Important Instructions 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 (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the 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) In case of some questions credit may be given by judgment on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

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1. Attempt any TEN: **20 Marks**

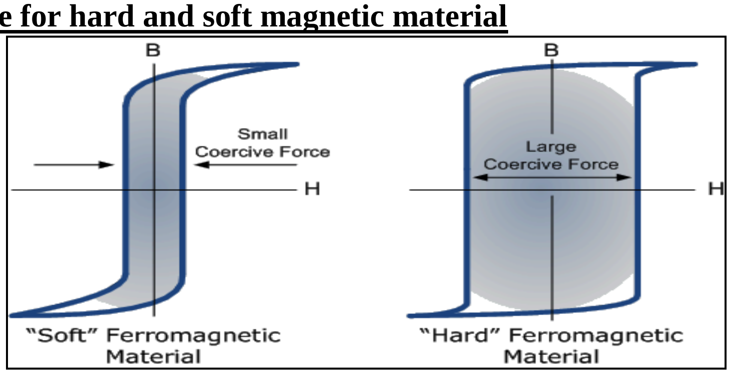
a) Define ferromagnetic and ferrimagnetic material. Give one example of each.

Ans: **(Definition: half mark each Example: half mark each)**

Ferromagnetic materials: The materials which possess magnetism in the absence of applied magnetic field is known as ferromagnetic materials.
Example: iron, nickel, cobalt

Ferrimagnetic materials: They contain magnetic moments aligned antiparallel to one another, similar to antiferromagnetic materials. However, instead of having a zero net magnetic moment, different numbers of unpaired electrons in the component transition metals result do not cancel one another out, resulting in a spontaneous magnetization.
Example: Magnetite, Ferrous ferrite, Nickel ferrite, Manganese ferrite.

b) Draw the B-H curve for hard and soft magnetic material.
Ans: **(1 mark for each diagram)**
Diagram: **The B-H curve for hard and soft magnetic material**



c) List four dielectric materials used for capacitors.
Ans: **(Any four, half mark each)**

Dielectric materials used for capacitors:
1) Air
2) Vacuum
3) Glass
4) Oxide film
5) PVC
6) Titanate ceramic
7) Paper
8) Plastic
9) Mica

d) State the necessity of rectifier and filter circuits.
Ans:

Need of Rectifiers: **1 Mark**
- Many electronic devices and circuits work on DC.
- It is then needed to convert A.C. into D.C.
- Rectifier is the best and cheapest way to provide D.C. for electronic devices.

Need of Filters: **1 Mark**
- The output of a rectifier is pulsating D.C. [i.e. it contain A.C and D.C]. The A.C. components are undesirable and must be moved from the pulsating D.C. to obtain pure D.C. signal. To remove this filter circuit is used.

e) List the advantages of bridge rectifier.
Ans: **(Any two, one mark each)**

The advantages of bridge rectifier:
- The output is twice that of the center-tap circuit for the same secondary voltage.
- The PIV is one half that of the center-tap circuit.
- The need for center tapped transformer is eliminated and hence needs a simple small size transformer.
- Transformer utilization factor, in case of a bridge rectifier, is higher than that of a centre-tap rectifier.
- There is no possibility of core saturation of transformer secondary winding and hence transformer losses are reduced.
- It can be used in applications allowing floating output terminals.
- For a given power output, power transformer of smaller size can be used in case of the bridge rectifier because current in both primary and secondary windings of the supply transformer flow for the entire ac cycle.

f) Define Kirchoff's voltage law.
Ans:

Kirchoff's law KVL: **2 Marks**

It states that "Algebraic sum of voltages in a loop or mesh is equal to zero"

Σ voltage= 0

g) State the internal resistance of ideal current and ideal voltage source.

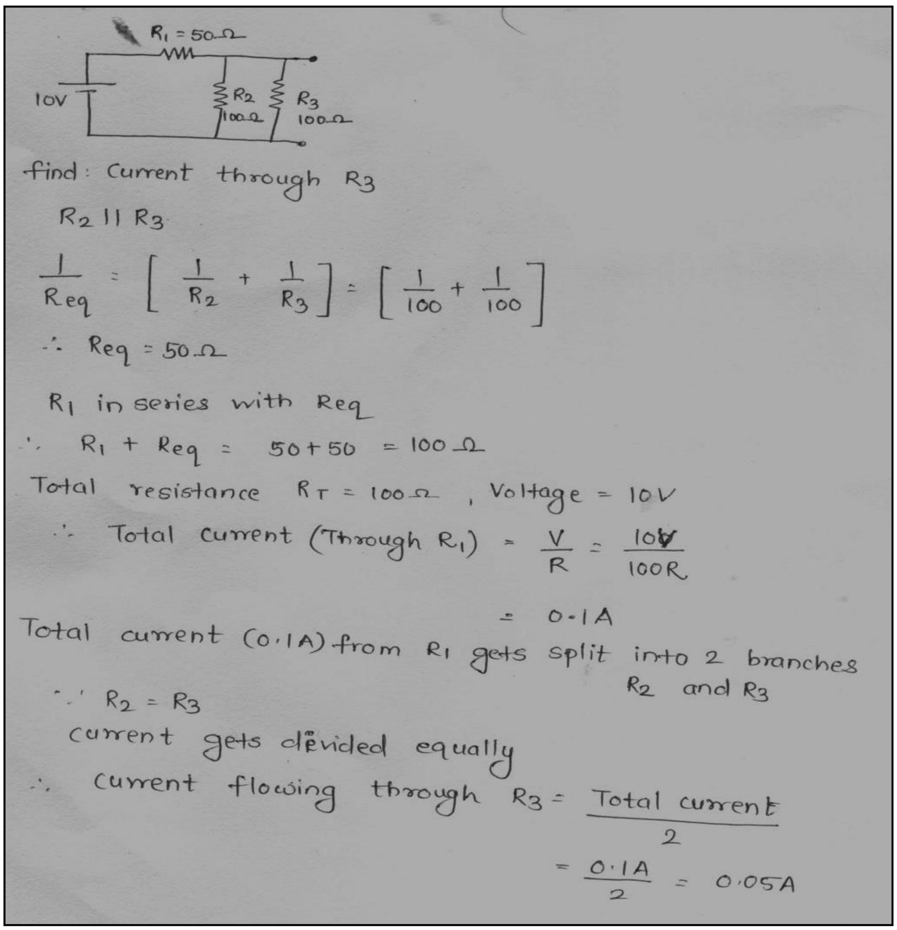
Ans:

The internal resistance of ideal current and ideal voltage source:

- Ideal voltage source has zero internal resistance **(1 Mark)**
- Ideal current source has infinite internal resistance **(1 Mark)**

h) Find the current through resister R3.

Ans: **(Total current: 1 mark, current though R3: 1 mark)**



find: Current through R_3

$R_2 \parallel R_3$

$$\frac{1}{R_{eq}} = \left[\frac{1}{R_2} + \frac{1}{R_3}\right] = \left[\frac{1}{100} + \frac{1}{100}\right]$$

$\therefore R_{eq} = 50\Omega$

R_1 in series with R_{eq}

$\therefore R_1 + R_{eq} = 50 + 50 = 100\Omega$

Total resistance $R_T = 100\Omega$, Voltage = 10V

$\therefore$ Total current (Through R_1) $= \frac{V}{R} = \frac{10V}{100R}$

$= 0.1A$

Total current (0.1A) from R_1 gets split into 2 branches R_2 and R_3

$\because R_2 = R_3$

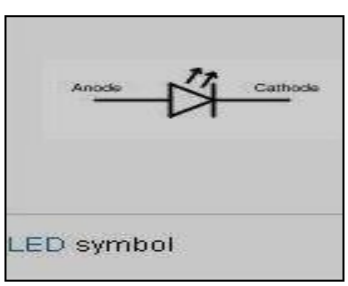
current gets divided equally

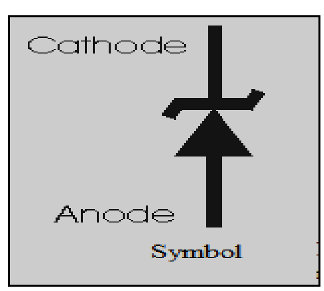
$\therefore$ Current flowing through $R_3 = \frac{\text{Total current}}{2}$

$= \frac{0.1A}{2} = 0.05A$

i) Draw symbol and state one application of zener diode and LED.

Ans: Diagram: **(Half mark for each diagram)**





Application of Zener diode: **(Half Mark for any one application)**

- It is used as voltage regulator.
- Used in protection circuits for MOSFET.
- Used in pulse amplifier.
- Used in clipping circuits.

Application of LED diode: **(Half Mark for any one application)**

It is used in:

- Opto couplers
- Optical switching applications
- Optical Communication system
- Infrared remote controls
- Image sensing circuits in videophones
- Burglar alarm systems
- 7-segment, 16- segment and dot matrix displays
- Indicating power ON/OFF conditions

j) List applications of Schottky diode and Laser diode.

Ans:

Application of Schottky diode: **(Any 2 applications 1/2M each)**

- It is used in rectification of very high frequency signals.
- It is used in communication system circuits.
- It is used in AC to DC converters.
- It is used in Radar system.
- It is used in switched mode power supply.
- It is used as fast switching device in digital computers.

Application of LASER diode: **(Any 2 applications 1/2M each)**

- It is used in detectors and sensors
- It is used for flow measurement.
- It is used to measure distance, angle etc.
- It is used in welding.
- It is used as a light source in fibre optic communication.

k) Write two applications of clipper and two of clamper.

Ans: Application of Clipper: **(Half Mark for any one application)**

- In the case of generating new waveforms and/or shaping the existing older waveforms.
- Clippers can be used as freewheeling diodes in protecting the transistors from transient effects by connecting the diodes in parallel with the inductive load.
- Commonly used in power supplies.
- In the separation of synchronizing signals existing from the composite color picture signals.
- Frequently used in FM transmitters for removing the excess ripples in the signals above a certain noise level.

Application of Clamper: **(Half Mark for any one application)**

- Clampers can be frequently used in removing the distortions and identification of polarity of the circuits.
- For improving the reverse recovery time, clampers are used.
- Clamping circuits can be used as voltage doublers and for modelling the existing waveforms to a required shape and range.
- Clampers are widely used in test equipments and other sonar systems.
- The complex transmitter and receiver circuitry of television clamper is used as a base line stabilizer to define sections of the luminance signals to preset levels.
- Clampers are also called as direct current restorers as they clamp the wave forms to a fixed DC potential.

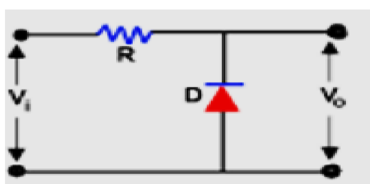
l) Define clipper. Draw circuit of negative shunt clipper.

Ans: **(Definition-1 mark and diagram-1 mark)**

Clipper: A clipper is a device designed to prevent the output of a circuit from exceeding a predetermined voltage level without distorting the remaining part of the applied waveform.

OR

Clipper: An electronic circuit that cutoffs the positive or negative peak or both from a specific level is known as clipper.

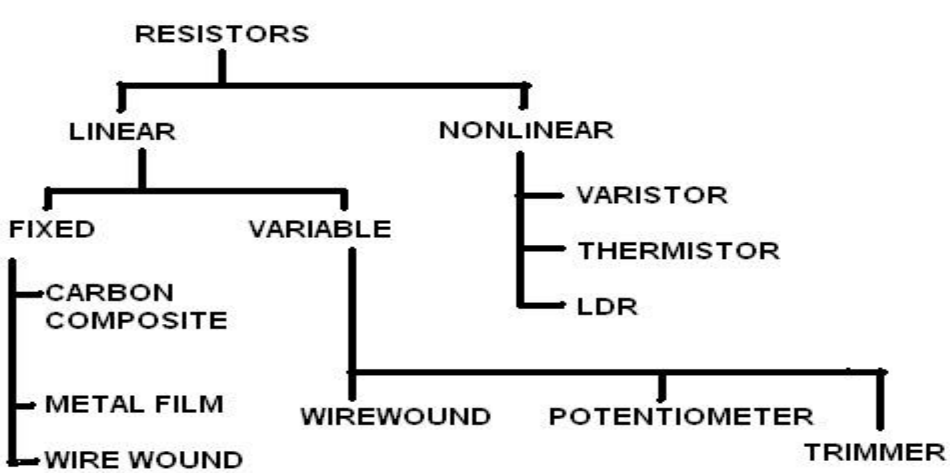


Negative shunt clipper

2. Attempt any FOUR: **16 Marks**

(a) Give the classification of resistors. List any four materials used for manufacturing of resistors.

Ans: **(Classification 2 Marks)**



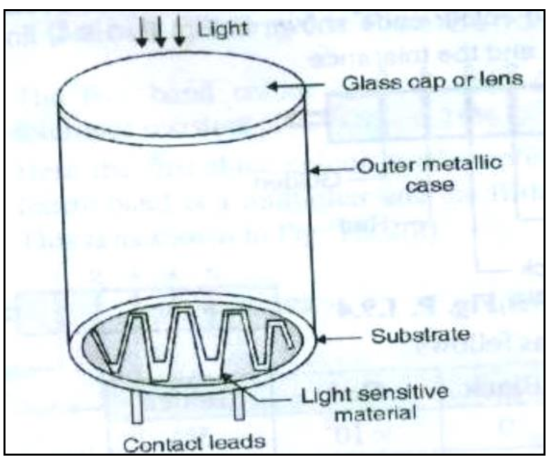
Materials used for manufacturing of resistors: **(Materials any four, half mark each)**

- Carbon Composition Resistor (carbon dust or graphite paste)
- Film or Cermet Resistor (conductive metal oxide paste)
- Nichrome, enamel
- LDR- Cadmium sulphide, Cadmium selenide, lead sulphide
- TDR- Cobalt, Nickel, Manganese

(b) With the help of neat diagram, describe working of LDR.

Ans: Working of LDR: **(Diagram – 2 marks, working – 2mark)**

- Due to the radiant energy supplied to the semiconductor, the covalent bonds are broken and the electron hole pairs are generated resulting into flow of current.
- These increased current increase the conductivity of the material and hence decrease the resistivity. Such a device is called as a photo resistor or photoconductor.
- The photoconductive cell or a light dependent resistor (LDR) makes use of the principle of photoconductivity.
- It is semiconductor device in which resistance is dependent on the intensity of incident light.
- The resistance of the LDR will decrease with increase in the intensity of incident light.



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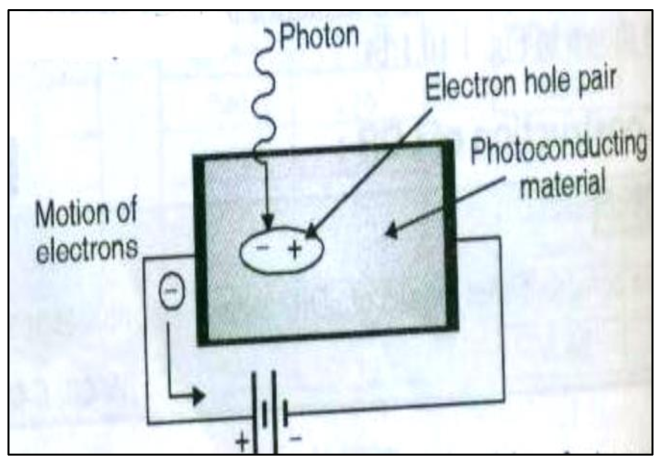
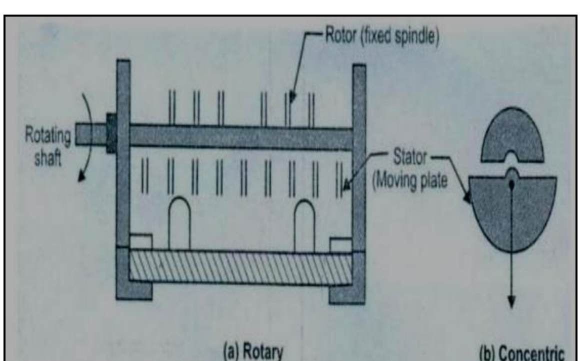


c) Describe working of variable air gang capacitor.

Ans: **(Diagram – 2 marks, explaination-2 marks)**



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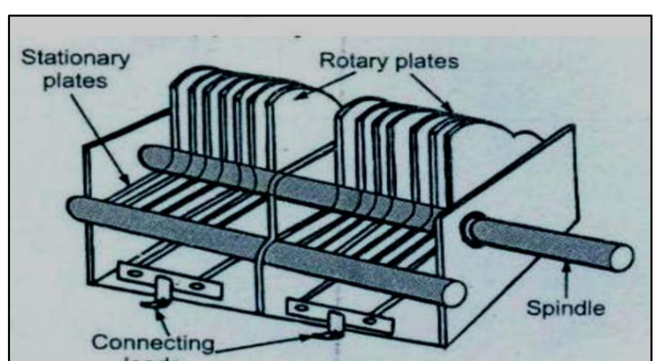


Construction : **(2M)**

- Consider the structure of the above figure. It mainly consists of two sets of aluminium plates separated from each other by air. These metal plates may be rotary or concentric type.
- The rotary type configuration has a rotor and a stator. The concentric type of configuration has two cups of aluminium.
- The concentric type variable capacitor consists of two cups of aluminium, one moving in other. The movement is actuated by a threaded screw.
- One set of the plates is fixed, while the other set is connected to a shaft and can be rotated.
- The fixed set of plates is insulated from the body of a capacitor on which it is mounted.
- The set of moving aluminium plates can be moved in or out of a fixed set of plates with the help of a suitable knob connected to a rotating shaft. As the plates are moved in and out of the fixed plates, the capacitance value varies.
- The capacitance is minimum, when the moving plates are completely out and it is maximum, when the moving plates are completely in.
- The fixed plates are called stators, which are normally made of brass, copper or aluminium. The cadmium plated steel is used for the frames in low cost capacitors.
- The outer set of plates is called rotors. They get interleaved with stators, when the shaft is rotated. Sometimes, two or more such capacitors are operated by a single shaft.

d) Using four band colour code find resistance value for:

(i) Brown Red Red Silver

(ii) Yellow violet orange gold

Ans: **(Each correct value of the resister- 2 marks)**

<u>(i) Brown Red Red Silver:</u>

- Brown 1
- Red 2
- Red 2
- Silver -/+ 10% i.e $12 \text{ X } 10^2 = 1200\ \Omega = 1.2K\Omega$ +/- 10%

<u>(ii) Yellow violet orange gold:</u>

- Yellow 4
- Violet 7
- Orange 3
- Gold +/- 5% i.e. $47 \text{ x } 10^3 = 47000 = 47K\Omega$ +/- 5%

e) Write the difference between iron core inductor and ferrite core inductor.

Ans: **(each point for 1 Mark)**

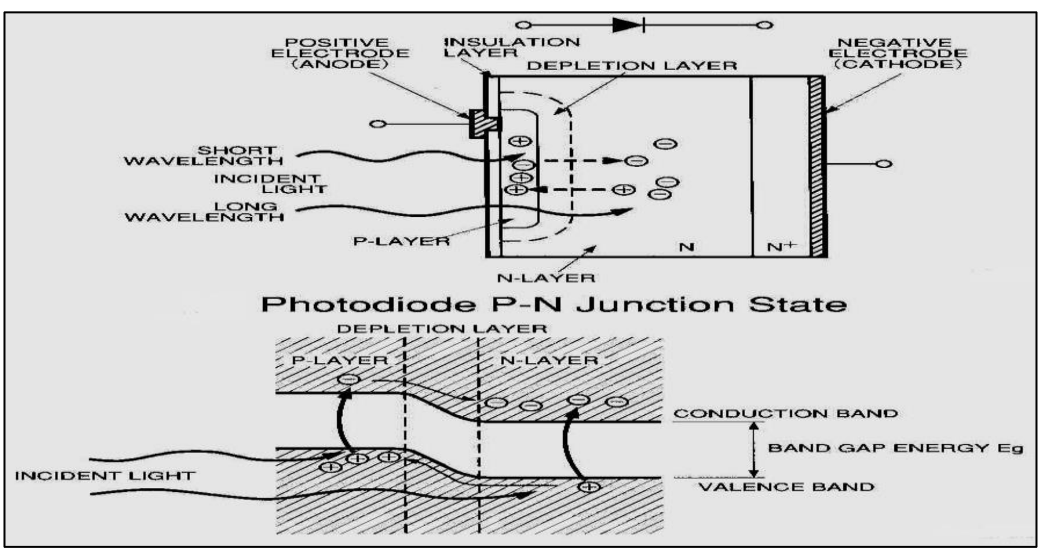
IRON CORE INDUCTOR	FERRITE CORE INDUCTOR
Large in size.	Small in size.
Has large eddy current loss.	Has lower eddy current loss.
Has low Q factor.	Has higher Q factor.
Has lower inductance value.	Has higher inductance value.
Has low operating frequency.	Has high operating frequency.
It is used in filter circuits and AF applications.	It is used at high and medium frequencies and also as ferrite rod antenna for MW band receivers.

f) State and explain operating principle of photodiode.

Ans: **(Marks should be assigned as per points covered)**

Operating principle of photodiode:

- A photodiode is a PN junction or PIN structure. When a photon of sufficient energy strikes the diode, it excites an electron, thereby creating a mobile electron and a positively charged electron hole. If the absorption occurs in the junction's depletion region, or one diffusion length away from it, these carriers are swept from the junction by the built-in field of the depletion region. Thus holes move toward the anode, and electrons toward the cathode, and a photocurrent is produced.
- Photovoltaic mode: When used in zero bias or photovoltaic mode, the flow of photocurrent out of the device is restricted and a voltage builds up. The diode becomes forward biased and "**dark current**" begins to flow across the junction in the direction opposite to the photocurrent. This mode is responsible for the photovoltaic effect, which is the basis for solar cells—in fact, a solar cell is just an array of large area photodiodes.
- Photoconductive mode: In this mode the diode is often (but not always) reverse biased. This increases the width of the depletion layer, which decreases the junction's capacitance resulting in faster response times. The reverse bias induces only a small amount of current (known as saturation or back current) along its direction while the photocurrent remains virtually the same.
- Diagram optional:

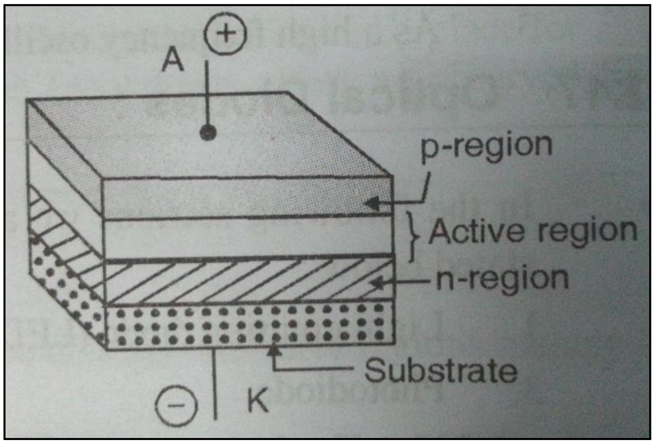


3. Attempt any four: **16M**

a) Draw and describe construction of LED.

Ans: **(Draw: 2 Marks & describe : 2 Marks)**

Construction of LED:



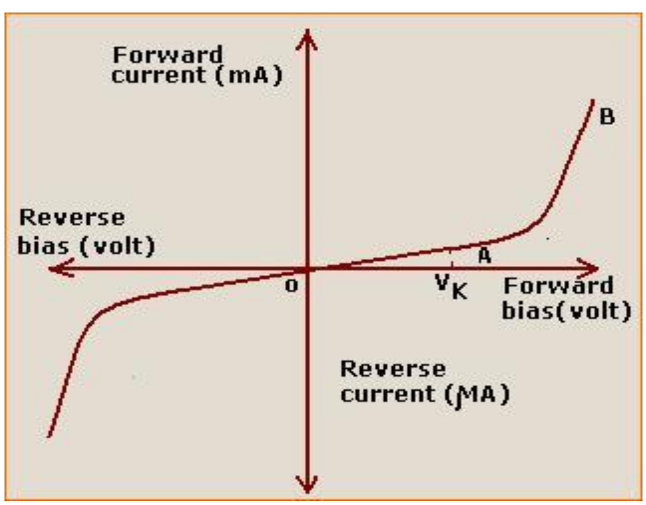
- Fig above shows the construction of LED.
- Here an N-type layer is grown on a substrate by a diffusion process.
- Then a thin P-type layer is grown on the N-type layer.
- The metal connections to both the layers make anode and cathode terminals as indicated.
- The active region exists between the P and N regions.
- The light energy is released at the junction when the electron hole pair recombination takes place.
- After passing through the P-region the light is emitted from the window provided at top.

Semiconductor Materials Used:

- Gallium Arsenide (GaAs) : Infrared (IR)
- Gallium Arsenide Phosphite (GaAsP) : Red or Yellow.
- Gallium Phosphite (GaP) : Red or Green.

b) Draw and describe V-I characteristics of P-N junction diode.

Ans: V-I Characteristics of a P-N junction: **(Draw: 2 Marks & describe: 2 Marks)**

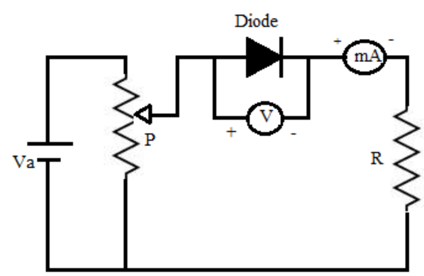


V-I characteristics of a Diode: **(Marks should be assigned as per points covered)**

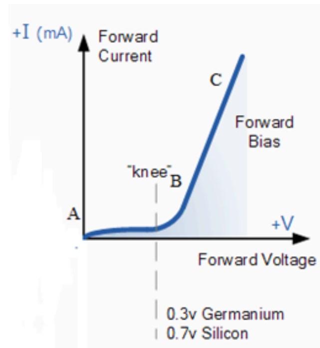
The V-I characteristics can be divided in two parts.
1. Forward characteristics.
2. Reverse characteristics

Forward characteristics of P-N Junction Diode.

- The forward characteristic is the graph of the anode to cathode forward voltage 'Vf' verses the forward current through the diode 'If'.
- The forward characteristics are divided into two portions AB and BC as shown in the fig below.



Circuit arrangement



Forward characteristics

[Note: above figure is optional]

Region A to B:

- In this region A to B of the forward characteristics shown in the fig, the forward voltage is small and less than the cut in voltage.
- Therefore the forward current flowing through the diode is small.
- With further increase in the forward voltage, it reaches the level of the cut in voltage and the width of depletion region grows on decreasing.

Region B to C:

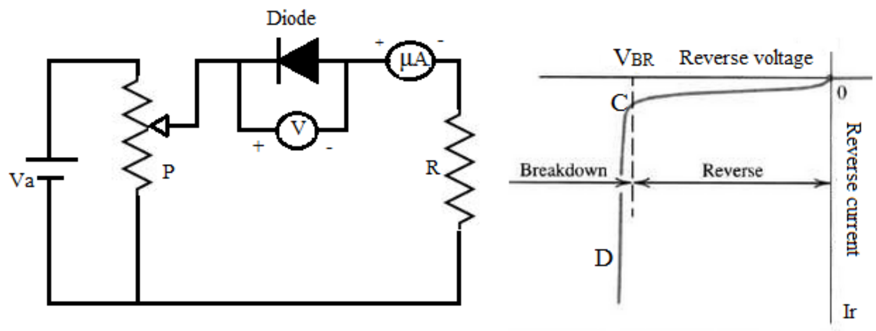
- As soon as the forward voltage equals the cut in voltage, current through the diode increases suddenly. The nature of this current is exponential.
- The large forward current in the region B-C of the forward characteristics is limited by connecting a resistor 'R' in series with the diode. Forward current is of the order of a few mA.
- The forward current is a conventional current that flows from anode to cathode.
- Therefore it is considered to be positive current, and the forward characteristics appears in the first quadrant as shown in the fig.

Cut in voltage (Knee Voltage):

- The voltage at which the forward diode current starts increasing rapidly is known as the cut-in voltage of a diode. As shown in fig above, the cut in voltage is very close to the barrier potential. Cut-in voltage is denoted byV_T. Cut-in voltage is also called as Knee voltage.
- Generally a diode is forward biased above the cut-in voltage. The cut-in voltage for a silicon diode is 0.6V and that for germanium diode is 0.3V.

Reverse Characteristics of Diode:

- The minority electrons in the p-region are attracted by the positive end of the dc supply. Hence these electrons will cross the junction and constitutes reverse current 'Ir' of the diode as shown in the fig.



Circuit arrangement (fig a)
Reverse characteristics (fig b)

[Note: above figure is optional]

- Since reverse current is very much less the resistance offered by reverse biased diode is very high of the order of few 'KΩ'.

Reverse Characteristics:

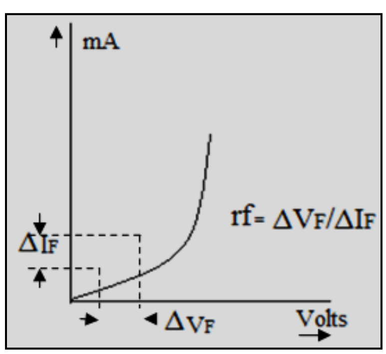
- The circuit arrangement for obtaining the reverse characteristics of the diode is shown in the fig above.
- The milli-ammeter is replaced by micro-ammeter.
- The applied reverse voltage is gradually increased above zero in suitable steps and the values of diode current are recorded at each step.
- Because of the minority carrier there will be small amount of current flowing through the diode is called reverse saturation current.
- Now, if we plot a graph with reverse voltage on horizontal axis and current on vertical axis, we obtain reverse characteristics.

c) Define dynamic resistance of diode. State, how it is calculated using forward characteristics of diode.

Ans: (Define:1 Mark, forward characteristics 1Mark, statement of calculation 1Mark, formula 1Mark)

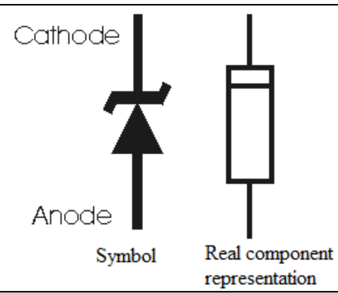
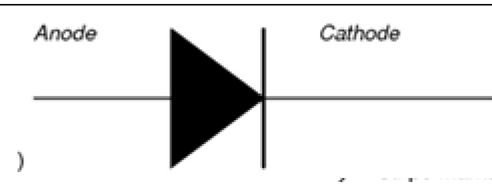
Definition:

- The resistance offered by the diode to the AC operating conditions is known as the 'Dynamic resistance' or 'Incremental resistance' or 'AC resistance' of a diode.
- It is denoted by rf in the forward biased condition.
- Dynamic forward resistance is calculated by taking change in forward voltage w.r.t. change in forward current
  $r_f = \Delta V_F / \Delta I_F$.



- Dynamic resistance is actually the reciprocal of the slope of the forward characteristics.

d) compare Zener diode and P-N junction diode.
Ans: **(1 mark for each point)**
[*Note: any other relevant points can be consider]*

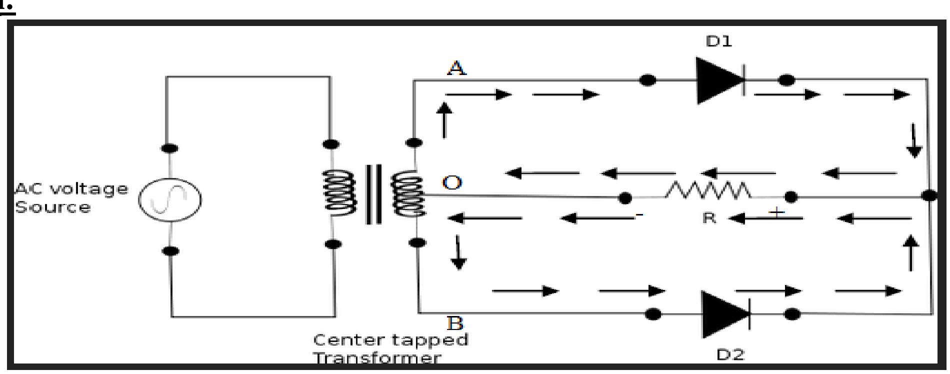
SR. NO.	PARAMETER	ZENER DIODE	P-N JUNCTION DIODE
1.	Conduction	Zener diode can conduct current in both direction.(i.e. forward as well as reverse)	P-N junction diode can conduct current only in forward direction.
2.	Type of breakdown	Zener breakdown	Avalanche breakdown
3.	Symbol		
4.	Applications	As a voltage regulator, In waveshaping circuits etc.	In rectifiers, Waveshaping circuits etc.

e) Draw and describe working of full wave rectifier using centre tapped transformer.
Ans: **(Draw: 2 Marks & describe: 2 Marks)**

<u>Full wave Rectifier with Center tapped transformer(FWR):</u>

- In full wave rectification, the rectifier conducts in both the cycles as two diodes are connected.

<u>Circuit diagram:</u>



<u>Operation:</u>

1. <u>In positive half cycle (0-Π).</u>

- The end A of the secondary winding becomes positive and end B negative.
- This makes diode D1 forward biased and diode D2 reverse biased. Therefore D1 conducts while D2 does not.
- The conventional current flow direction in the upper half winding as shown in the fig above.

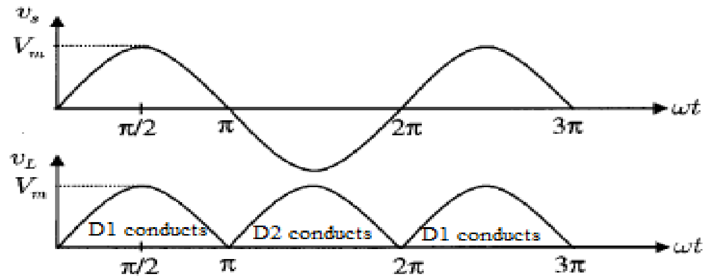
A – D1 – RL – O

2. In negative half cycle (Π-2Π):

- End A of secondary winding becomes negative and end B positive. Therefore diode D2 conducts while diode D1 does not.
- The conventional current flow is from as shown by the arrows in the above fig.

B – D2 – RL – O

- From fig. current in the load RL is in the same direction for both half-cycles of input AC voltage. Therefore DC is obtained across the load RL.



f) Define given parameters and state their values for bridge rectifier.

(i) Ripple factor

(ii) PIV of diode

Ans: **(Definition 1Mark each, Values 1Mark each)**

(i) Ripple factor:

- Ripple factor is defined as ratio of RMS value of AC component of output to the DC or average value of the output.
- Ripple Factor(r) = $\frac{\text{RMS value of the AC component of output}}{\text{DC or average value of the output}}$
- r = 0.482 or 48.2%

(ii) PIV of diode:

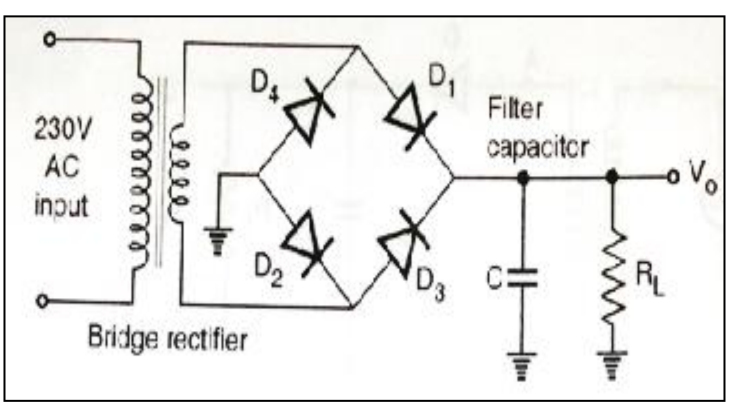
- This is the maximum negative voltage which appears across a non-conducting reverse biased diode.
- PIV = Vm (Volts)

4. Attempt any four: **16 M**

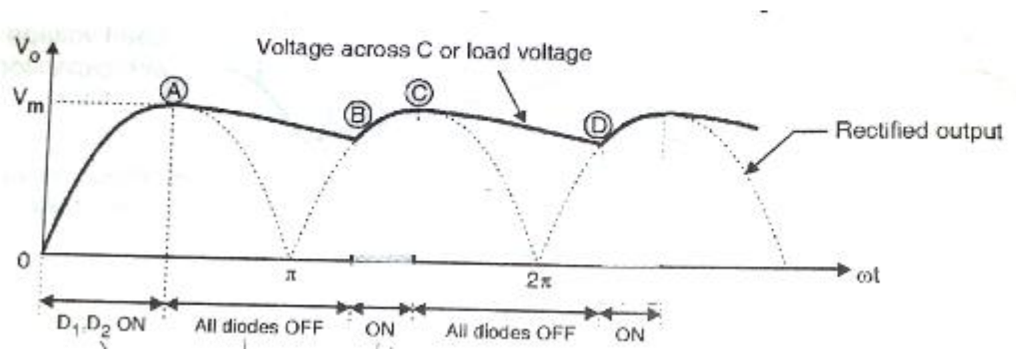
a) Draw circuit of capacitor filter with bridge rectifier. Draw input and output waveforms.

Ans: **(Draw circuit: 2 Marks, input waveforms: 1Mark, Output waveforms: 1 Mark)**

Capacitor filter with bridge rectifier



Waveforms

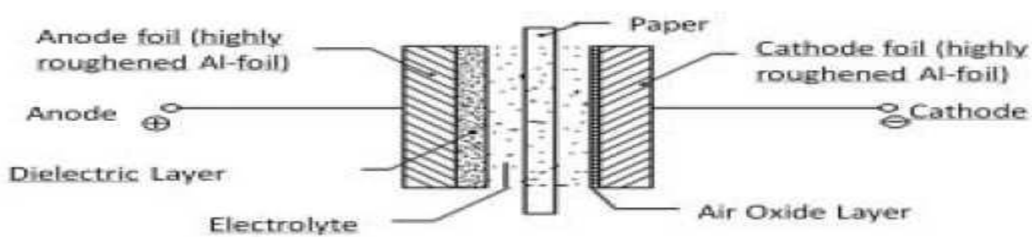


b) Explain the working principle of electrolytic capacitor.

Ans **(Diagram 2M, Explaination:2 Marks)**

Principle:

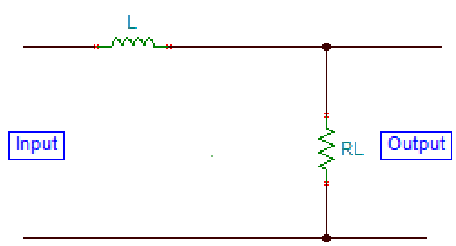
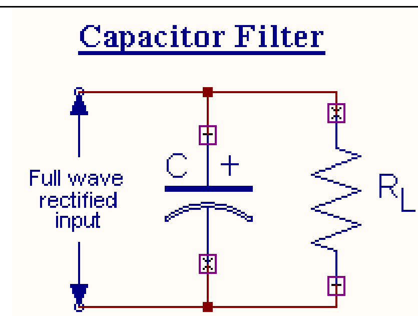
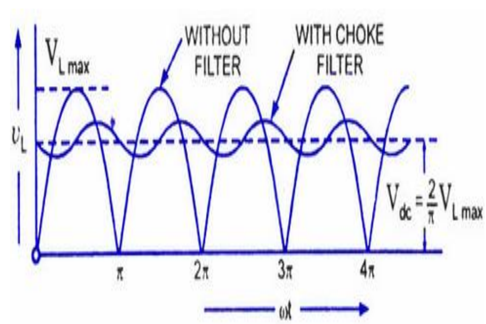
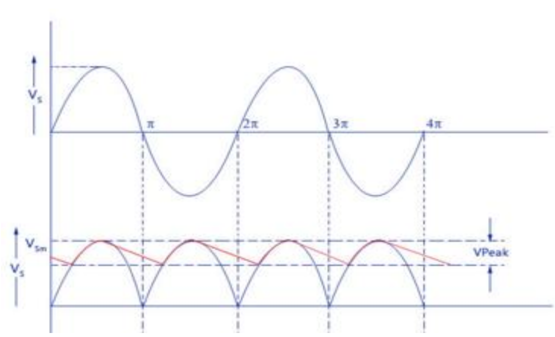
Electrolytic capacitors are using a chemical feature of some special metals, on which by anodically oxidation, an insulating oxide layer or dielectric originates. The metal is placed in an electrolytic solution and a positive voltage is applied to the anode material. This forms a thin layer of oxide barrier layer on the anode. This oxide layer acts as dielectric in an electrolytic capacitor. This oxide film can be made extremely thin (typically less than 1µm) with a high dielectric constant. This increases the value of capacitance. Because of the use of the electrolytic process to form the thin oxide dielectric, this type of capacitor is called 'electrolytic'.



c) Compare inductor filter and capacitor filter.

Ans. **(1 mark for each point, Any 4)**

[Note: any other relevant points can be consider]

SR. NO.	PARAMETERS	INDUCTOR FILTER	CAPACITOR FILTER
1	Place of filter	In series with load	Across the load
2	Usefulness in ripple reduction	Low	High
3	Suitability for heavy/light load current	Heavy load	Light load
4	Useful in	Reducing ripple in load current	Reducing ripple in load voltage
5	Ripple factor expression	$r = \frac{R_L}{3\sqrt{2}\omega L}$	$r = \frac{1}{4\sqrt{3} f C R_L}$
6	Ripple factor	High	low
7	Circuit diagram		
8	Waveforms		

d) A bridge rectifier is delivering dc power to load resistance of 1 KΩ.AC Voltage of 230 V is given to rectifier through transformer with turn ratio 10:1. Find

(i) Peak output current I_m

(ii) DC output current I_{dc}

(Consider diode and transformer as ideal)

Ans:

Given: Bridge rectifier is used.

$R_L = 1K$

$V_{rms} = 230 V$.

$\frac{N_1}{N_2} = \frac{10}{1}$

To find: (i) Peak output current I_m

(ii) DC output current I_{dc}.

formula: $V_2 = \left[V_1 \cdot \frac{N_2}{N_1}\right]$

$V_m = \sqrt{2}(V_2)$.

$I_m = V_m/R_L$ & $I_{dC} = 2\frac{I_m}{\pi}$

Sol^n: $V_m = \sqrt{2}.$(DC o/p voltage)

$= \sqrt{2} \cdot \left[V_1 \cdot \frac{N_2}{N_1}\right]$

$= \sqrt{2}\left[230 \cdot \frac{1}{10}\right]$

$= \sqrt{2}\,[23]$

$= 32.527 V$.

$I_m = \frac{V_m}{R_L} = \frac{32.527}{1K} = 32.52 mA$.

$I_{dc} = \frac{2 I_m}{\pi} = 20.7 mA$.

e) Draw the characteristics of tunnel diode, showing operating regions. State two applications of tunnel diode.

Ans: **(Draw 2 Marks, Application 1mark each)**

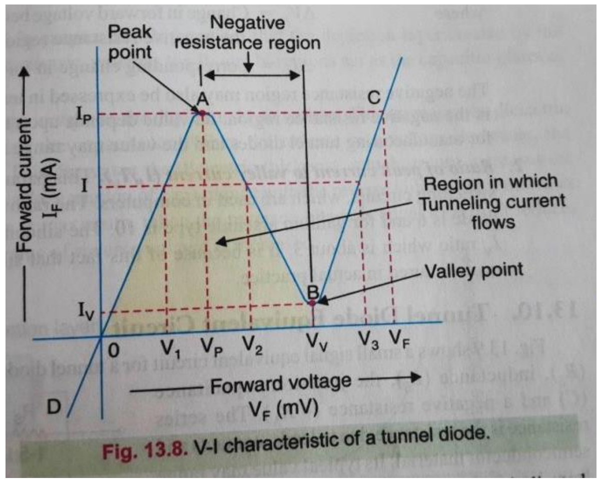


Fig. 13.8. V-I characteristic of a tunnel diode.

Applications:

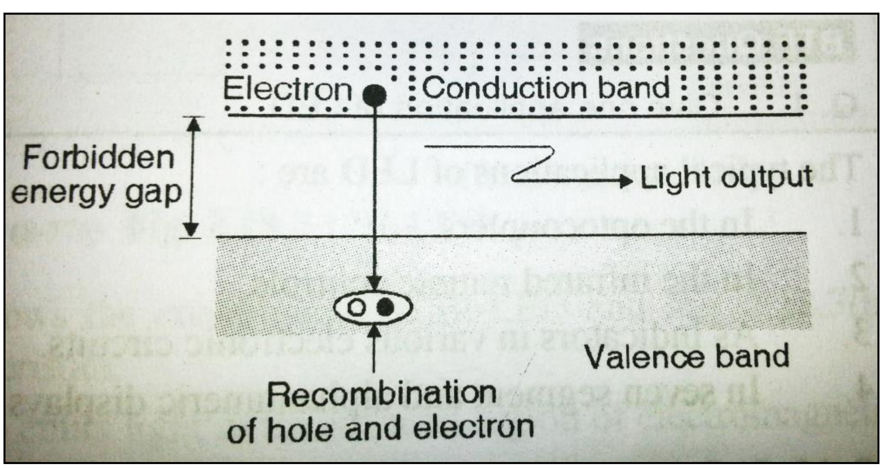
- One of the important application of a tunnel diode is in high speed computers where the switching times in the order of nanoseconds or picoseconds are desirable.
- A tunnel diode can be used at such high speeds as a result of the electrons "punching through" at velocities that far exceed those in conventional diodes.
- The punching through takes place due to narrow depletion region.
- Some other applications are :

1. In digital networks.
2. As a high speed switch.
3. As a high frequency oscillator.

f) State operating principle of LED. Write material names used to manufacture LED.

Ans: **(Operating principle 2marks, Martials used 2marks)**

Principle of Operation of LED:



- When an LED is forward biased, the electron in the n-region will cross the junction and recombine with the holes is p-type.

- When the recombination takes place, electrons from the conduction band resides these electrons return back to the valance band.
- While returning back, the recombining electrons give away the excess energy in the form of light.

Semiconductor Materials Used:
- Gallium Arsenide (GaAs) : Infrared (IR)
- Gallium Arsenide Phosphite (GaAsP) : Red or Yellow.
- Gallium Phosphite (GaP) : Red or Green.

5. Attempt any four: **16M**

(a) Draw and describe working of positive clamper.

Ans: **(Diagram with waveform: 2M and explanation:2M)**
Fig shows the circuit diagram of an unbiased positive diode clamper.

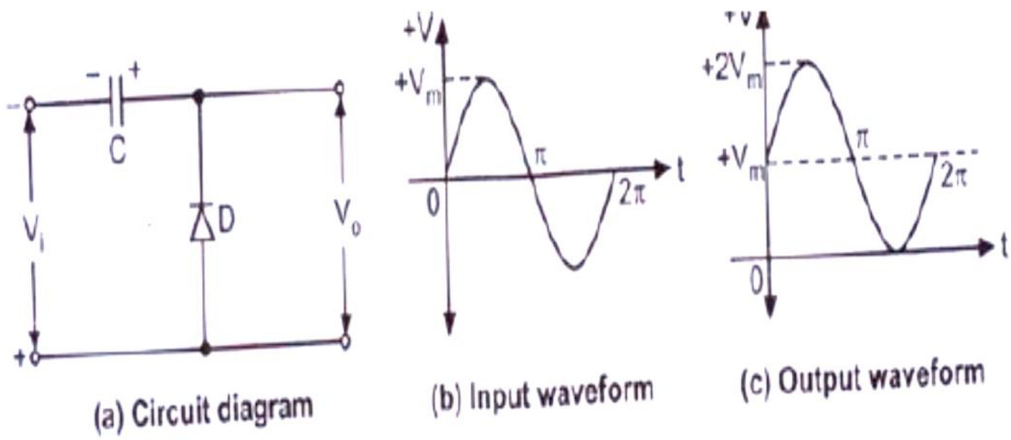


fig shows the input waveform applied to the positive diode clamper.

- During the negative half cycle of the A.C. input signal Vi, the diode D is forward biased and current flows through the circuit.
- The diode D acts as a short- circuit, i.e closed series switch and the capacitor C is charged to a voltage equal to the negative peak voltage –Vm.
- Once the capacitor is C is fully charged to –Vm, it is not discharged because the diode D cannot conduct in reverse bias condition.
- Now the capacitor C stores the charge and acts as a battery with an e.m.f equal to –Vm.
- The polarity of this voltage is such that it adds to the positive half cycle of the input signal. So the output voltage is equal to the sum of the input voltage Vi and the capacitor voltage Vm. The output will be given by,
- Vo=Vi+Vm=Vmsinwt + Vm.
- The input signal voltage at the output becomes twice the peak voltage of the input signal.
- The output signal will make excursion between zero level and +2Vm of the input signal.This causes the input signal to clamp positively at 0V,i.e. negative peak is clamped at zero level as shown in fig.

(b) Comparison between linear & non-linear waveshaping networks.

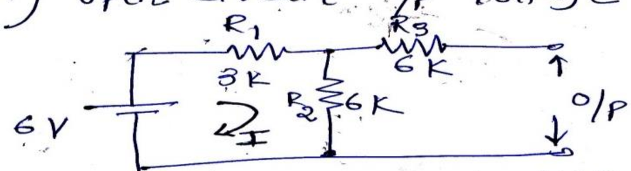
Ans: **(2Mark each point)**

Comparison between linear & non-linear waveshaping circuit:

LINEAR WAVE SHAPING CIRCUIT	NON LINEAR WAVE SHAPING CIRCUIT
The circuits which make use of only linear circuit element such as the inductors, capacitors and resistors are known as linear wave shaping circuit	The circuits which make use of non- linear circuit element such as diodes and transistors are as Non Linear wave shaping circuit.
Examples: Integrator ,differentiator	Examples: clipper, clamper

(c) For given circuit(Fig.2.).Find

i) open circuit o/p voltage and o/p current



Apply KVL to loop & calculate I to find open circuit voltage across o/p

$6 - 3I - 6I = 0$

$6 - 9I = 0$

$6 = 9I$

$\therefore I = 6/9\,k\Omega$

$I = 0.6667\ mA$

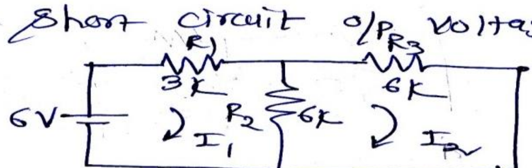
$\therefore V_{oc} = I \times 6K$

$= 0.6667 \times 6 \times 10^{3} \times 10^{-3}$

$V_{oc} = 4\ volt$ — 1 Mark

$I_{oc} = 0\ amp$ {as it is open circuited the current thr o/p is zero} — 1 mark

ii) Short circuit o/p voltage & o/p current



Apply KVL to loop 1

$-3I_1 - 6(I_1 - I_2) + 6 = 0$

$-3I_1 - 6I_1 + 6I_2 + 6 = 0$

$-9I_1 + 6I_2 = -6$ —— (1)

Apply KVL to loop 2

$-6I_2 - 6(I_2 - I_1) = 0$

$-6I_2 - 6I_2 + 6I_1 = 0$

$-12I_2 + 6I_1 = 0$

$\therefore 6I_1 - 12I_2 = 0$ —— (2)

Solving eq^n (1) & (2) using Determinant or simultaneous eq^n method we get

$$\begin{bmatrix} -9 & +6 \\ 6 & -12 \end{bmatrix} \begin{bmatrix} -6 \\ 0 \end{bmatrix}$$

$$\Delta = 108 - 36 = 72$$

$$\Delta_1 = \begin{bmatrix} -6 & +6 \\ 0 & -12 \end{bmatrix} = 72 - 0 = 72$$

$$\Delta_2 = \begin{bmatrix} -9 & -6 \\ 6 & 0 \end{bmatrix} = 0 + 36 = 36$$

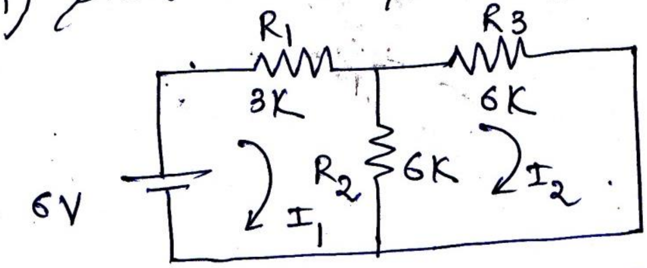
$$I_1 = \frac{\Delta_1}{\Delta} = \frac{72}{72} = 1\,mA$$

$$I_2 = \frac{\Delta_2}{\Delta} = \frac{36}{72} = 0.5\,mA$$ —— 1 mark

- The output current is equal to $I_2 = 0.5\,mA$
- The short circuit o/p voltage $V_{sc} = 0V$
  {∵ as output is short hence o/p voltage is zero} —— 1 mark

OR

ii) Short circuit o/p Voltage & o/p current



Step 1. find out I_T using following method. calculate total current & total Resistance

R_T = 6K parallel to 6K & this total is in series with 3k.

$$\therefore R_T = \frac{6K \times 6K}{6K + 6K} + 3K$$

$$= \frac{36K}{12K} + 3K$$

$$= 3K + 3K$$

$$\therefore R_T = 6K$$

$$\therefore I_T = \frac{6V}{6K} = 1\ mA \simeq I_1$$ —— 1 Mark

Step 2 :- Apply current divison Rule to findout current I_2 ie o/p current.

$$I_2 = \frac{6K}{6K + 6K} \times I_T$$

$$= \frac{6K}{12K} \times 1\ mA$$

$$= 0.5 \times 1\ mA$$

$$I_2 = 0.5\ mA$$ —— 1 Mark

(d) With the help of circuit diagram and waveforms, explain working of RC differentiator.

Ans: **(Diagram 1M, Explanation 2M , waveform 1M)**

<u>RC differentiator:</u>

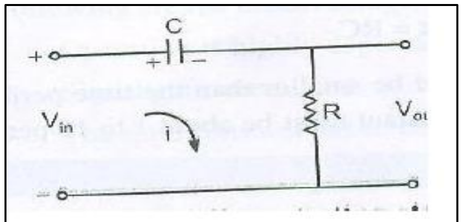


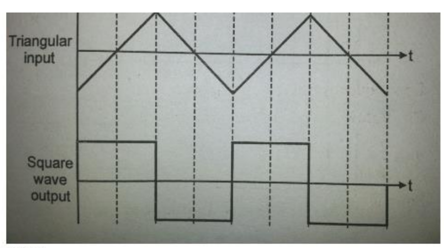
Fig: RC differentiating circuit

- Figure shows a RC differential circuit. It is also known as high pass filter. The reactance of a capacitor decreases with increasing frequency.
- The higher frequency components in the input signal appear at the output i.e. the capacitor acts as a short circuit for very high frequencies and virtually all the input appears at the output. Therefore, it is also called as high pass RC circuit.
- In above circuit the voltage drop across R will be very small in comparison with the drop across C. Hence, the current is completely determined by the capacitance C.
- The value of current I will be,
- I = C x dvi / dt
- The output voltage Vo is as given,
- . Vo = iR

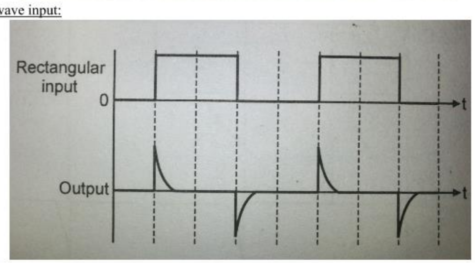
$$Vo = RC \times dvi / dt$$

- where R and C are constants
- Vo α dvi / dt
- i.e. the output signal is directly proportional to the derivative of the input signal

<u>Waveforms:</u> (Any input waveforms can be considerd)



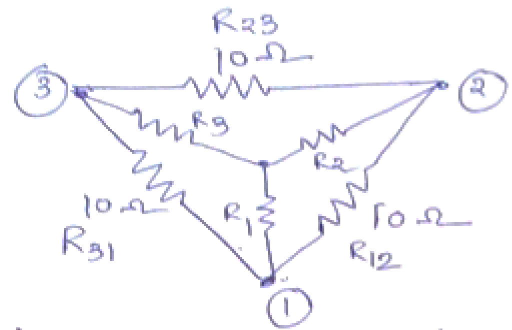
<u>Rectangular wave input:</u>



(e) Conversion of delta to star network:

Ans: **(Each diagram 1M, formulae 1M, correct conversion 2M)**

Q 5 e

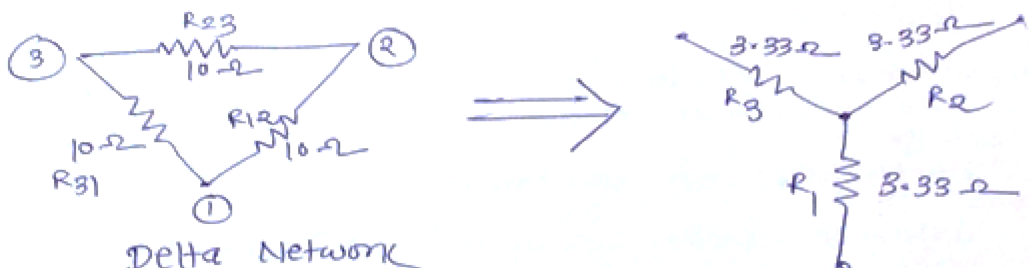


- Conversion of Δ to Y Network.

$$R_1 = \frac{R_{12} \times R_{31}}{R_{12}+R_{23}+R_{31}} = \frac{10 \times 10}{10+10+10} = \frac{100}{30} = 3.33\ \Omega$$

$$R_2 = \frac{R_{12} \times R_{23}}{R_{12}+R_{23}+R_{31}} = \frac{10 \times 10}{10+10+10} = \frac{100}{30} = 3.33\ \Omega$$

$$R_3 = \frac{R_{23} \times R_{31}}{R_{12}+R_{23}+R_{31}} = \frac{10 \times 10}{10+10+10} = \frac{100}{30} = 3.33\ \Omega$$



Delta Network   Star Network.

(f) State : (i) Norton's theorem.

(ii) super-position theorem.

Ans: **(Each Statement 2M)**

Norton's theorem Statement:

Any linear, active, resistive, network containing one or more voltage and / or current sources can be replaced by an equivalent circuit containing a current source called Norton's equivalent current I_{SC} and an equivalent resistance in parallel.

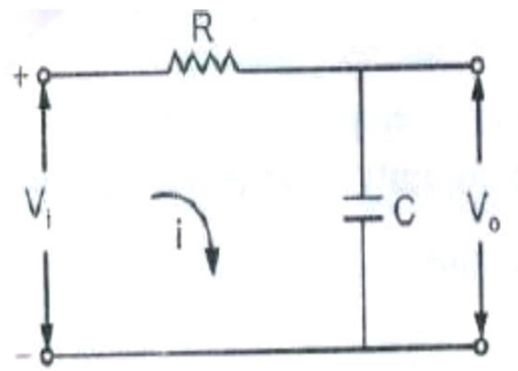
Superposition theorem Statement:

Superposition theorem states that in any linear network containing two or more sources, the response (current) in any element is equal to the algebraic sum of the response (current) caused by individual sources acting alone, while the other sources are inoperative.

6. Attempt any four: 16M

(a) Draw RC integrator circuit. Write expression for Vo. Draw input & output waveforms for square-wave input.

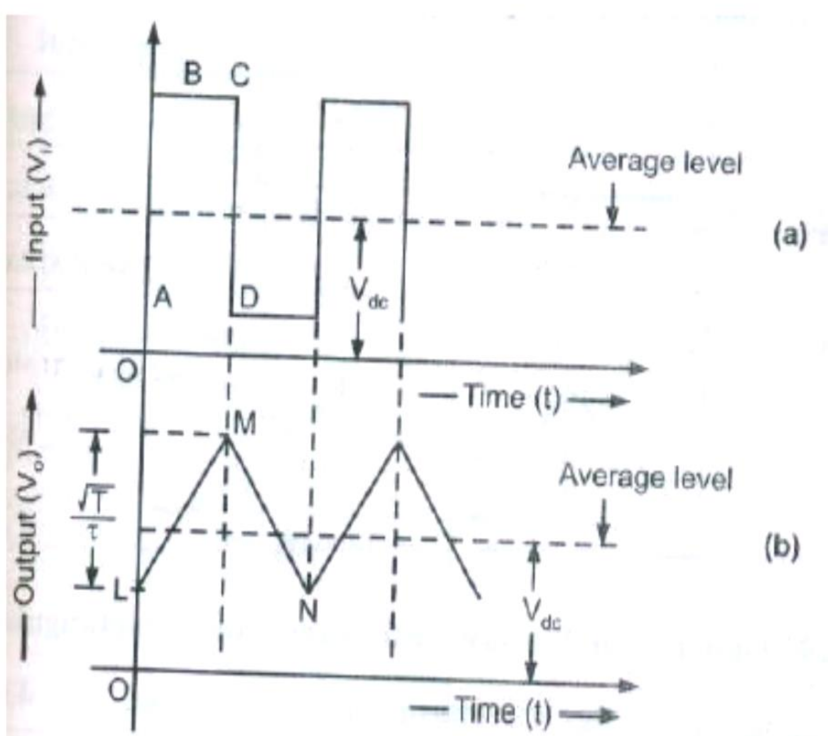
Ans:



(2 Marks)

(1 Marks)

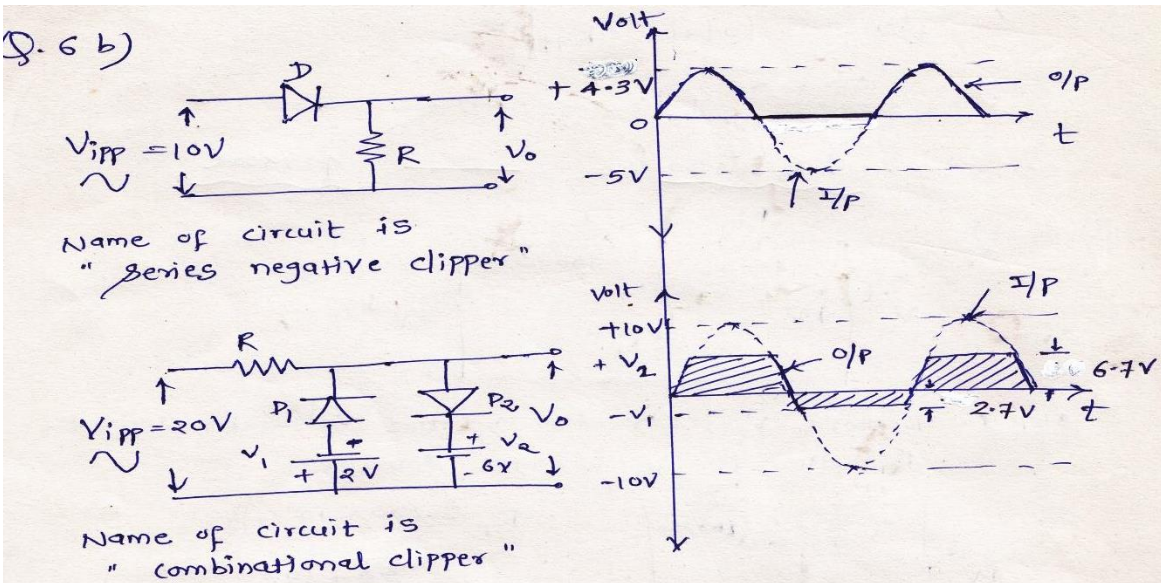
$$V_0 \propto \int V_i \cdot dt$$



(1 Marks)

(b) Draw output waveforms for following circuits:

Ans: (Note:Each Circuit 2 Marks, 1 Mark for waveforms & 1 Mark for Name of the circuit)



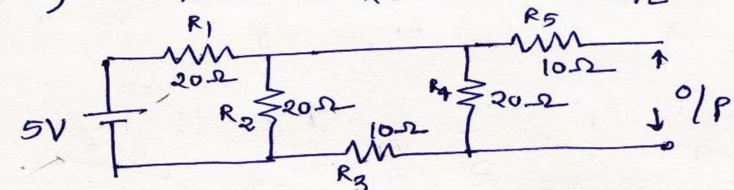
(c) State Thevenien's theorem. Find Thevenien's resistance R_{TH} for given circuit.

Ans: **(Statement 2M Value of R_{TH} 2M)**

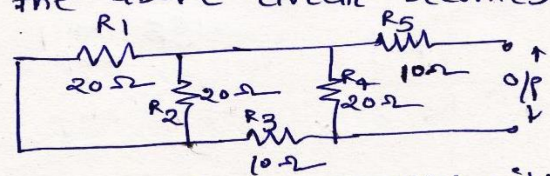
Thevenien's theorem Statement:

Any network containing active and/or passive elements and one or more dependent and/or independent voltage/or current sources can be replaced by an equivalent network containing a voltage source (Thevenien's equivalent voltage VTH or VOC) and a series resistance (called Thevenien's equivalent resistance R_{TH}).

Q. 6 c) Thevinin's Resistance R_{Th}



Step 1: To find R_{Th}, short the voltage sources and open circuit the current sources if any. Hence the above circuit becomes.



- $R_1 \parallel R_2$ (ie R_1 parallel with R_2) + R_3

  $\frac{20 \times 20}{20+20} + 10 = 20\Omega$

- (Above calculated 20Ω again parallel to R_4) + R_5

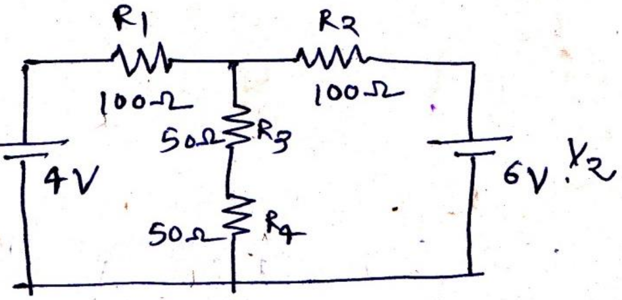
Hence total R_{Th}

$$\frac{20 \times 20}{20+20} + 10 = 20\Omega$$

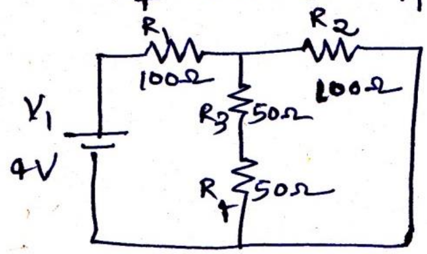
$\therefore R_{Th} = 20\Omega$

(d) Find current through resistance R_4 using super-position theorem.

Q.6 d)



Step 1. Remove V_2, consider V_1 and calculate current R_4 due to V_1 voltage source.



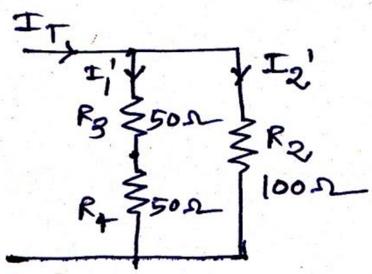
$$R_T = \frac{100 \times 100}{100 + 100} + 100$$

$$= 50 + 100$$

$$R_T = 150\,\Omega$$

$$I_T = \frac{4}{150} = 0.0267 \text{ Amp.}$$ —— 1 Mark

- current through R_4 due to 4V is



$$I_1' = \frac{100}{100+100} \times I_T$$

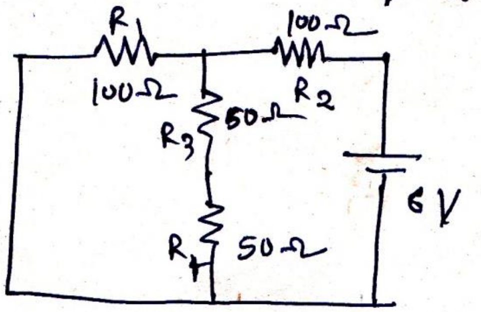
$$= \frac{100}{200} \times 0.0267$$

$$I_1' = 0.01335 \text{ amp}$$ —— 1 Mark.

Hence current thr R_4 is 0.01335 Amp.

Q 6 d) continue - - -.

Step 2. Now consider V_2 & Remove V_1 and calcu current thr R_4 due to V_2 Voltage source.

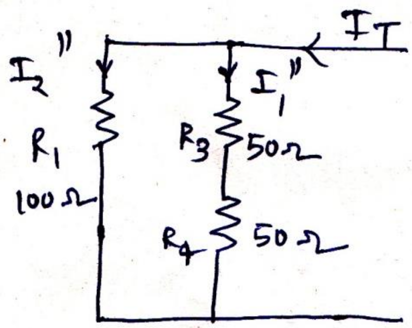


$$R_T = \frac{100 \times 100}{100+100} + 100$$

$$R_T = 150\Omega$$

$$I_T = \frac{6}{150} = 0.04 \text{ Amp} \text{ —— 1 Mark}$$

- current through R_4 due to 6V is



$$I_1'' = \frac{100}{100+100} \times I_T$$

$$= \frac{100}{200} \times 0.04$$

$$I_1'' = 0.02 \text{ Amp}$$

Step 3: The total current flowing thr R_4 due to $V_1 = 4V$ & $V_2 = 6V$ is.

$$I_1 = I_1' + I_1''$$

$$= 0.01335 + 0.02 \text{ —— 1 Mark}$$

$$\boxed{I_1 = 0.03335 \text{ Amp}}$$

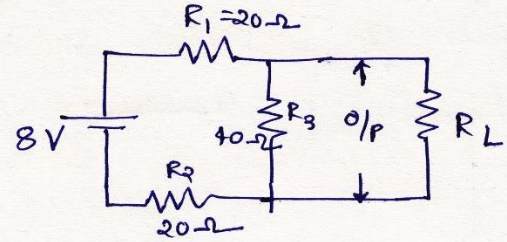
∴ The current thr R_4 is 0.03335 amp.

(e) For the given circuit,

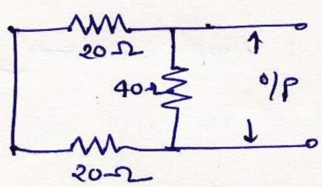
Find (i) Load resistance R_L to which maximum power will be transferred.

(ii) Maximum power transferred to load R_L.

Q.6. e) for the given circuit



Step 1 : To find R_L. First find out the thevenin's equivalent Resistance R_{Th}. & V_{Th}.

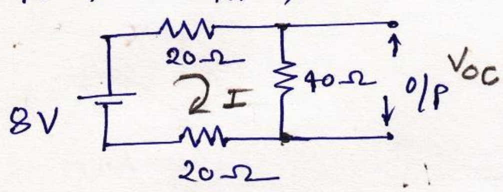


$$R_{Th} = \frac{(20+20)\times 40}{(20+20)+40}$$

$\therefore R_{Th} = 20\Omega$ —— 1 Mark

Step 2

To find $V_{Th} \Rightarrow$



Apply KVL to loop

$8 - 20I - 40I - 20I = 0$

$8 - 80I = 0$

$8 = 80I$

$\therefore I = 8/80 = 0.1$ amp.

$V_{oc} = I \times 40\Omega$

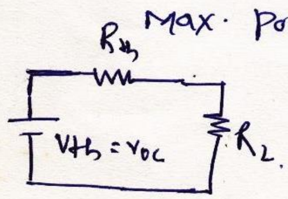
$= 0.1 \times 40$

$V_{oc} = 4V$ —— 1 Mark.

Step 3 :- The load Resist. $R_L = R_{Th}$ to maximum power to transferred

$\therefore R_L = 20\Omega$ —— 1 Mark

Max. Power transferred to $R_L = \frac{V_{oc}^2}{4 \cdot R_L}$

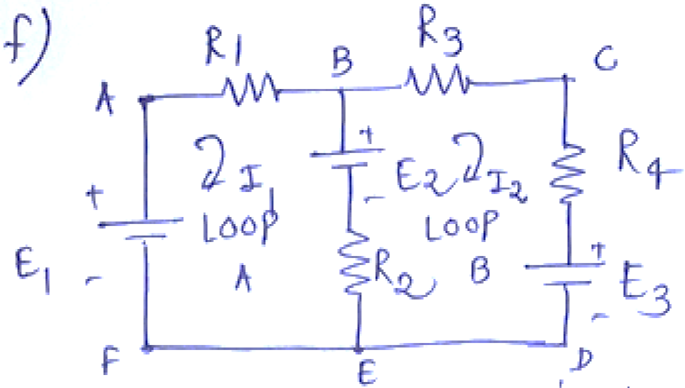


$\therefore P_{max} = \frac{(4)^2}{4 \times 20} = 0.2$ watt —— 1 Mark

(f) Using Max well's loop current method, write equations for Loop-A and Loop-B.

Ans:

Q.6 f)



Step 1 :- Using Maxwell's loop current method. write equation for loop A ⇒ ABEFA

$$-I_1R_1 - E_2 - R_2(I_1 - I_2) + E_1 = 0$$ — 1 Mark

$$-I_1R_1 - E_2 - I_1R_2 + I_2R_2 + E_1 = 0$$ — 1 Mark

Step 2 :- Write equation for Loop - B ⇒ BCDEB.

$$-I_2R_3 - I_2R_4 - E_3 - R_2(I_2 - I_1) + E_2 = 0$$ — 1 Mark

$$-I_2R_3 - I_2R_4 - E_3 - I_2R_2 + I_1R_2 + E_2 = 0$$ — 1 Mark

OR

$$-I_2R_3 - I_2R_4 - E_3 + R_2(I_1 - I_2) + E_2 = 0$$

$$-I_2R_3 - I_2R_4 - E_3 + I_1R_2 - I_2R_2 + E_2 = 0$$