SUMMER – 14 EXAMINATION

Model Answer

Subject Code: **17215** Page No: 1/

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.

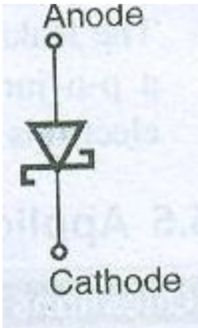
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.

7) For programming language papers, credit may be given to any other program based on equivalent concept.

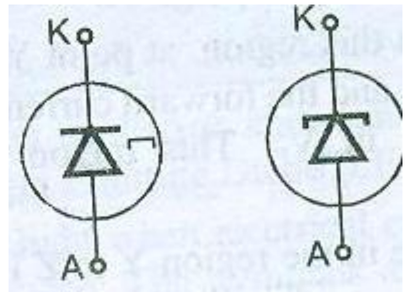
Q1. Attempt any ten of the following: (20 Marks)

a) Draw symbols of Schottkey diode and Tunnel diode.

Ans: (Schottkey diode – 1 Mark and Tunnel diode – 1 Mark)



Symbol of a Schottkey Diode



Symbols of tunnel diode

b) Define permeability and reluctivity of magnetic material.

Ans: (Permeability – 1 Mark and reluctivity – 1 Mark)

- Permeability is the capability of a specific material to allow the flow of magnetic flux more easily. Thus higher permeability enables a material to pass more magnetic flux.
- Reluctivity is equal to the ratio of the intensity of the magnetic field to the magnetic induction of the material.

c) State different types of filters.

Ans: (Four filters – 2 Marks)

Some of the important filter types are as follows:

1. Capacitor input filter (shunt capacitor filter)
2. Choke input filter (series inductor filter)
3. LC filter
4. π Type filter.
5. RC filter.

d) List two applications of LDR.

Ans: (Two applications – 2 Marks)

1. It is used for automatic contrast of brightness control in television receivers.
2. It is used as a proximity switch.
3. It is used in the street light control circuits.
4. It is used in the optical coding.
5. It is used in the light (flux meter).

6. It is used in the photosensitive relay.
7. It is used in camera light meters.
8. It is used in the security alarms.
9. It is used in the smoke detectors.
10. It is used in the infrared astronomy.

e) Define Rectifier. List its types.

Ans: (Define Rectifier – 1 Mark, Any two types – 1 Mark)

A rectifier may be defined as an electronic device, such as a PN junction diode, used for converting alternating (AC) voltage or current into unidirectional (DC) voltage or current.

Types:

1. Half-wave rectifier.
2. Full-wave rectifiers :
    a) Centre-tapped full wave rectifier.
    b) Full-wave bridge rectifier.

f) List any two applications of photodiode and IRLED.

Ans: (Any two applications of photodiode & IRLED– 1 Mark each)

Photodiode

1. In the cameras for sensing the light intensity.
2. In CD players.
3. In the fiber optic receiver.
4. As photo (light) detector.
5. In light intensity meters.
6. In the object counting system.

IRLED

1. In the remote control handsets.
2. In optocouplers.
3. In the shaft encoders
4. As a light source in optical fiber system
5. In the burglar alarm system.

g) State the necessity of wave shaping circuits.

Ans: (Any two necessities – 2 Marks)

1. To limit the voltage level of the waveform to some present value.
2. To shift the waveform to a particular voltage level.

3. To generate one wave from the other.
4. To cut the negative and positive portions of the waveform.

h) State Kirchhoff's current law along with its formula.

Ans: (Law – 1 Mark, Formula – 1 Mark)

The algebraic sum of all currents entering or leaving a node must be equal to zero

Therefore,

$\sum I = 0$

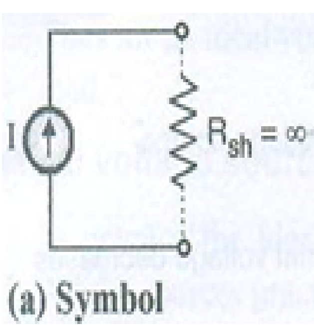
i) List any four applications of Laser diode.

Ans: (Any four applications – 2 Marks)

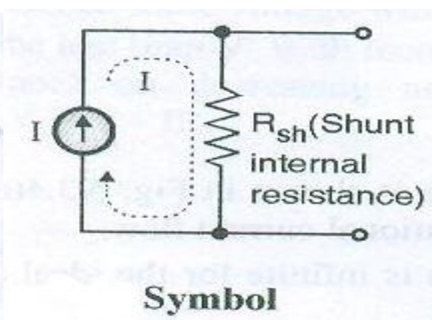
1. As light source in fiber optic communication.
2. In the infrared spectrometers.
3. In the medical field.
4. In military applications.
5. To measure distance, alignment angle etc.
6. For flow measurement.
7. As a sharp cutting tool in machine tool application.
8. In the communication.
9. For welding.
10. For sound recording and reproduction (in CD players)
11. In holography.

j) Draw ideal current source and practical current source.

Ans: (Ideal current source – 1 Mark, Practical current source – 1 Mark)



Ideal current source



Practical current source

k) Define rectification efficiency. Give its formula.

Ans: (Define – 1 Mark, Formula – 1 Mark)

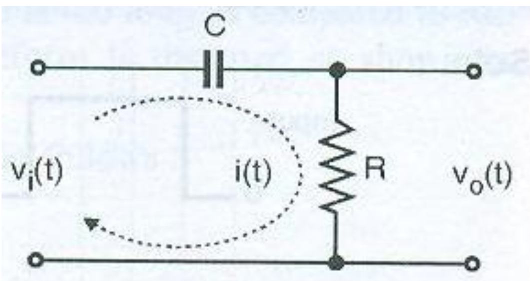
The ratio of output DC power delivered to the load to the applied input AC power is called rectification efficiency. It is denoted by η.

η = Output DC power delivered to the load / Input AC power from transformer secondary

$\eta = P_{dc} / P_{ac}$

l) Draw circuit diagram of RC differentiator. Write expression for output.

Ans: (circuit diagram – 1 Mark, expression for output – 1 Mark)



A RC differentiator

$$V_o(t) = RC \frac{d}{dt} V_i(t)$$

m) List any four dielectric materials used in manufacturing the capacitor.

Ans: (Any four dielectric materials – 2 Marks)

1. Mica, glass, ceramic
2. High permittivity ceramic
3. Paper and metallized paper
4. Electrolytic : Oxide film, tantalum
5. Dielectrics such as polystyrene, polythene polytetrafluoroethylene.

n) State superposition theorem.

Ans: (Statement – 2 Marks)

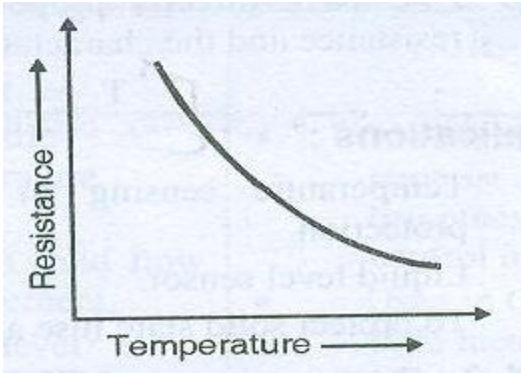
The superposition theorem states that in any linear network containing two or more sources, the response (current) in any element is equal to the algebraic sum of the response (current) caused by individual sources acting alone, while the other sources are inoperative.

Q2. Attempt any four of the following: (16 Mark)

a) Describe NTC and PTC resistors with temperature resistance characteristics.

Ans:

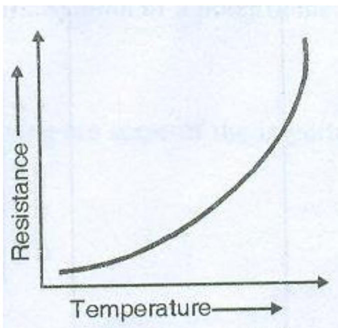
<u>Diagram</u> **(1 Mark)**



<u>NTC Thermistors</u> **(1 Mark)**

- NTC thermistors have negative temperature co-efficient of resistance where resistance of the resistive material decreases with increase in temperature.
- NTC thermistors are used when continuous change of resistance is required over wide temperature range.
- $[R \propto 1/T]$

<u>Diagram</u> **(1 Mark)**



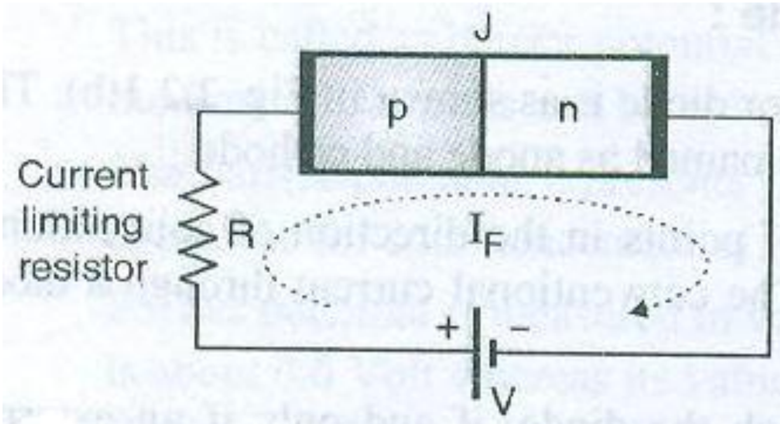
<u>PTC Thermistors</u> **(1 Mark)**

- PTC thermistors have positive temperature co-efficient of resistance in which resistance value decreases with decrease in temperature.
- PTC thermistors are used when a drastic change in resistance is required at specific temperature.
- $R \propto T$

b) Describe the working of PN junction diode with neat sketch under forward biased condition.

Ans: (Diagram – 2 Marks, Explanation – 2 Marks)

- If the p-region (anode) is connected to the positive terminal of the external DC source and n-side (cathode) is connected to the negative terminal of the DC source then the biasing is said to be "forward biasing".

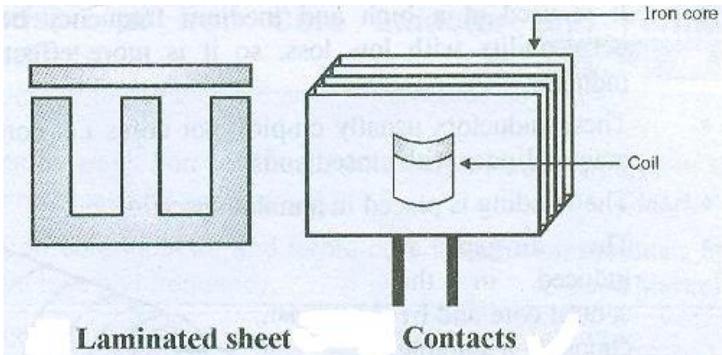


Forward biasing of a diode

- Due to the negative terminal of external source connected to the n-region, free electrons from n-side are pushed towards the p-side. Similarly the positive end of the supply will push holes from p-side towards the n-side.
- With increase in the external supply voltage V, more and more number of holes (p-side) and electrons (n-side) start travelling towards the junction as shown in figure.
- The holes will start converting the negative ions into neutral atoms and the electrons will convert the positive ions into neutral atoms. As a result of this, the width of depletion region will reduce.
- Due to reduction in the depletion region width, the barrier potential will also reduce. Eventually at a particular value of V the depletion region will collapse. Now there is absolutely no opposition to the flow of electrons and holes.
- Hence a large number of electrons and holes (majority carriers) can cross the junction under the influence of externally connected DC voltage.
- The large number of majority carriers crossing the junction constitutes a current called as the forward current.

c) Draw the constructional diagram of iron core inductor. List applications.

Ans: (Diagram – 2 Marks, Any two relevant Applications – 2 Marks)



Iron core inductor

Note: Laminated sheet diagram is optional.

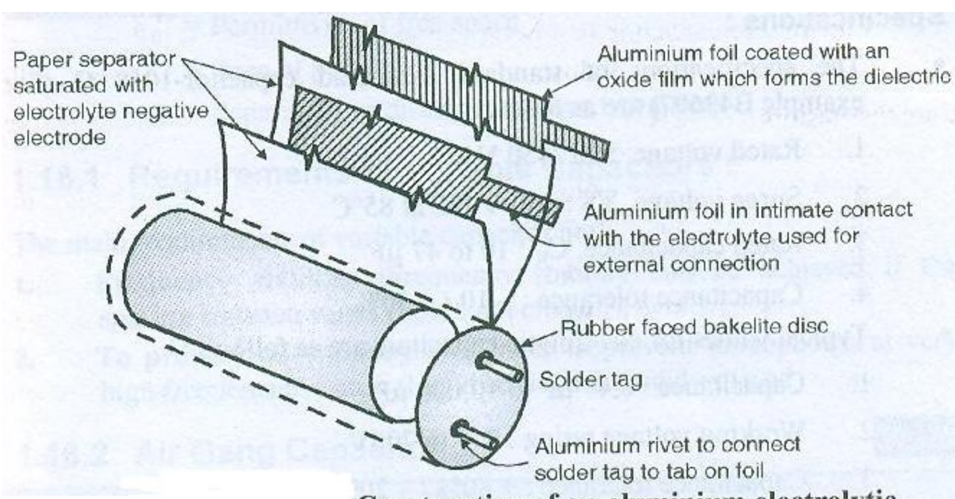
Applications:

- Iron core inductors are used in filter circuit.
- They are also used in A.F. applications.

d) Describe construction of Aluminium Electrolytic capacitor.

Ans: (Diagram – 2 Marks, Explanation – 2 Marks)

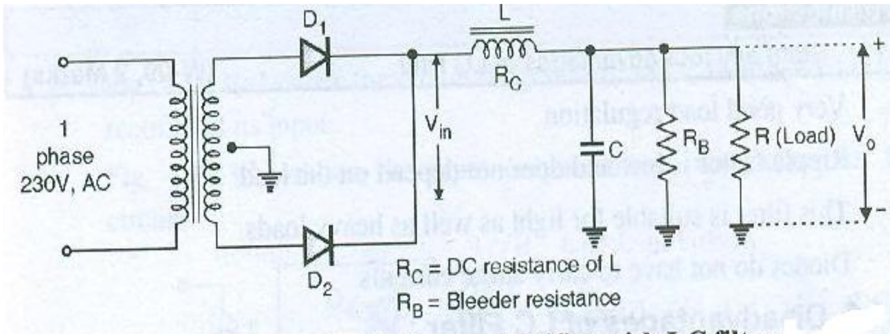
- A plain foil dry electrolytic capacitor is made by forming a coating of aluminium oxide on both sides of an aluminium foil.
- Two strips of aluminium foil used are then separated by two layers of porous paper soaked with electrolyte. This assembly is rolled up the ends closed with wax and then sealed into an aluminium container.



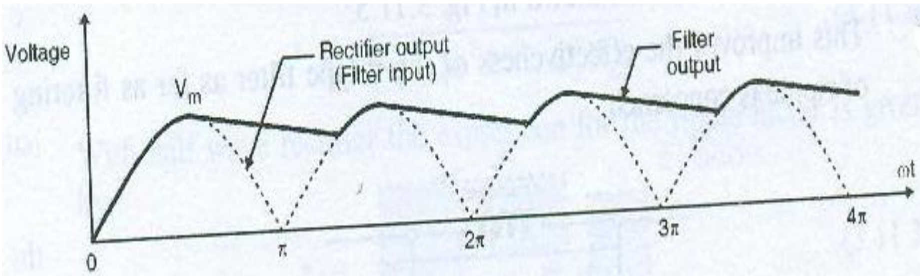
Construction of an aluminium electrolytic capacitor

e) Draw the circuit diagram for centre tap full wave rectifier with LC filter. Draw its input and output waveforms.

Ans: (circuit diagram – 2 Marks, input and output waveforms – 2 Marks)



Full wave rectifier with LC filter

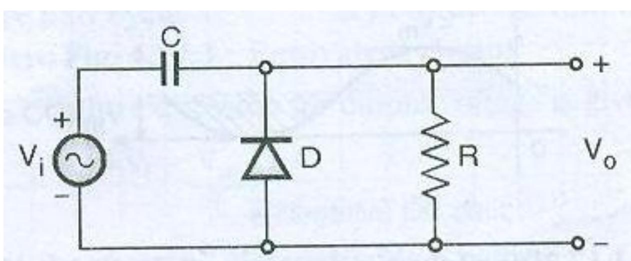


Input output voltage waveforms

f) Describe the working of positive clamper with neat circuit diagram and input/output waveforms.

Ans :

Circuit Diagram **(1 Mark)**



A positive clamper

Operation **(2 Mark)**

- In the first negative half cycle after turning on the circuit, the diode acts as a closed switch and charges the capacitor to peak input voltage V_m with the polarities.
- In all the subsequent positive and negative half cycles, due to large RC time constant, the capacitor does not loose much charge. So V_o almost remains constant.

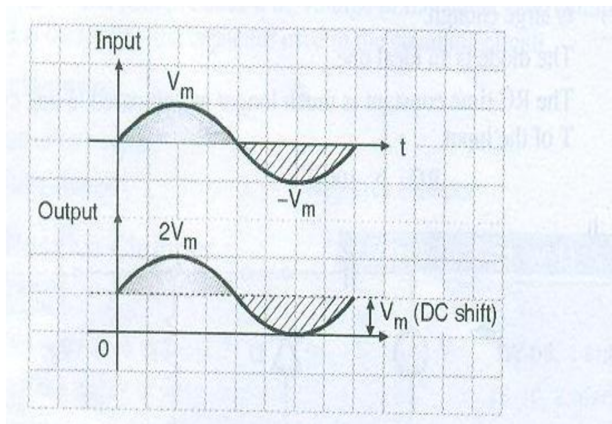
- So for the rest of operation, the equivalent circuit is as shown in figure. The diode is reverse biased in both half cycles, so it remains off.
- From figure we can write the expression for Vo as,

$$V_o = V_i + V_m$$

(V_m → Positive DC shift)

This shows that the clamper adds a positive DC shift.

<u>Waveform</u> **(1 Mark)**



Input output waveforms of a positive clamper

Q3. Attempt any four of the following **(16 Marks)**

a) Write color codes for following resistors.

i) 470 kΩ ± 5% ii) 1.2 MΩ ± 10%

Ans:

i) 470 KΩ ± 5% **(2marks)**

4	7	10^4	±	5%
↓	↓	↓		↓
Yellow	Violet	Yellow		Gold

ii) 1.2 MΩ ± 10% **(2 marks)**

1	2	10^5	±	10%
↓	↓	↓		↓
Brown	Red	Green		Silver

b) Define following terms in case of PN junction diode:

i) Static resistance **ii) Dynamic resistance**

iii) Cut-in voltage **iv) Breakdown voltage**

Ans:

<u>Note:</u> Formulas are optional.

<u>Static resistance</u> **(1 Mark)**

The ratio of d.c. voltage across the diode to the d.c. current flowing through it is called static resistance.

$$R_F = V_F / I_F$$

<u>Dynamic resistance</u> **(1 Mark)**

The resistance offered by the diode to an a.c. signal is called its dynamic resistance.

$r_{ac} = 1 /\Delta I_F / \Delta V_F = \Delta V_F /\Delta I_F$

= Change in voltage / Resulting change in current.

<u>Cut-in voltage</u> **(1 Mark)**

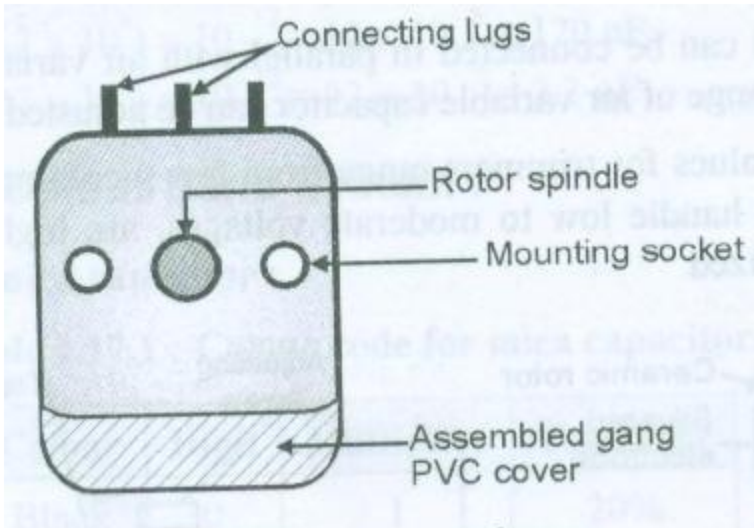
It is the minimum voltage at which current through diode start increasing rapidly. It is also known as knee voltage.

<u>Breakdown voltage</u> **(1 Mark)**

The voltage, at which the abrupt increase in reverse current through the PN junction occurs, is known as breakdown voltage.

c) Draw construction of PVC gang capacitor and describe it's working.

Ans: <u>Diagram</u> **(2 Marks)**



PVC gang condenser

<u>Working</u> **(2 Marks)**

In plastic core capacitor, poly-vinyl chloride (PVC) type of plastic film is used as dielectric between the fixed & movable vanes instead of air. This increases the dielectric constant of the capacitor & results in great reduction of size of capacitor in comparison with the air core capacitor.

d) Compare HWR and FWR (any four points)

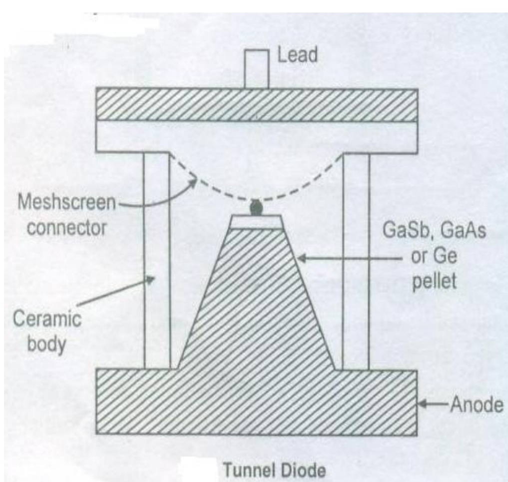
Ans: (Any four points – 4 Marks)

Note: Any one type of Full wave rectifier should be considered

Sr. No.	Rectifier Parameters	Half-wave	Full wave	
			Centre-tap	Bridge
1	Number of diodes	1	2	4
2	Transformer necessity	No	Yes	No
3	Peak secondary voltage, V_s	V_m	V_m	V_m
4	Peak Inverse voltage	V_m	$2\ V_m$	V_m
5	Peak load current, I_m	$V_m / (R_f + R_L)$	$V_m / (R_f + R_L)$	$V_m / (2R_f + R_L)$
6	RMS current, I_{rms}	$I_m /2 = 0.5\ I_m$	$I_m / \sqrt{2} = 0.707\ I_m$	$I_m / \sqrt{2} = 0.707\ I_m$
7	D.C. current, I_{dc}	$I_m / \pi = 0.318\ I_m$	$2\ I_m / \pi = 0.636\ I_m$	$2\ I_m / \pi = 0.636\ I_m$
8	Ripple factor, r	1.21	0.482	0.482
9	Form factor, F	1.57	1.11	1.11
10	Maximum rectification efficiency, η_{max}	40.6%	81.2%	81.2%
11	Transformer utilization factor (TUF)	0.287	0.693	0.812
12	Ripple frequency, f_r	f_i	$2\ f_i$	$2\ f_i$

e) Draw construction of Tunnel diode. Describe its working.

Ans: Construction **(2 Marks)**



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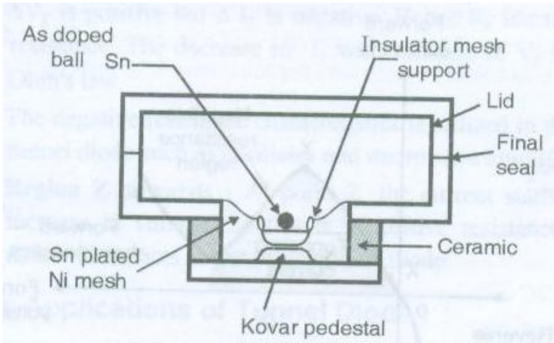


(2 Marks)

Working

The operation of tunnel diode is based on special characteristics known as negative resistance.

The width of the depletion region is inversely proportional to the square root of impurity concentration.

So increase in the impurity concentration, the depletion region width will reduce. The thickness of depletion region of this diode is so small. That indicates there is large probability of an electron can penetrate through this barrier.

This behavior is called is tunneling & hence the name of the high impurity density PN junction is called as tunnel diode.

f) Identify the following circuit. Draw its input/output waveforms (Refer Figure 1)

Ans:

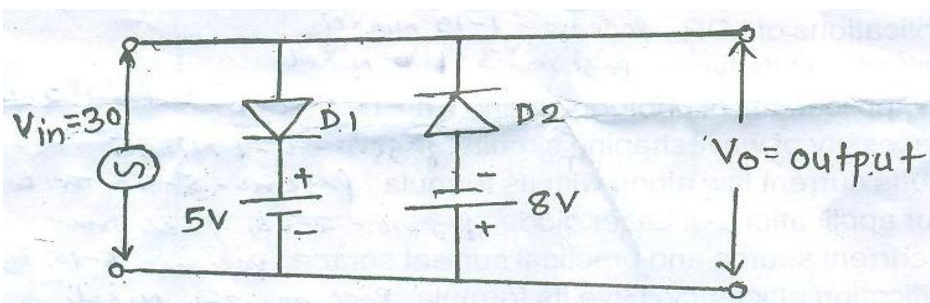
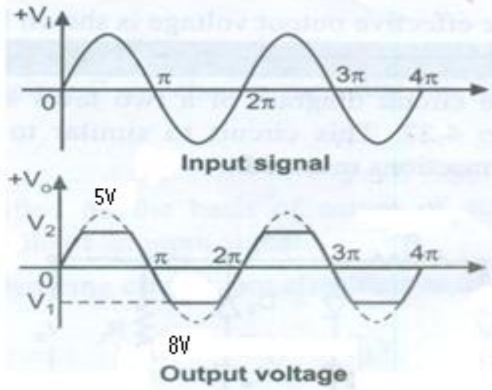


Figure : 1 [Q. 3(f)]

Identification **(2 Marks)**

The circuit is Combinational Clipper for waveform.

Waveform **(2 Marks)**

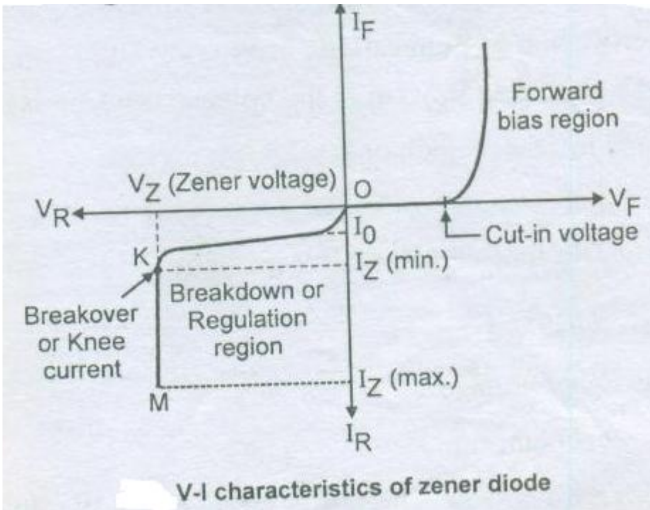


Q4. Attempt any four of the following : (16 Marks)

a) Draw VI characteristics of zener diode. Lists its two specifications.

Ans:

Diagram **(2 Marks)**



V-I characteristics of zener diode

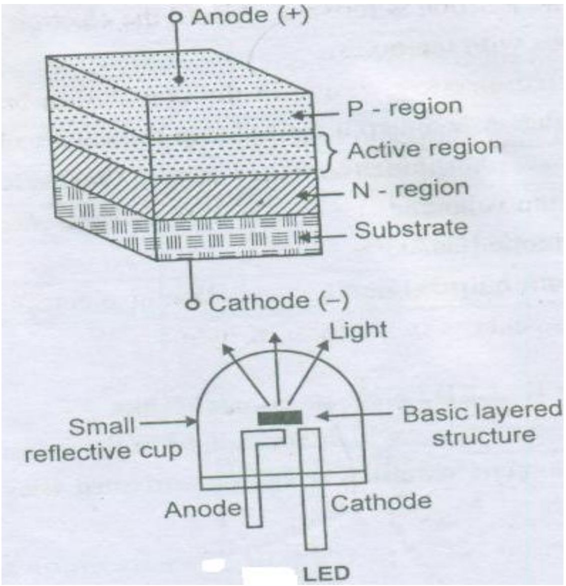
Note: **Any two Specifications.**

Specifications **(2 Marks)**

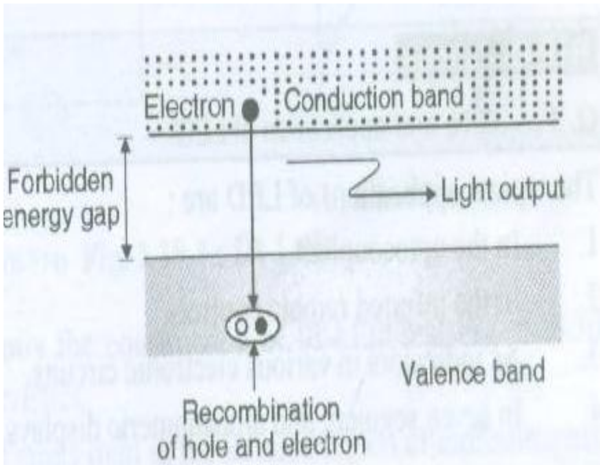
- **Zener Voltage (V_z)**
- **Power Dissipation (P_Z)**
- **Dynamic Resistance**

b) Draw construction of LED and explain its working.

Ans: (Construction figure – 1 Mark, Working figure – 1 Mark, Explanation – 2 Marks)



Construction Diagram



Working Diagram

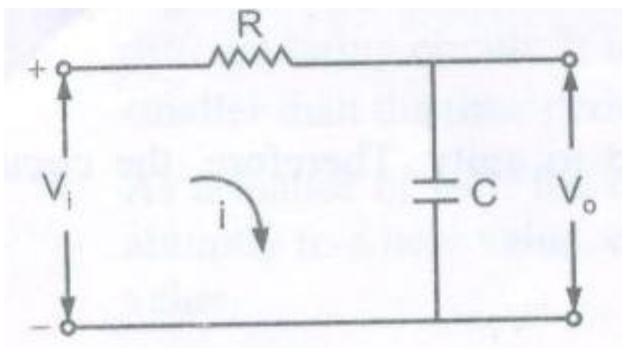
Working

When the junction is forward – biased the electron in the n-region combines with the holes.

- These free electrons reside in the conduction band and at the higher energy level from the holes in the valence band. When the recombination takes place, these electrons return back to the valence band which is at a lower energy level than the conduction band.
- While returning back, the recombining electrons give away the excess energy in the form of light.

c) Draw circuit diagram for RC integrator. Write expression for output voltage. Draw output waveform for square wave as input.

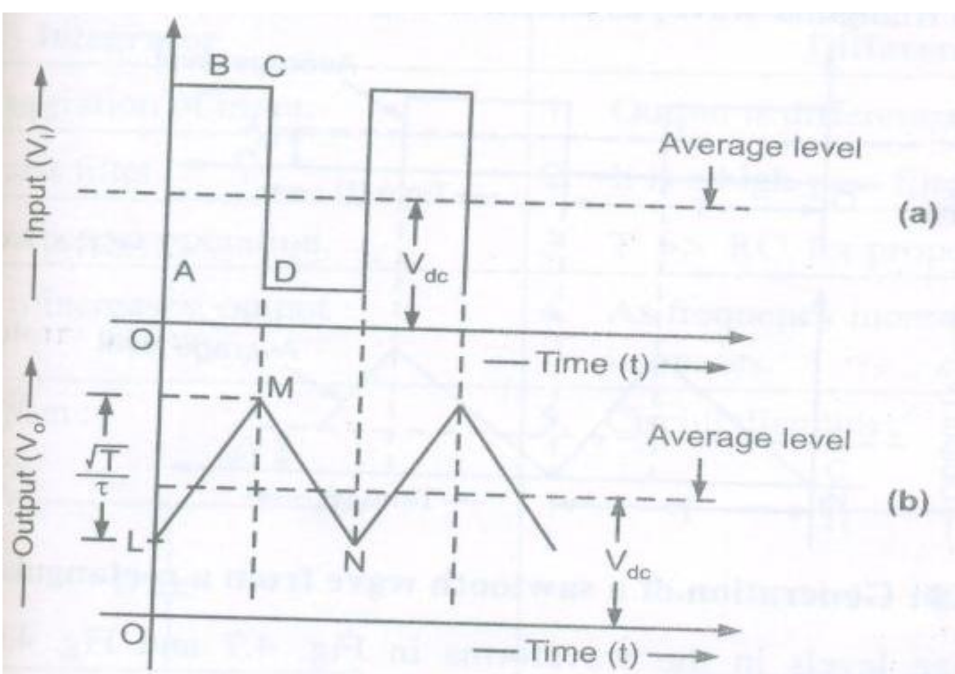
Ans :



(2 Marks)

(1 Marks)

$$V_o \propto \int V_i \cdot dt$$



(1 Marks)

d) In full wave bride rectifier load resistance RL = 2 kΩ . The diode has forward bias dynamic resistance of 10Ω . If AC voltage across secondary winding of transformer is V = 100 sin 314t.

Determine

i) Peak value of current (l_m) **ii) DC value of voltage (V_{dc})**

iii) DC value of current (l_{dc}) **iv) PIV**

Ans :

Given :

$R_L = 2\ K\Omega = 2000\ \Omega$

$R_F = 10\ \Omega$

$V_m = 100\ V$

To find :

a) $I_m = ?$

b) $V_{dc} = ?$

c) $I_{dc\ =}\ ?$

d) PIV = ?

Soln.

i) Peak value of current (l_m) **(1 mark)**

$I_m = V_m / R_S + 2R_F + R_L$, Assume $R_S = 0$

Therefore $I_m = 100 / (2x10) + 2000 = 0.0495$ A

Therefore $I_m = 0.0495A$

ii) DC value of voltage (V_{dc}) **(1 mark)**

$V_{dc} = Z_{dc} \times R_L$

$= 0.0315 \times 2000$

Therefore Vdc = 63 V

iii) DC value of current (l_{dc}) **(1 mark)**

$I_{dc} = 2\ I_{m\ /}\ \pi$

$= 2 \times 0.0495 / 3.14$

Therefore, $I_{dc} = 0.0315$ A

iv) PIV **(1 mark)**

V = 100 sub 314 t

V = Vm sin wt

Therefore, PIV = 100 V

e) Compare soft magnetic materials and hard magnetic materials. (For four points)

Ans : (Any relevant Four points – 1 Mark each)

Sr. No.	Soft magnetic materials	Hard magnetic materials
1	It has high resistivity	It has low resistivity
2	It has low coercivity	It has high coercivity
3	It has low residual magnetism	It has high residual magnetism
4	It is easily magnetized	It is not easily magnetized.

f) Calculate equivalent resistance R_{AB} using delta-star transformation (Refer Fig.2)

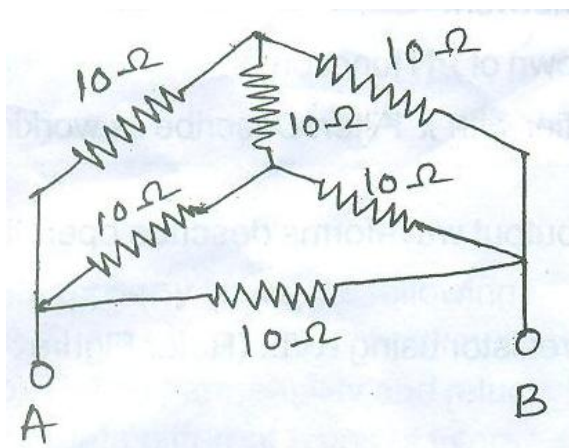
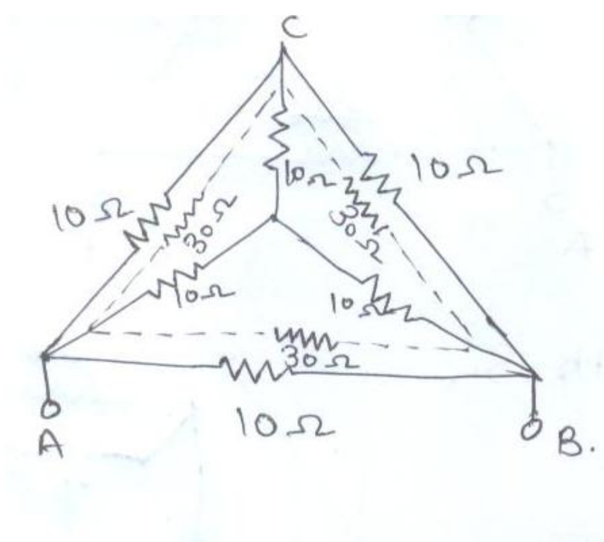


Figure : 2 [Q. 4 (f)‾]

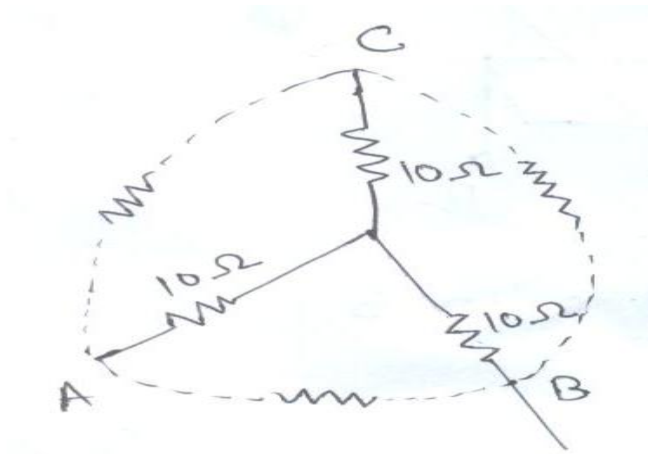
Solution:

i)



10 + 10 + 10 x 10 / 10 = 30

ii)



(1 mark)

iii) $R_{AB} = R_1R_2 + R_2R_3 + R_1R_2 / R_3$

$= (10X10) + (10X10) + (10X10) / 10$

Therefore, $R_{AB} = 30\ \Omega$

Similarly,

$R_{BC} = 30\ \Omega$

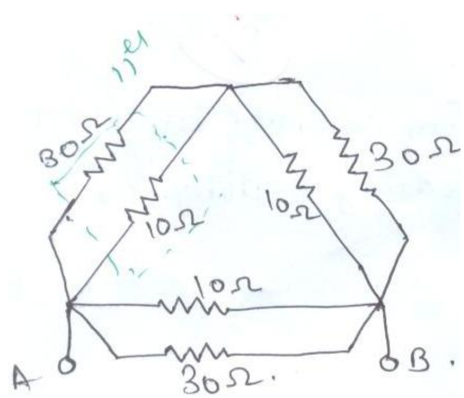
$R_{AC} = 30\ \Omega$

Resistors are

Therefore, 30 x 10 / 30 + 10 = 300 / 40

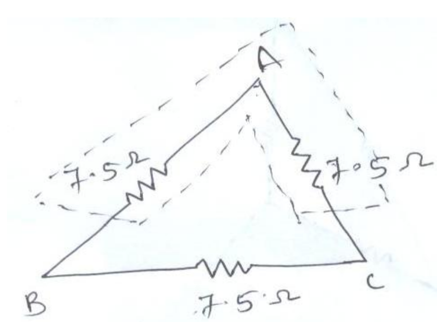
= 7.5Ω **(1 mark)**

iv)



(1/2 mark)

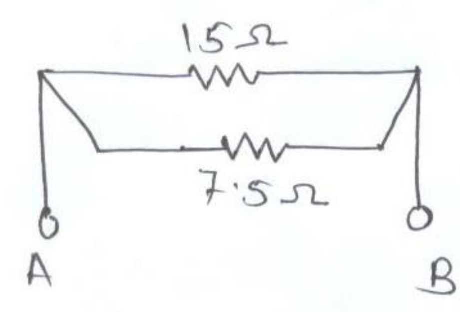
v)



7.5 in series with 7.5

Therefore, 7.5 + 7.5 = 15 Ω **(1/2 mark)**

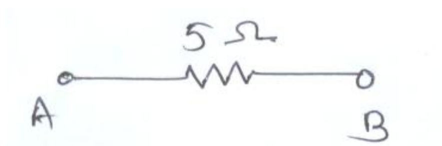
vi)



15 in parallel with 7.5

Therefore, 15 x 7.5 / 15 + 7.5 = 112.5 / 22.5 = 5 Ω **(1/2 mark)**

vi)



Therefore, Equivalent Resistance R_{AB} = 5 Ω **(1/2 mark)**

5. Attempt any FOUR of the following **(16 marks)**

a) Describe the meaning of the term open circuit and short circuit with neat diagram.

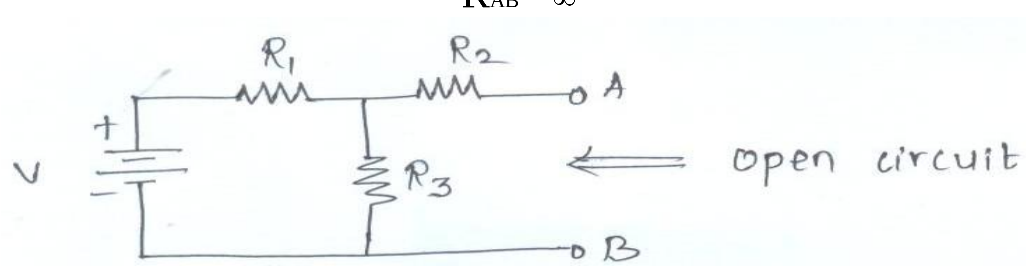
Ans:

Open Circuit **(2 Marks)**

Two points in a circuit are said to be open circuited if there is no circuit element or direct connection between them.

An open circuit exist between points 'A' and 'B' in below figure. The resistance between the open circuited points is infinite.

$$R_{AB} = \infty$$

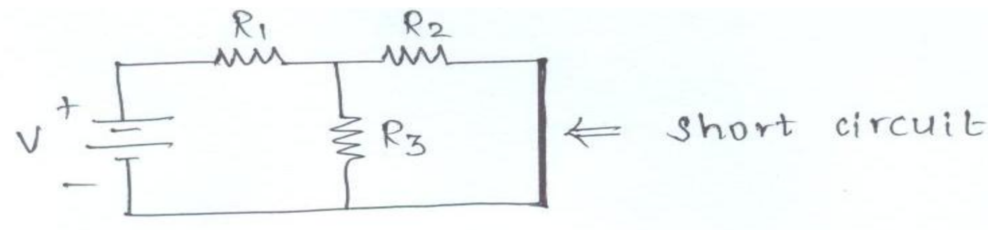


Short Circuit **(2 Marks)**

Two points in a circuit are said to be short circuited when they are connected to each other by a good conducting wire.

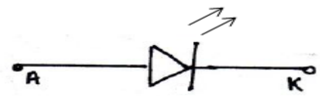
Points 'A' and 'B' are short circuited in below figure. The resistance between short circuited points is zero.

$$R_{AB} = 0\Omega$$



b) Compare LED and PN Junction Diode (any four points).

Ans: **(Any four relevant points – 1 Mark each)**

Sr.No	Parameter	PN Junction Diode	LED
1	Symbol		
2	Material used	Silicon or Germanium	Gallium Arsenide
3	Capacity to emit light	Cannot emit light	Can emit light when excited electrically
4	ON state voltage drop	0.7 V for silicon diode, 0.3 V for germanium diode	Ranges between 1.2 to 2 V
5	Reverse Breakdown Voltage	High	Very Low
6	Application	Rectifier, clipper, clamper etc.	As a light source in optical fibre application, as an indicator in seven segment displays etc.

c) Define the following terms in case of rectifier

- **i. Ripple Factor**
- **ii. TUF**
- **iii. Ripple Frequency**
- **iv. PIV**

Ans:

<u>Note:</u> Formulas are optional.

<u>Ripple Factor</u> **(1 Mark)**

Ripple Factor is defined as the ratio of RMS value of the AC component of output to the DC or average value of the output.

Mathematically it is expressed as,

$$\text{Ripple Factor} = \frac{\text{RMS value of the AC component of output}}{\text{DC or average value of the output}}$$

<u>TUF</u> **(1 Mark)**

Transformer Utilization Factor (TUF) is defined as the ratio of DC output power to the AC power ratings of the transformer.

Mathematically it is expressed as,

$$\text{TUF} = \frac{\text{DC output power}}{\text{AC power ratings of the transformer}}$$

<u>Ripple Frequency</u> **(1 Mark)**

Ripple frequency is defined as the frequency of the pulsating load voltage waveform. For a half wave rectifier, ripple frequency is 50 Hz.

PIV (**1 Mark)**

Peak Inverse Voltage (PIV) is defined as the maximum negative voltage which appears across nonconducting reverse biased diode.

d) Compare clipper and clamper by any four points.

Ans:- **(Any four relevant points – 1 Mark each)**

Sr. No	Parameter	Clipper	Clamper
1	Components used	Diode, Resistors	Diode, Capacitors, Resistors
2	Function	To remove a part of input waveform	To add a DC shift to the input waveform
3	Frequency of input	Not important as capacitor is not used	The value of C needs to be chosen on the basis of input frequency
4	Application	Diode clamp, wave shaping circuits	Voltage Multipliers

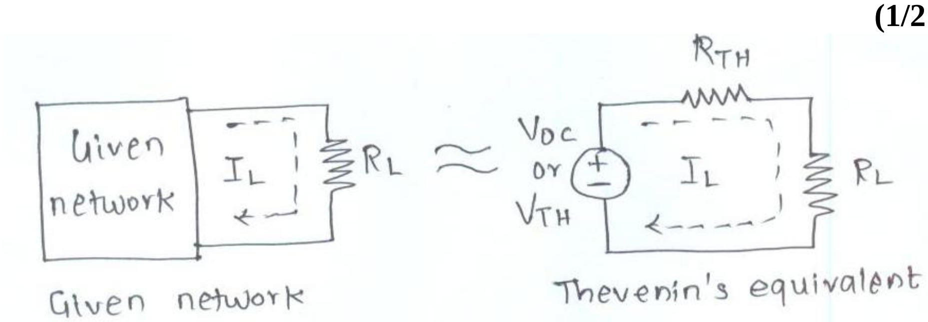
e) State and explain Thevenien's theorem with suitable example. (4 marks)

Ans: **(Note: Any suitable example can be considered and given marks)**

Statement **(1 Mark)**

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 V_{TH} or V_{OC}) and a series resistance (called Thevenien's equivalent resistance R_{TH})

Diagram **(1/2 Mark)**



Explanation **(1 Mark)**

Figures below illustrate the concept explained in the Thevenien's theorem. Figure shows the given network with a load resistance R_L connected between points A and B. the load current is I_L.

Figure shows that the given network is replaced by its Thevenien's equivalent which contains a voltage source V_{OC} or V_{TH} and a Thevenien's equivalent resistance R_{TH}.

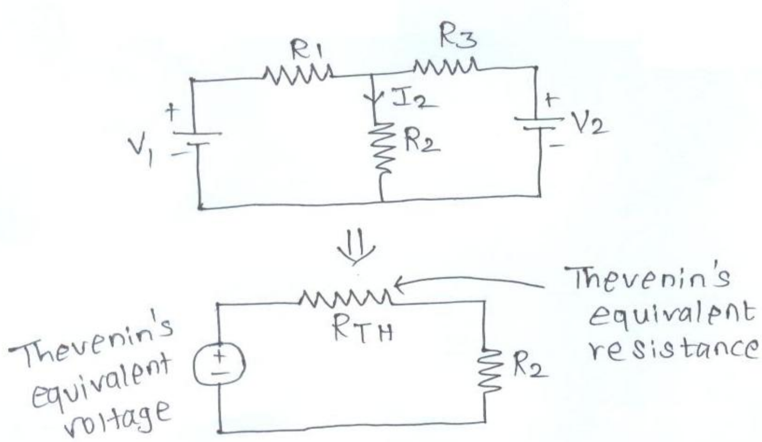
V_{OC} or V_{TH} – this voltage is called as open circuit voltage or Thevenien's voltage and it a voltage between the open circuited load terminals as shown in figure.

So, $V_{OC} = V_{TH} = V_{AB}$ with R_L open circuited.

R_{TH} – R_{TH} is the Thevenien's equivalent resistance which is measured between the open circuited load terminals with all the voltage or current sources replaced by their internal resistances.

The internal resistance of an ideal voltage source is zero and that of an ideal current is source is infinite.

Example network
Diagram **(1/2 Mark)**



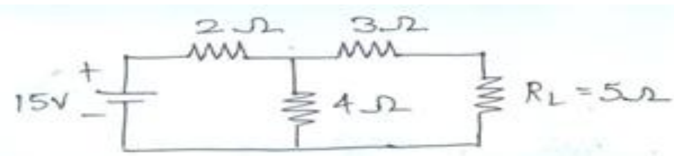
Explanation **(1 Mark)**

Consider the example network if the figure shown below. Let us obtain the Thevenien's equivalent for this circuit.

The current through a branch (say I_2 in figure can be determined by using the Thevenien's theorem. The voltage V_{OC} (open circuited voltage) or V_{TH} (Thevenien's equivalent voltage) is obtained by removing the resistance R_2 in figure and measuring the open circuit voltage between points A and B. And R_{TH} is the Thevenien's equivalent resistance which is resistance between A and B (with R2 removed) when all the voltage/current sources are replaced by their internal resistances.

f) Calculate the value of current in 5Ω resistor using Norton's theorem for a network as shown below.

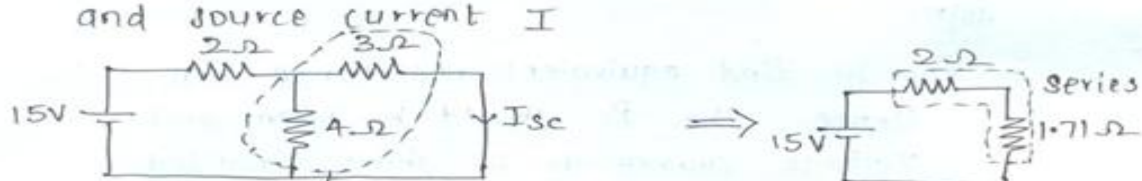
Ans: (Finding I – 1 Mark, Isc – ½ Mark, R_{TH} – ½ Mark, I_L – 1 Mark, Norton Ckt. – 1 Mark)



To find: Current through $R_L = 5\Omega$ Using Norton's theorem

Soln:

(1) Short the load and find total resistance R_T and source current I



Parallel $3 \| 4 = \frac{3 \times 4}{3+4} = \frac{12}{7} = 1.71\Omega$

From above figures,

$R_T = 2\Omega + 1.71\Omega = 3.71\Omega$

$\therefore\ I = \frac{15V}{R_T} = \frac{15}{3.71} = 4.04\,A$ **1 Mark**

(2) Find Isc

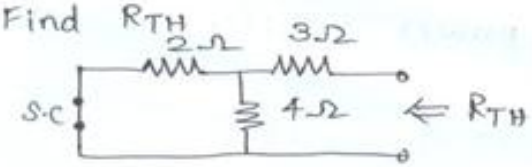
Apply current division to above figure between the parallel resistors to get,

$$I_{sc} = I \times \frac{4}{4+3} = 4.04 \times \frac{4}{7}$$

$$= 2.30A$$

½ Mark

(3) Find R_{TH}



$$R_{TH} = (2\Omega \,//\, 4\Omega) + 3\Omega$$

$$= \frac{2 \times 4}{2+4} + 3$$

$$= \frac{8}{6} + 3$$

$$= 1.33 + 3$$

$$R_{TH} = 4.33\Omega$$

½ Mark

4) Find I_L

From above figure,

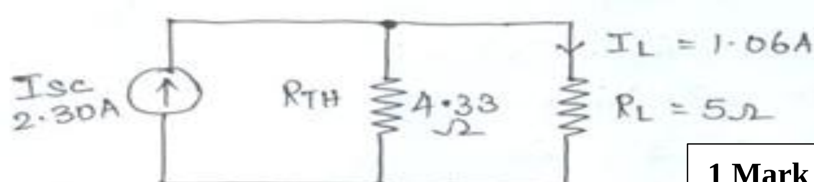
$$I_L = \frac{R_{TH}}{R_{TH} + R_L} \times I_{sc}$$

$$= \frac{4.33}{4.33+5} \times 2.30$$

$$= 1.06 A$$

1 Mark

5) Norton's equivalent circuit



1 Mark

6. Attempt any FOUR of the following. (16 marks)

a) Define the following terms

i.	**Active Network**	**iii.**	**Linear Network**
ii.	**Passive Network**	**iv.**	**Non-Linear Network**

Ans:

Active Network **(1 Mark)**

If a network consists of an energy source then it is called an active network. The type of energy source can be a voltage source or a current source.

Passive Network **(1 Mark)**

If a network does not contain any energy source then it is called an passive network.

Linear Network **(1 Mark)**

If the characteristics, parameter such as resistances, capacitances, inductances etc. remain constant irrespective of changes in temperature, time, voltage etc. then the circuit or network is called Linear network.

Non-Linear Network **(1 Mark)**

If the parameters of a network change their values with change in voltage, temperature, time etc. then the network is called as Non-Linear Network.

b) Describe avalanche and Zener breakdown of PN Junction.

Ans:

Avalanche breakdown **(1 ½ Marks)**

The increased reverse voltage increases the amount of energy impaled to minority carriers, as they diffuse across the function.

As the reverse voltage is increased further the minority carriers acquire a large amount of energy.

When these carriers collide with atoms, within the crystal structure they impact sufficient energy to break a covalent bond and generate additional carriers (electron hole pairs).

These additional carriers pick up energy from the applied voltage and generate more carriers, and reverse current increased rapidly.

This cumulative process of carrier generation (or multiplication) is known as Avalanche breakdown.

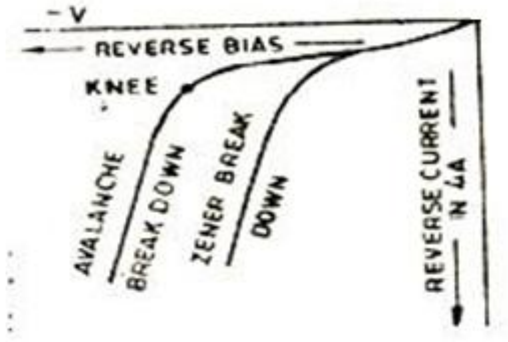
Zener Breakdown **(1 ½ Marks)**

It occurs when diode is heavily doped. Due to heavy doping, depletion layer is narrow.

When the reverse voltage across the diode is increased, electric field is developed across depletion layer.

Electric field is strong enough to generate large number of electron-hole pair by breaking covalent bonds.

Because of large number of these carriers reverse current increases sharply and breakdown occurs which is known as Zener Breakdown.

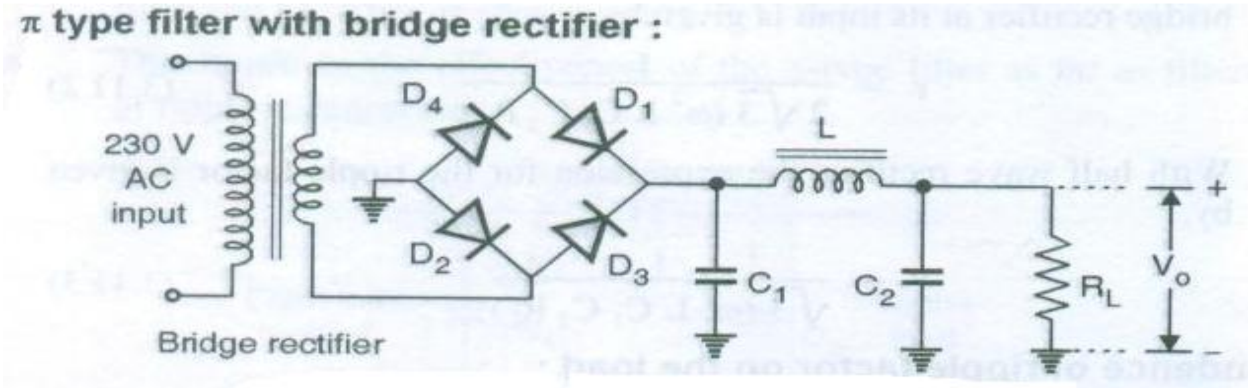


(1 Mark)

c) Draw the circuit diagram of bridge rectifier with π filter. Describe its working and draw its input/output waveforms.

Ans:

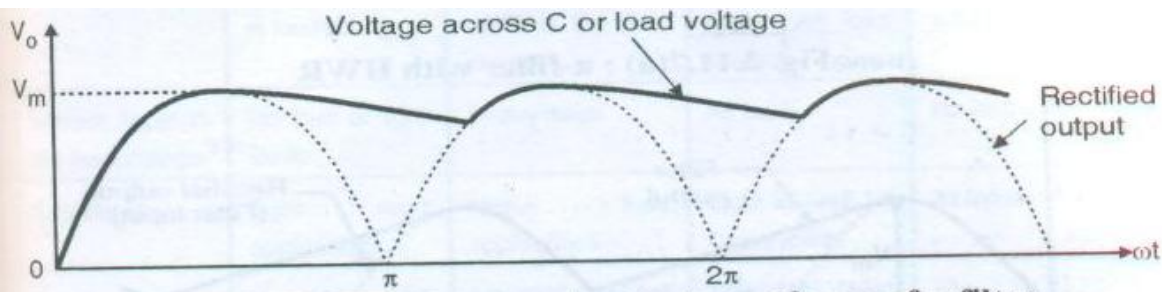
Circuit Diagram **(1 Mark)**



Explanation **(2 Mark)**

- A full wave bridge rectifier drives the π filter as shown above.
- As C1 comes first, looking from the rectifier side, the π filter behaves in a very similar manner as the capacitor filter.
- The rectifier converts the AC input into pulsating DC waveform and since the bridge rectifier is used the efficiency is more.
- Due to use of three filtering components (C1, L, and C2), the ripple factor of the π filter is very low as compared to the other filters.
- The capacitors C1 and C2 provide a low reactance path for the ripple whereas the series inductor L provides a high reactance to the AC ripple.
- The combined effect of this is the reduction in ripple and improvement in the output waveform which is shown below.

Waveform **(1 Mark)**

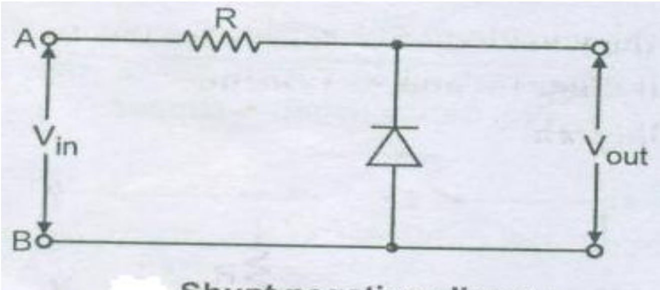


Input and output waveforms of π filter

d) With the help of circuit diagram, input/output waveforms describe the operation of negative shunt clipper.

Ans:

Circuit Diagram **(1 Mark)**



Shunt negative clipper

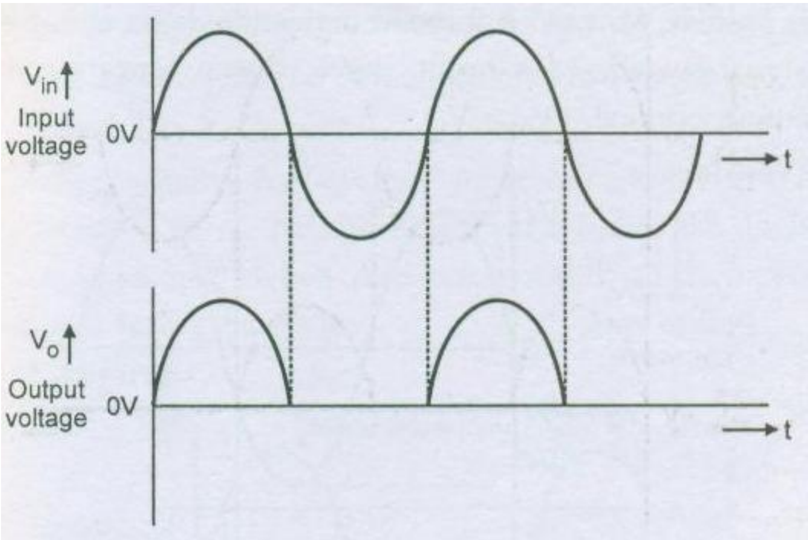
Explanation **(2 Marks)**

In this circuit, diode acts as shunt between source and the load.

During positive half cycle of the input voltage, the terminal A is positive w.r.t B. this reverse biases the diode, it behave as open switch. As a result, all the input voltage appear across the diode ($V_0 = V_{in}$)

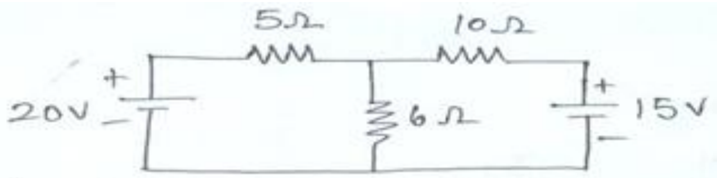
During the negative half cycle of the input voltage, the terminal B is positive w.r.t A. this forward biases the diode and it acts as a closed switch. The voltage drop across the diode is zero ($V_0 = 0V$)

Waveform **(1 Mark)**



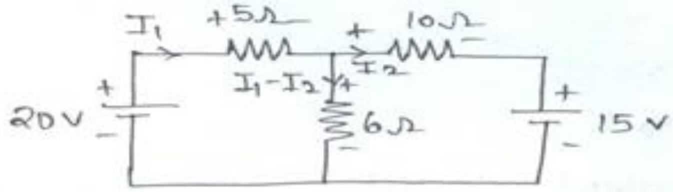
e) Calculate the current flowing through 6Ω resistor using KVL for below figure.

Ans:



To find : Current through 6Ω resistor using KVL

Soln:



Apply KVL to loop 1

$20 - 5I_1 - 6(I_1 - I_2) = 0$

$-5I_1 - 6I_1 + 6I_2 = -20$

$-11I_1 + 6I_2 = -20$

$\therefore 11I_1 - 6I_2 = 20$ ---- (I)

Apply KVL to loop 2

$6(I_1 - I_2) - 10I_2 = 15$

$6I_1 - 6I_2 - 10I_2 = 15$

$6I_1 - 16I_2 = 15$ ---- (II)

(I) × 6 ⇒ $66I_1 - 36I_2 = 120$

(II) × 11 ⇒ $-\ 66I_1 - 176I_2 = 165$

$\quad\quad - \quad\quad + \quad\quad -$

$140I_2 = -45$

$I_2 = -\frac{45}{140} = -\frac{9}{28} = -0.321$

$\therefore$ $\boxed{I_2 = -0.321A}$

2 Marks

Put value of I_2 in eqn. (I) we get,

$11I_1 - 6 \times -0.321 = 20$

$11I_1 + 1.92 = 20$

$\therefore 11I_1 = 20 - 1.92$

$11I_1 = 18.08$

$\therefore I_1 = \frac{18.08}{11}$

$\boxed{I_1 = 1.64}$

1 Mark

Current flowing through 6Ω resistor is $(I_1 - I_2)$.

$\therefore I_1 - I_2 = 1.64 - (-0.32)$

$= 1.64 + 0.32$

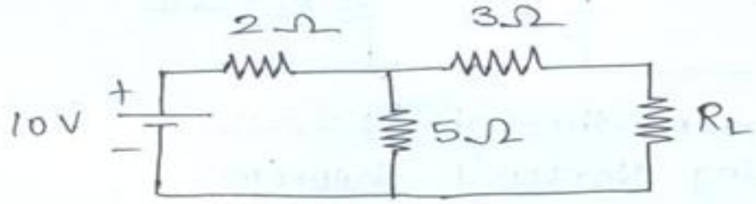
$= 1.96$

$\boxed{\therefore (I_1 - I_2) = 1.96\ A}$

1 Mark

f) Calculate the value of R_L, so that power transferred is maximum in the circuit given below.

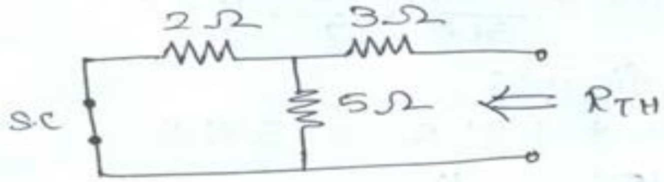
Ans:



To find: R_L (For maximum power transfer)

Soln:

1) To find equivalent resistance R_{TH}. Hence, the R_L should be open and voltage source to be short circuited. Hence, circuit becomes.



$$R_{TH} = (2\Omega \parallel 5\Omega) + 3\Omega$$

$$= \frac{2 \times 5}{2+5} + 3$$

$$= \frac{10}{7} + 3$$

$$= 1.42 + 3$$

$$R_{TH} = 3.42\ \Omega$$

2 Marks

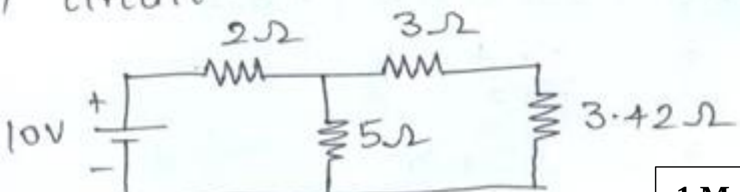
2) For maximum power transfer to take place,

$$R_L = R_{TH}.$$

$$\therefore \quad R_L = 3.42\ \Omega$$

1 Mark

3) Final circuit



1 Mark