region, because for operating the transistor as an amplifier it is necessary to bias it in the active region.
- Rc – collector resistor is used to control the collector current.
- C_1= Input coupling capacitor
- C_2=Output coupling capacitor
- C_E = Emitter bypass capacitor.

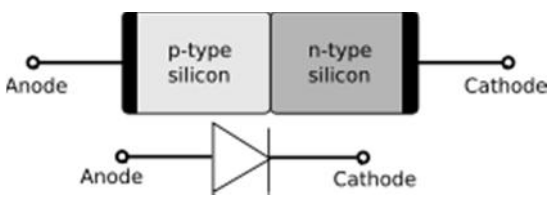
1. In the absence of ac input, IB=IBQ, IC = ICQ, VCE = VCEQ. The Q point is selected in the active region of transistor.
2. As Vin is applied, the base current varies above and below IBQ .
3. Hence Ic =βI_B varies above and below ICQ. Variation in Ic is large.
4. Therefore voltage across Rc varies. VRC = Ic x Rc.
5. Hence collector voltage Vc varies above and below VCEQ as Vc = Vcc- Ic .Rc.
6. Trough C2 only the ac part of Vc is coupled to the load. Vo is of same shape as Vin but of larger size. Thus amplification has taken place. Vo is also 180 degree phase shifted with Vin.

WAVEFORMS :-



f) Explain construction and working of PN junction diode. Also draw symbol of PN junction diode.

Construction of PN junction diode: - **(1 Mark for construction and 1 Mark for symbol)**



A P-N junction is formed at the boundary between a p-type and n-type semiconductor created in a single crystal of semiconductor by doping.

Working- **(2 Marks)**

In forward bias, the p-type is connected with the positive terminal and the n-type is connected with the negative terminal. With a battery connected this way, the holes in the P-type region and the electrons in the N-type region are pushed toward the junction. This reduces the width of the depletion zone. The positive charge applied to the P-type material repels the holes, while the negative charge applied to the N-type material repels the electrons. As electrons and holes are pushed toward the junction, the distance between them decreases. This lowers the barrier in potential. With increasing forward-bias voltage, the depletion zone eventually becomes thin enough that the zone's electric field cannot counteract charge carrier motion across the p–n junction, as a consequence reducing electrical resistance. The electrons that cross the p–n junction into the P-type material (or holes that cross into the N-type material) will diffuse in the near-neutral region. Therefore, the amount of minority diffusion in the near-neutral zones determines the amount of current that may flow through the diode.

Reverse-bias usually refers to how a diode is used in a circuit. If a diode is reverse-biased, the voltage at the cathode is higher than that at the anode. Therefore, no current will flow until the diode breaks down. Connecting the P-type region to the negative terminal of the battery and the N-type region to the positive terminal corresponds to reverse bias. Because the p-type material is now connected to the negative terminal of the power supply, the 'holes' in the P-type material are pulled away from the junction, causing the width of the depletion zone to increase. Likewise, because the N-type region is connected to the positive terminal, the electrons will also be pulled away from the junction. Therefore, the depletion region widens, and does so increasingly with increasing reverse-bias voltage. This increases the voltage barrier causing a high resistance to the flow of charge carriers, thus allowing minimal electric current to cross the p–n junction. The increase in resistance of the p–n junction results in the junction behaving as an insulator.

---------- **Section II End**----------