



WINTER – 14 EXAMINATION

Model Answer

Subject Code: **17215**

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.

1. Attempt Any Ten of the following:

(20 Marks)

a. State the Faraday's law of electromagnetic induction along with formula.

Ans. (Each Law – 1 Mark)

Faradays first law:

- The first law states that whenever the magnetic lines of force (flux lines) linking with a coil or conductor changes, an emf gets induced in the coil or conductor. Such an emf lasts as long as this change is taking place.

Faraday's second law:

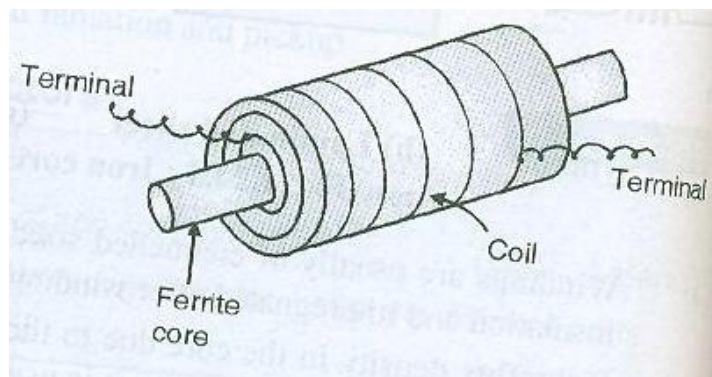
- Whenever a conductor cuts or is cut by the magnetic flux an emf is induced in the conductor the magnitude of which is proportional to the rate at which the conductor cuts or is cut by the magnetic field. In short the second law can be stated as:
- The magnitude of the induced emf is directly proportional to the rate of change of flux linkage where flux linkage = Flux X Number of turns of coil.

Expression for the induced emf:

$$e = N \frac{d\Phi}{dt} \text{ volts}$$

b. Draw a label diagram of ferrite core inductor.

Ans. (Correct diagram – 2 Marks)



Ferrite core inductor

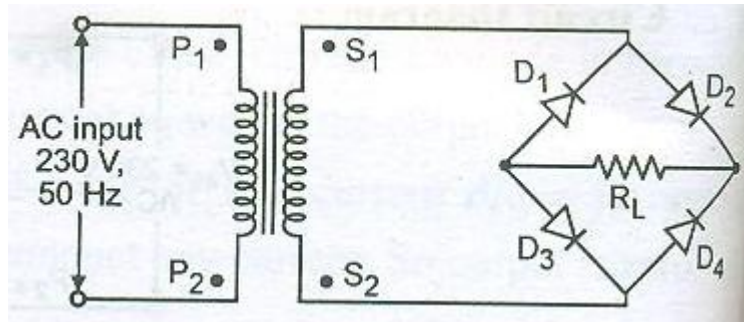
c. State the specifications of capacitor.

Ans. (Any four correct specifications – 2 Marks)

- Working voltage
- Capacitive reactance
- Dissipation factor
- Frequency characteristics
- Equivalent series resistance
- Quality Factor
- Tolerance

d. Draw the circuit diagram of bridge rectifier and label it.

Ans. (Correct diagram with labeling – 2 Marks)



Circuit Diagram Bridge rectifier

e. List the types of filters.

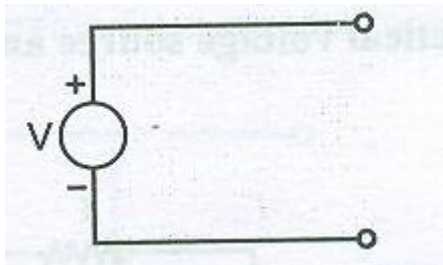
Ans. (4 Correct types of filters – 2 Marks)

The types of filters are:

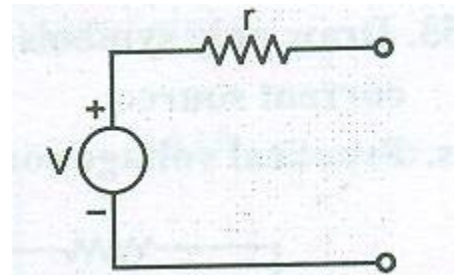
- i. Shunt capacitor filter or C filter.
- ii. Series inductor filter or L filter.
- iii. LC filter or choke filter
- iv. π filter or CLC filter.

f. Draw the ideal and practical voltage source

Ans. (Correct diagrams – 1 Mark each)



Ideal Voltage Source



Practical Voltage Source

g. State the Kirchoff's voltage law.

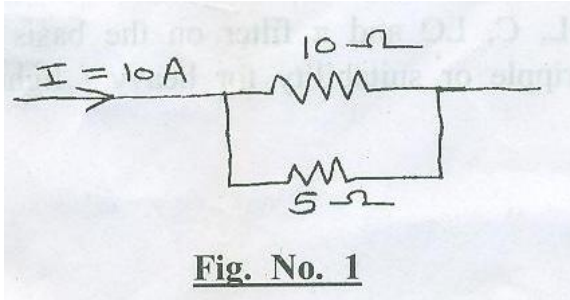
Ans. (Correct statement – 2 Marks)

Kirchoff's voltage law [KVL]:

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

$$\Sigma \text{ voltage} = 0$$

h. Calculate the current through $10\ \Omega$ resistor



Ans. (Correct Answer – 2 Marks)

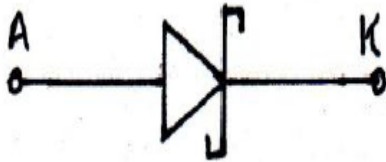
$$I_1 = (5 / 10 + 5) \times 10$$

$$= (5 / 15) \times 10$$

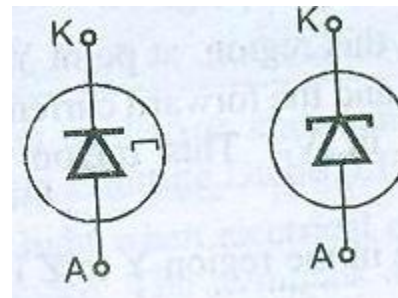
$$I_1 = 3.33 \text{ Ampere}$$

i. Draw the symbol of Schottky diode and tunnel diode.

Ans. (Schottky diode – 1 Mark and Tunnel diode – 1 Mark)



Symbol of a Schottky Diode



Symbols of tunnel diode

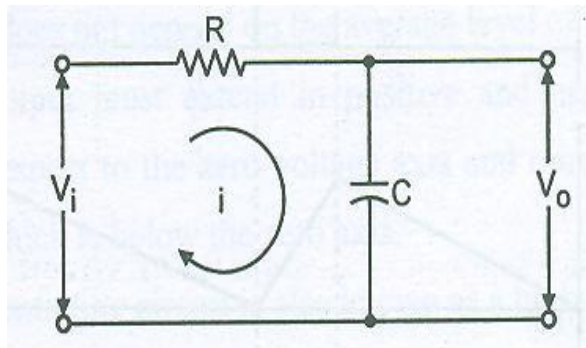
j. State four applications of PIN diode.

Ans. (Four Correct Applications – 2 Marks)

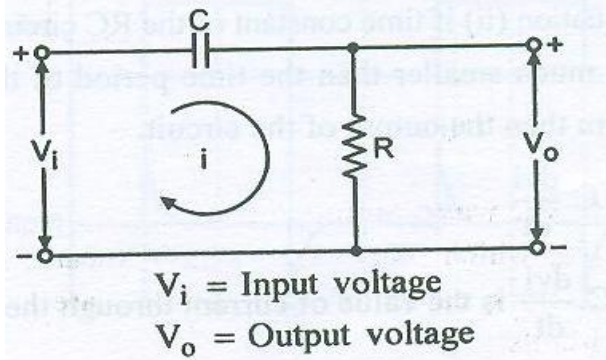
- i. Used in rectifier circuit.
- ii. Used in clipping and clamping circuit.
- iii. Used for A.M detection.
- iv. Used for voltage multiplier.

k. Draw RC integrator and differentiator.

Ans. (Each correct diagram – 1 Mark)



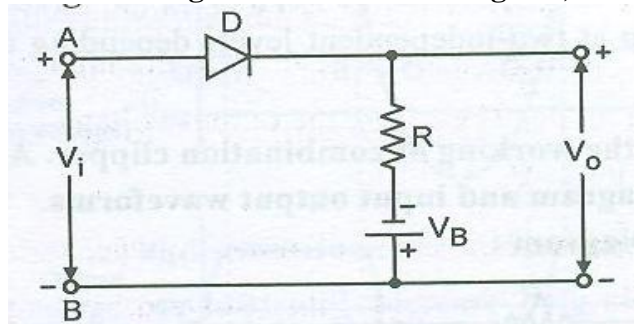
RC Integrator



RC Differentiator.

l. Draw the circuit diagram of clipper.

Ans. (Any other Relevant Correct Diagram – 2 Marks to be given)



Circuit Diagram of Clipper.

2. Attempt any four of the following:

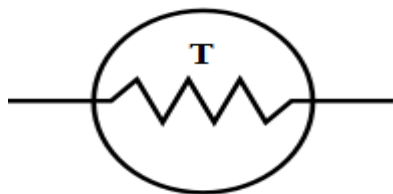
(16 Marks)

a. Explain the working of TDR along with its symbol and characteristics.

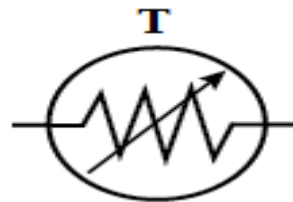
Ans. (Working – 1 Mark, Symbol – 1 Mark & Characteristics – 2 Marks)

- TDR are also called as thermistors.
- Thermally sensitive materials are used to manufacture thermistors.
- Depending on the temperature co- efficient of resistance value thermistors are classified as
NTC Thermistors: Negative temperature co- efficient
PTC Thermistors: Positive temperature co- efficient.

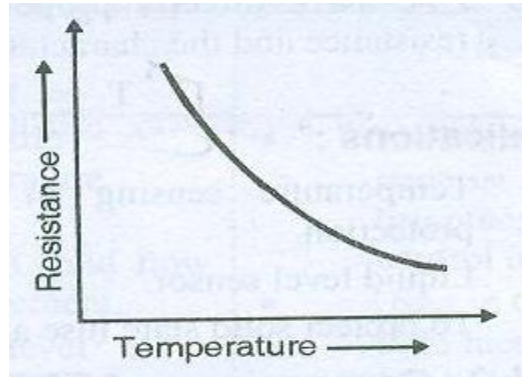
Symbol



(OR)



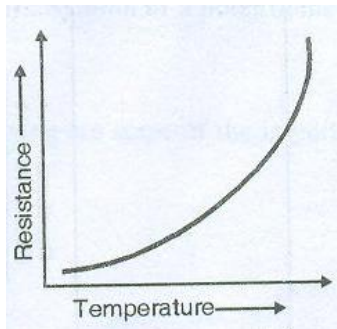
Diagram



NTC Thermistors

- 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.
- $R \propto 1/T$

Diagram



PTC Thermistors

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. List the specifications of linear & nonlinear potentiometers. State its applications (4 points.)

Ans.

Specifications of linear & nonlinear potentiometers: (Any four Correct Points- 2 Marks)

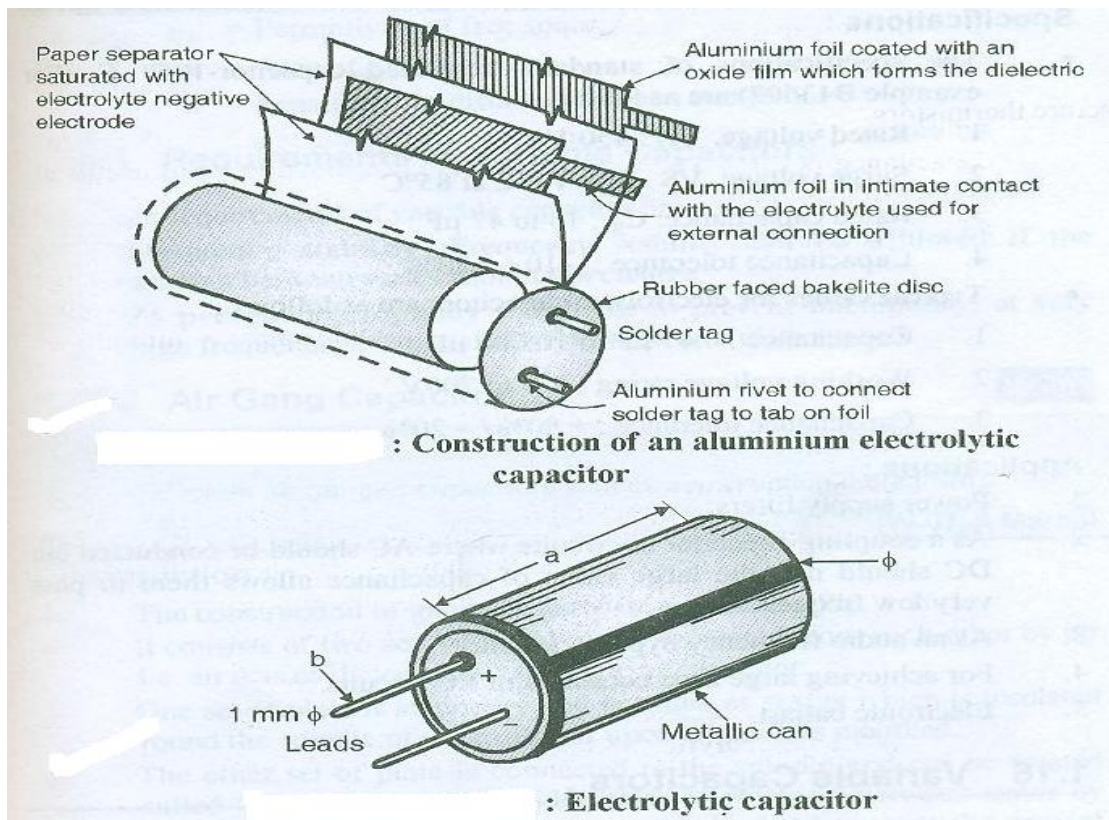
1. Ohmic range: 10Ω to $125\text{ k}\Omega$
2. Power rating : 100watt to 200 watt
3. Tolerance : $\pm 2\%$
4. Voltage Rating: 5V-500V
5. Operating Temperature: 100°C
6. Power wattage: 1W and 3W

Applications of linear & nonlinear potentiometers: (Any four Correct Points- 2 Marks)

1. In DC power supplies to vary the output voltage.
2. In signal generators to vary the amplitude of output voltage.
3. IN radio receiver (as a volume control)
4. In TV receiver as volume control.
5. In amplifier circuits.
6. In the public address amplifier (P.A.) system.
7. Used as potential dividers.
8. It is used for panel control in receivers, function generator etc.

c. Draw the constructional diagram of electrolytic capacitor. Explain the working.

Ans c. **(Diagram – 2 Marks, Explanation – 2 Marks)**

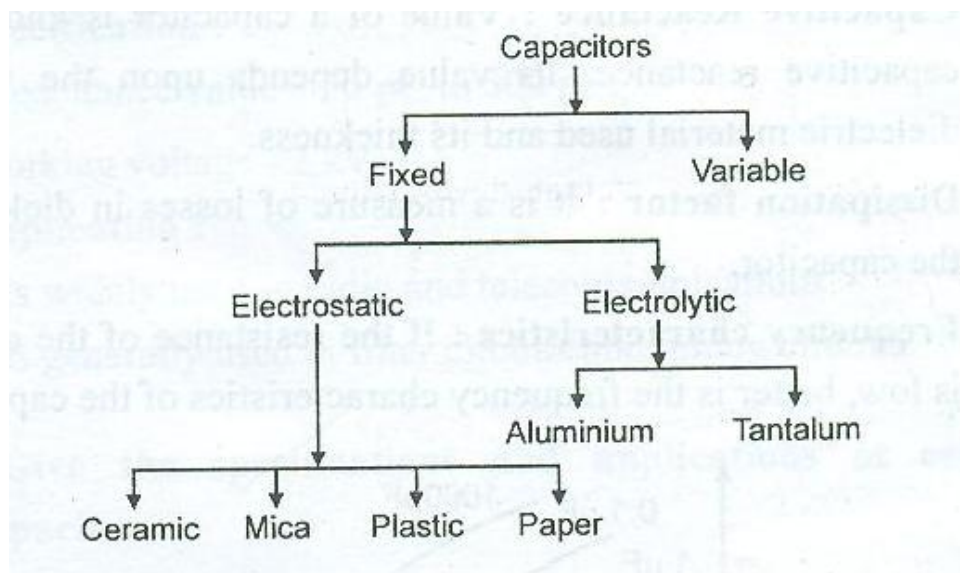


- Electrolytic capacitor is a polarized capacitor. This type of capacitor consists of pasty, semiliquid electrolyte between aluminum foil electrodes or plates.
- An electrolytic capacitor is a type of capacitor typically with a large capacitance per unit volume than other types, making them useful in high current and low frequency electrical circuits.
- Electrolytic capacitors have highest capacitance voltage (CV) product in a given case size as well as the largest capacitance value. The large capacitance values are attainable because of the use of a very thin dielectric film formed by oxidizing a metal usually aluminum tantalum.
- There are two types of electrolytic capacitors:
 1. Aluminum electrolytic capacitor.
 2. Tantalum electrolytic capacitor.
- A plain foil dry electrolytic capacitor is made by forming a coating of aluminium oxide on both sides of an aluminium foil.
- Two stripes 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 as shown in fig.

d. List the classification of capacitor. Which type of dielectric materials used in capacitor?

Ans. (**Classification – 2 Marks, Any 4 Types of Dielectric Material – 2 Marks**)

Classification of capacitor is as follows:

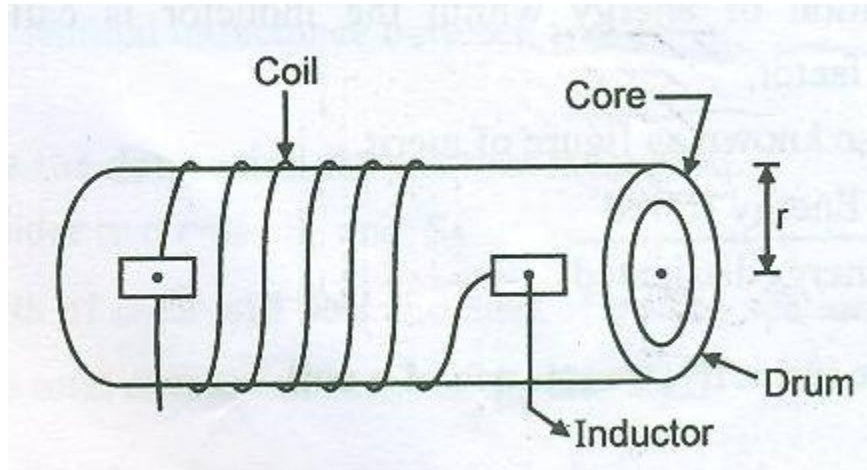


Types of Dielectric Materials used in Capacitor:

1. Mica, Glass, Ceramic
2. High permittivity Ceramic
3. Paper & Metallized Paper
4. Electrolytic: Oxide film, Tantalum
5. Polythene
6. Polystyrene

e. Draw the construction diagram of air core inductor. List two applications

Ans. (Diagram – 2 Marks, Two Correct Applications – 2 Marks)



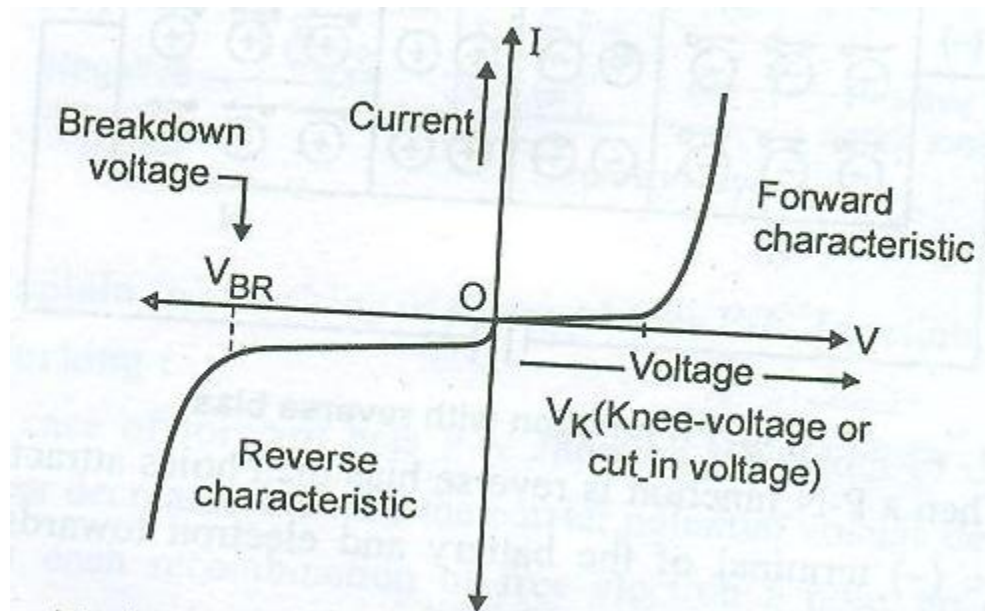
Air core inductor

Applications:

- i. It is used for construction of IF and RF tuning coils.
- ii. It is used for interstage coupling.

f. Draw the V-I characteristics of P-N junction Diode. What is static & dynamic resistance of it?

Ans. (Characteristics – 2 Marks, two Definitions – 1 Mark each)



V-I characteristics of P- N junction Diode

Static resistance

(1 Mark)

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

$$R_F = V_F / I_F$$

Dynamic resistance

(1 Mark)

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

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

= Change in voltage / Resulting change in current.

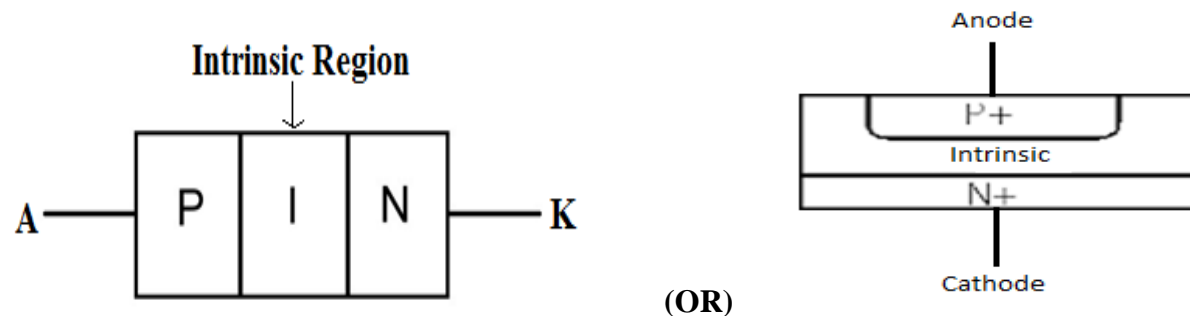
Q.3 Attempt any FOUR of the following

(16 Marks)

a) Explain with neat sketch construction of PIN Diode. Draw its characteristics in reverse bias mode.

Ans. (**Any Construction Diagram – 1 Mark, Explanation – 2 Mark, Characteristics – 1 Mark**)

Construction



A PIN diode is made up of three semiconductor materials; two heavily doped P- and N- type material separated by an intrinsic (undoped) semiconductor (I) as shown in above figure.

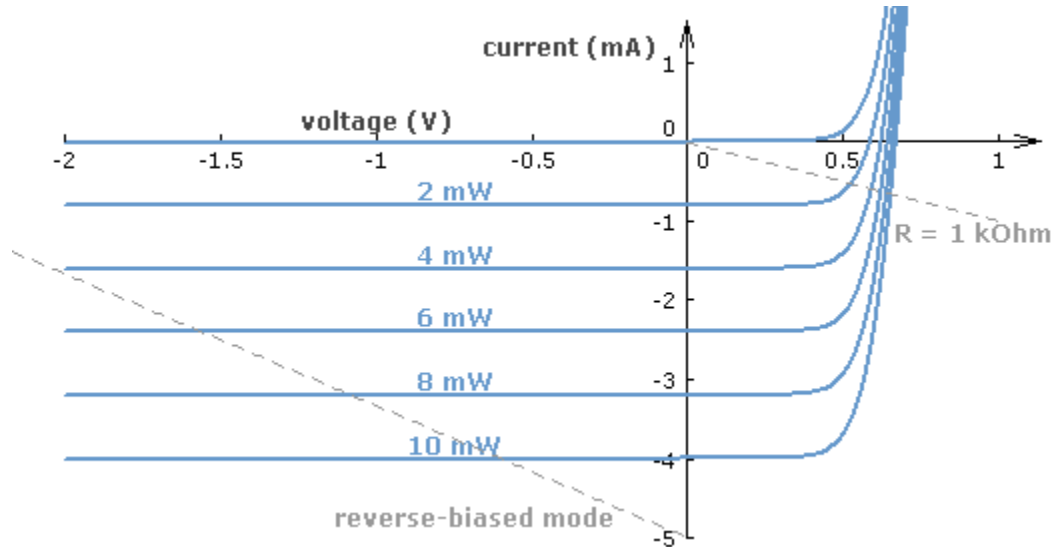
The wide intrinsic region is in contrast to an ordinary PN diode. The wide intrinsic region makes the PIN diode an inferior rectifier (one typical function of a diode), but it makes the PIN diode suitable for attenuators, fast switches, photo detectors, and high voltage power electronics applications.

The Intrinsic region offers a high resistance to the current flowing through it.

The capacitance between the P and N region decreases because of the increased separation between the P and N region. This advantage allows the PIN diode to have fast response time. Hence these diodes are used at very high frequencies (i.e. above 300 MHz).

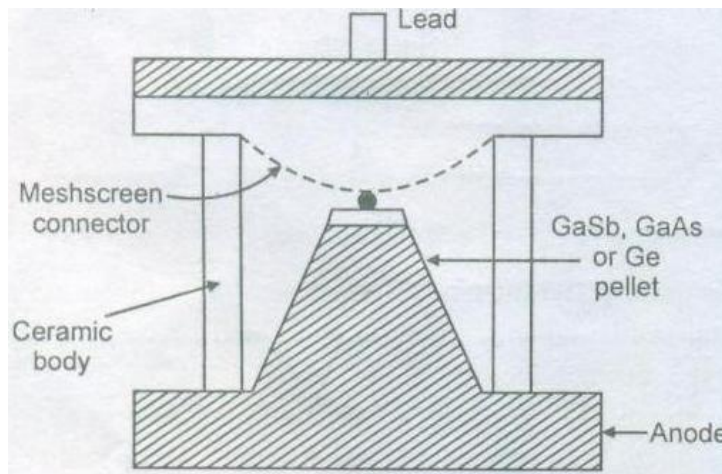
There is a greater electron-hole pair generation because of the increased electric field between the P and N region. This advantage allows the PIN diode to process even weak signals.

Characteristics



b) Describe the working of tunnel diode. Draw its characteristics.

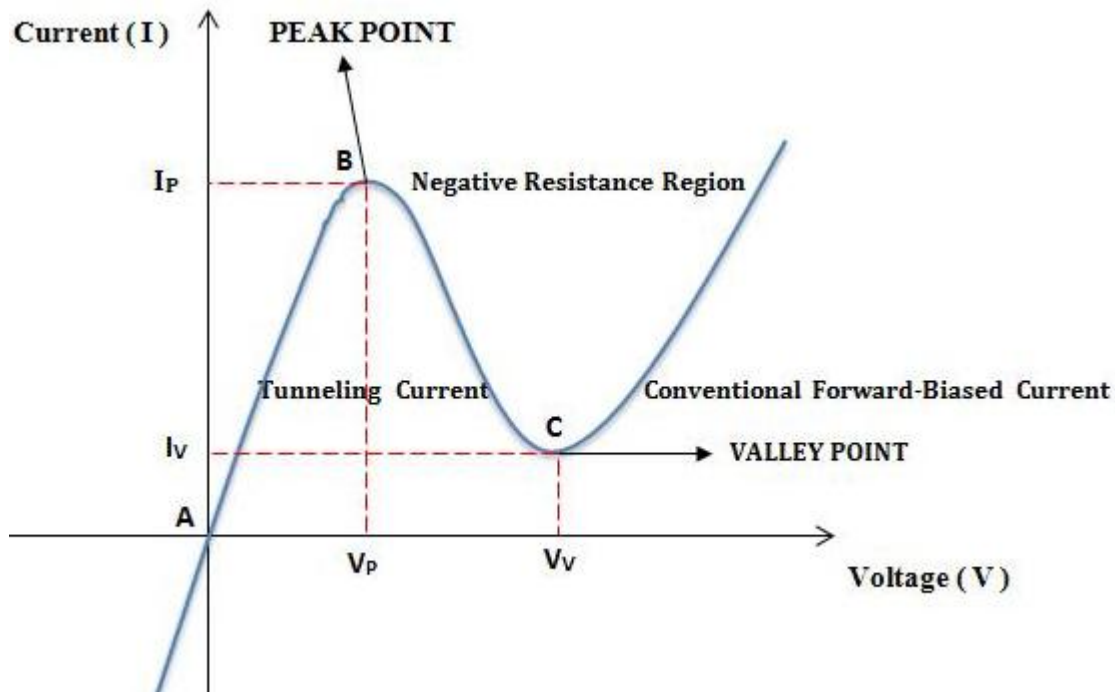
Ans. (Diagram & working – 1 Mark each, Characteristics – 2 Marks)



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.

Characteristics

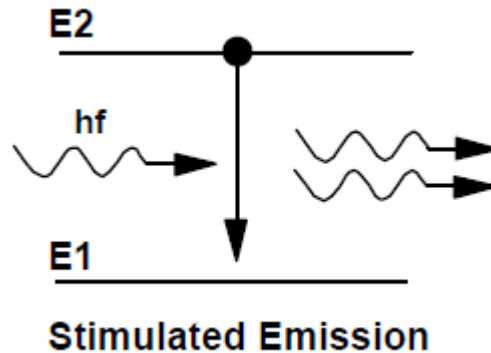


c) Describe the working principle of LASER Diode.

Ans. (**Diagram – 2 Marks, Explanation – 2 Marks**)

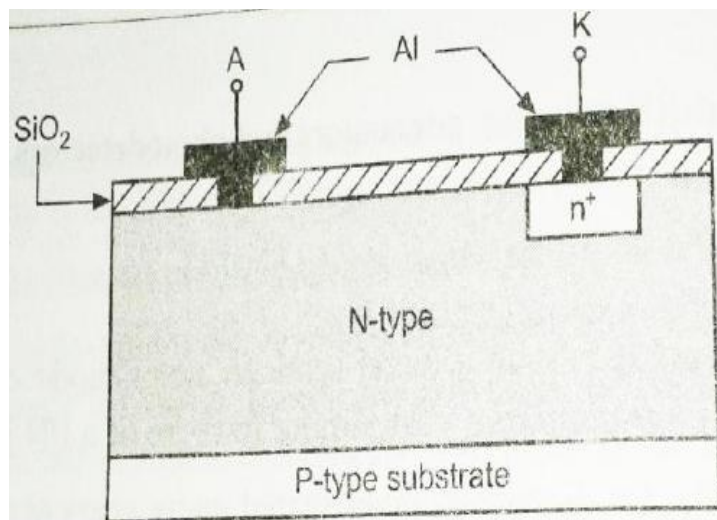
There are three main processes in semiconductors that are associated with light:

- Light absorption:
- Spontaneous emission:
- Stimulated emission:
 - Stimulated emission is different. A light photon entering the semiconductor lattice will strike an electron and release energy in the form of another light photon.
 - The way in which this occurs releases this new photon of identical wavelength and phase. In this way the light that is generated is said to be coherent.
 - This type of process is the basic principle on which LASER Diode operates.
 - Photon, with energy equal to $E_2 - E_1$ interacts with an atom in upper energy state, causing it to return to lower energy state with the emission of a second photon.
 - Second photon has the same phase, frequency and polarization as the first.
 - It is stimulated emission which gives LASER special properties such as narrow spectral width and coherent output radiation.



d) Explain the working of SCHOTTKY Diode.

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



Working

- The metal region of a Schottky diode is heavily occupied with the conduction band electrons and the N-type region is lightly doped.
- There are no minority carriers as in other types of diodes, but there are only majority carriers as electrons. It operates only with majority carriers.
- When it is forward biased, higher energy electrons in the N regions are injected into the metal region where that gives up their excess energy very rapidly.
- Since there are no minority carriers as in conventional diodes, there is no charge storage and hence there is no reverse recovery diode when it is switched from the forward-biased condition (i.e. ON state) to the reverse biased condition (i.e. OFF state).
- It has negligible storage time and hence there is a very rapid response to a change in bias. Because of this property, it acts as a very fast switching diode.

e) Compare L, C, LC and π Filter on the basis of – usefulness in reducing ripple or suitability for heavy or light load.

Ans. (Correct Point – 2 Marks Each)

Sr.No	Parameter	L filter	C filter	LC filter	π filter
1	Usefulness in ripple reduction	Low	High	High	Highest
2	Suitability for light/Heavy load	Heavy Load	Light Load	Both light & Heavy Load	Light Load

f) State the values of following parameters with reference to full wave rectifier

- | | |
|------------------|----------|
| i. Ripple Factor | iii. TUF |
| ii. Efficiency | iv. PIV |

Ans. (Each Correct Point – 1 Mark)

Note: Any one type of full wave rectifier written, marks should be given

		Full Wave Rectifier	
Sr.No	Parameters	Centre Tap Rectifier	Bridge Rectifier
1	Ripple Factor	0.482	0.482
2	Efficiency	81.2%	81.2%
3	TUF	0.693	0.812
4	PIV	$2V_m$	V_m

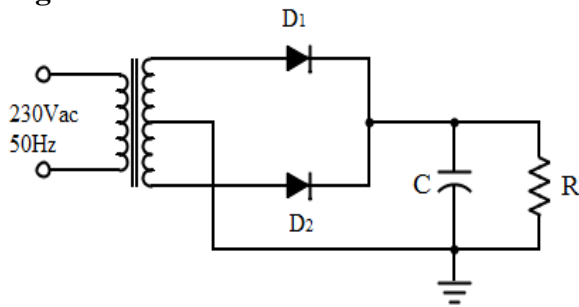
Q.4 Attempt any FOUR of the following

(16 Marks)

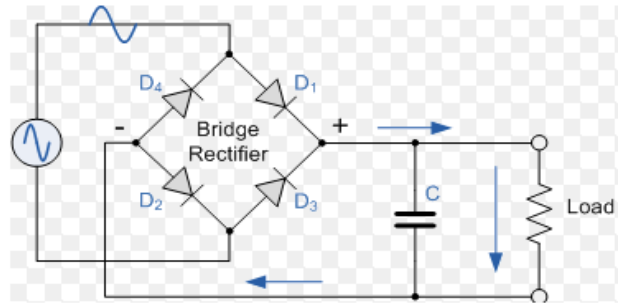
a) Draw the circuit diagram of full wave rectifier with filter. State any four advantages.

Ans. (Circuit diagram – 2 Marks, 4 Correct Advantages – 1/2 Mark each)

Note: Any type of full wave rectifier with any type of filter should be considered and marks to be given



(OR)



Advantages of full wave rectifier

1. The DC output voltage and load current values of full wave rectifier are twice than those of half wave rectifier.
2. The ripple factor is much less (0.482) than that of half wave rectifier (1.21).
3. The efficiency of full wave rectifier is twice (81.2%) than that of half wave rectifier (40.6%).
4. The TUF of full wave rectifier is more than that of half wave rectifier.



b) Using colour codes, write the colour codes for the following resistors-

i. $680 \text{ K}\Omega, \pm 5\%$

ii. $3.3 \Omega, \pm 10\%$

Ans. (Correct Code – 2 Marks Each)

i. $680 \text{ K}\Omega, \pm 5\%$

6	8	x 10^4	$\pm 5\%$
↓	↓	↓	↓
Blue	Grey	Yellow	Gold

ii. $3.3 \Omega, \pm 10\%$

3	3	x 10^{-1}	$\pm 10\%$
↓	↓	↓	↓
Orange	Orange	Gold	Silver

c) State the advantages of L and C filter (four points).

Ans.

Advantages of L filter (½ Mark for each correct point)

1. It has low ripple factor at heavy load currents (i.e. low load resistance)
2. It has no surge current through the diode.
3. It reduces the ripple in the DC output of rectifier circuit.
4. The L filter is more suitable for heavy loads.

Advantages of C filter (½ Mark for each correct any four points)

1. It is easy to design
2. It is small in size and cheap
3. It has low ripple factor for heavy loads.
4. It has high output DC voltage for light loads.
5. It is more suitable for light loads.
6. It has no load voltage equal to maximum transformer voltage.

- d) An AC supply of 230V is applied to HWR through a transformer with turns ratio 10: 1. Find
- i. DC output voltage
 - ii. PIV of diode

Ans.

Given $V_1 = 230$ Volts

$$\frac{N_2}{N_1} = \frac{V_2}{V_1} \quad (1/2 \text{ Mark})$$

- i. We know that the secondary voltage

$$V_2 = \frac{N_2}{N_1} \times V_1 = 230 \times \frac{1}{10} = 23 \text{ volts.} \quad (1 \text{ Mark})$$

Maximum value of secondary voltage


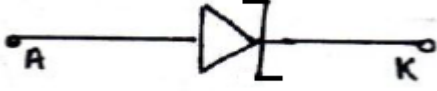
$$V_m = \sqrt{2} \times V_2 = \sqrt{2} \times 23 = 32.5 \text{ volts.} \quad (1 \text{ Mark})$$

Therefore, DC voltage $V_{dc} = \frac{V_m}{\pi} = \frac{32.5}{3.14} = 10.3 \text{ volts} \quad (1 \text{ Mark})$

- ii. PIV of a diode = $V_m = 32.5$ volts. (1/2 Mark)

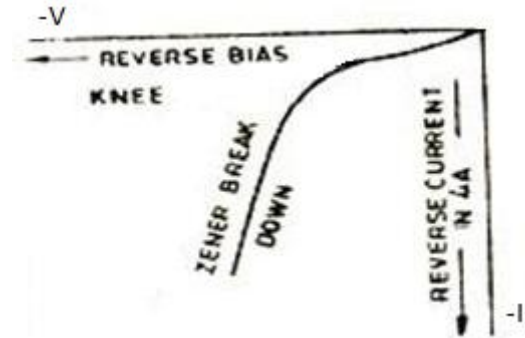
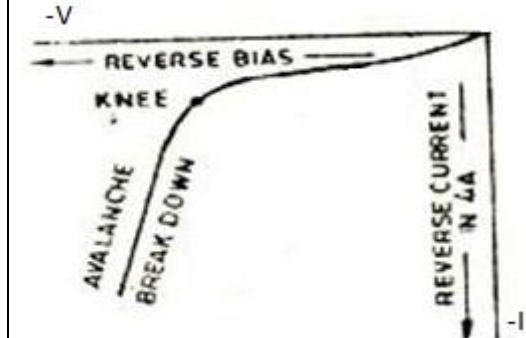
e) Compare PN Junction diode and Zener diode (four points).

Ans. (Any four correct points – 1 Mark each)

Sr. No	PN Junction Diode	Zener Diode
1	It is operated in forward biased condition	It is operated in forward as well as reverse biased condition also.
2	It is not properly doped	Doping in Zener diode is controlled during manufacturing.
3	Applications: Rectifier, Clippers, Clampers	Applications: Voltage Regulators, Voltage Limiters etc.
4	Symbol: 	Symbol: 

f) Compare Zener breakdown and avalanche breakdown (four points).

Ans. (Any four points – 1 Mark Each)

Sr. No	Zener Breakdown	Avalanche Breakdown
1	It is observed in diodes having $V_z = 5 - 8V$.	It is observed in diodes having $V_z > 8V$.
2	Breakdown is very sharp.	It shows gradual change.
3	Occurs due to increased electric field.	Occurs due to accelerating minority carriers.
4	Breakdown voltage decreases with increase in temperature.	Breakdown voltage increases with increase in temperature.
5		

5. Attempt any FOUR of the following:

16 Marks

a. What is linear and non linear wave shaping circuit?

Ans. (Both Correct definitions – 2 Mark Each)

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.

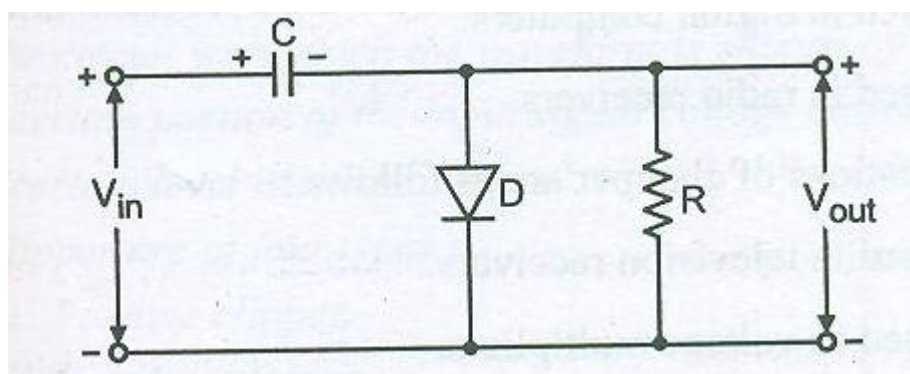
Non Linear wave shaping circuit:

- The circuits which make use of non- linear circuit element such as diodes and transistors are as Non Linear wave shaping circuit.

b. Draw the circuit diagram of negative clamper.

Write one application of negative and positive clamper

Ans b. (Diagram – 2 Marks, Any 2 Correct Application – 1 Mark Each)



Negative clamper

Application of clamper (both positive & negative):

- It is used in television receivers.
- It is used as voltage multipliers.
- In order to provide DC shift to input waveform.

c. Explain the following terms

1. Bilateral Network

2. Linear Network

Ans. (Both Correct explanation – 2 Marks each)

Bilateral Network

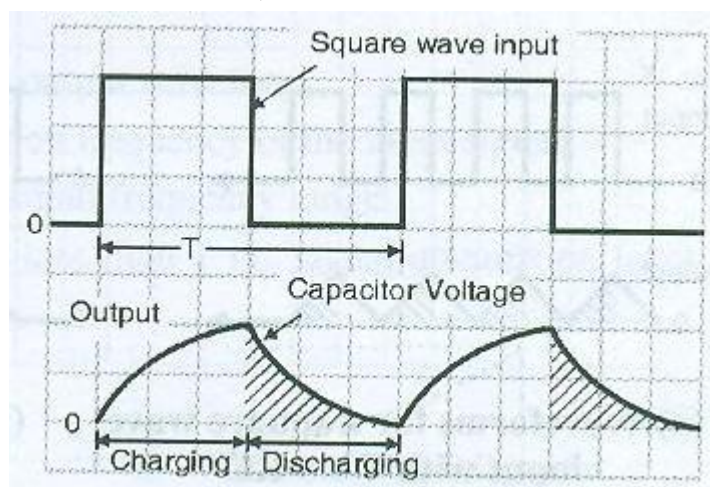
- If the magnitude of current flowing through a circuit element is not affected when the polarity of the applied voltage is changed, then the element is known as a bilateral element.
- The bi lateral elements offer the same impedance in both directions.
- A resistors is a bilateral element.
- A network comprising of one or more number of bilateral elements is known as a bilateral network.

Linear Network:

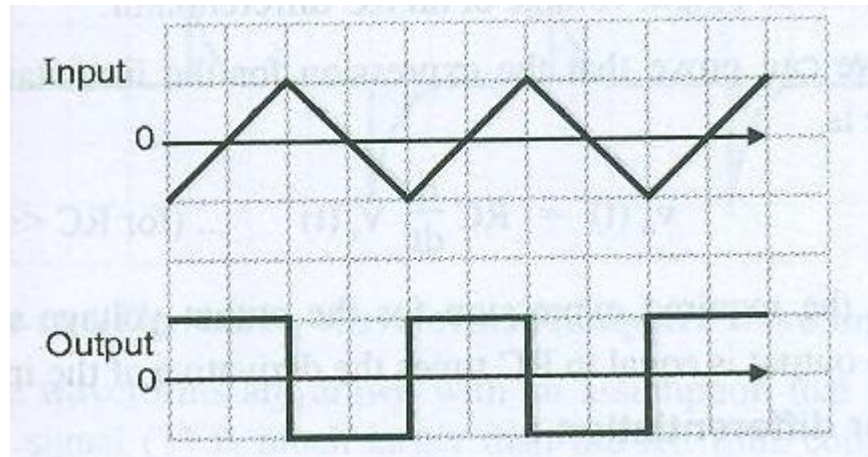
- If the resistance, capacitance or inductance offered by the passive elements does not change with a change in the applied e.m.f or the circuit current the element is called as a linear element.
- The linear element shows a linear relation between voltage and current.
- The network comprising of one or more linear number of elements is known as a linear network.

d. Draw the output waveform of RC integrator for square wave and triangular wave as input signal.

Ans d. (Correct Diagram – 2 Marks each)



Output waveform of RC integrator for square wave



Output waveform of RC integrator for triangular wave

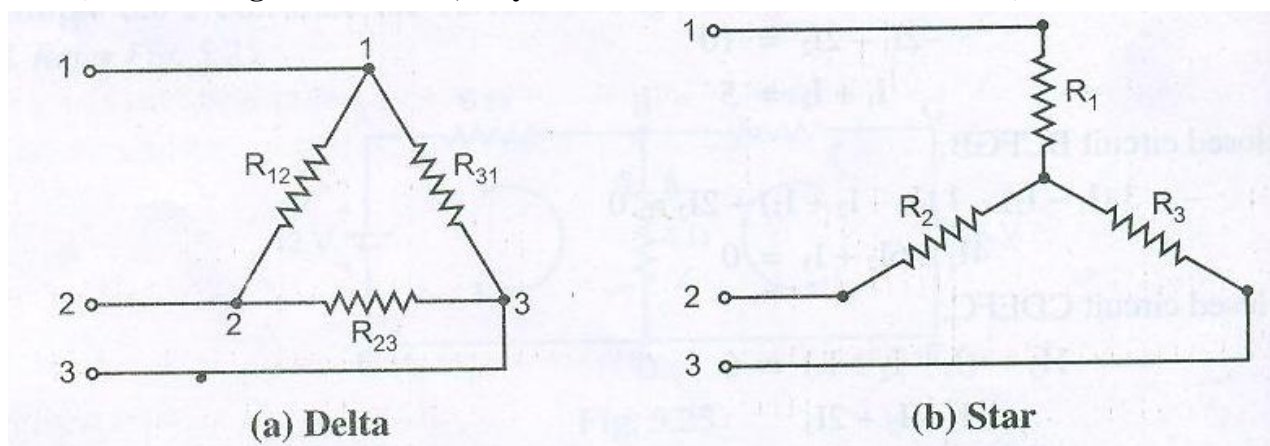
e. State the superposition theorem.

Ans. (Correct Statement – 4 Marks)

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.

f. Draw the star and delta connection. State any one conversion formula.

Ans. (Correct Diagram- 2 Marks, Any one Conversion formula – 2 Marks)



$$R_{12} = R_1 + R_2 + \frac{R_1 R_2}{R_3}$$

$$R_{23} = R_2 + R_3 + \frac{R_2 R_3}{R_1}$$

$$R_{31} = R_3 + R_1 + \frac{R_3 R_1}{R_2}$$

(OR)

$$R_{12} = \frac{R_1 \cdot R_2 + R_2 \cdot R_3 + R_3 \cdot R_1}{R_3}$$

$$R_{23} = \frac{R_1 \cdot R_2 + R_2 \cdot R_3 + R_3 \cdot R_1}{R_1}$$

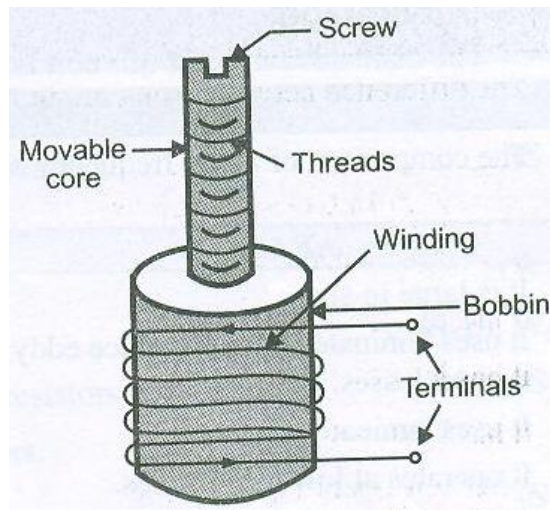
$$R_{31} = \frac{R_1 \cdot R_2 + R_2 \cdot R_3 + R_3 \cdot R_1}{R_2}$$

Delta to star conversion

Star to Delta conversion

g. Explain the working principle of slug tuned inductor.

Ans. (Correct Diagram- 2 Marks, Explanation – 2 Marks)



Slug tuned inductor

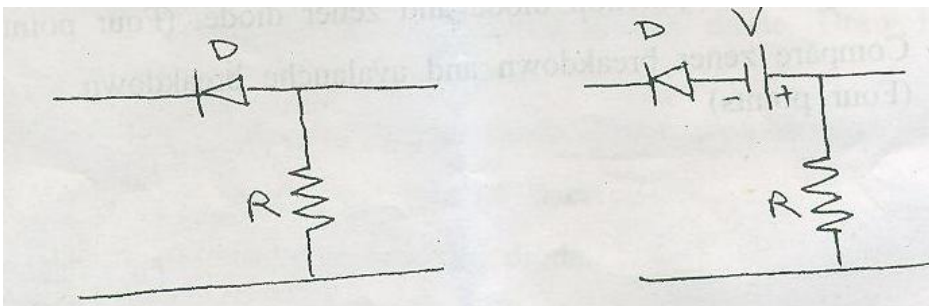
- The value of inductor increases, when the slug (moving coil) is moved into the coil winding and hence decreases the resonant frequency of the tuned circuit. Similarly, when the slug is moved out of the coil winding, the inductance decreases and hence the resonant frequency of the tuned circuit increases.
- The value of inductance can be varied by using movable core which can be moved up or down by using screw driver.

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

a. Draw the output waveform, when a sine wave is applied to following circuits

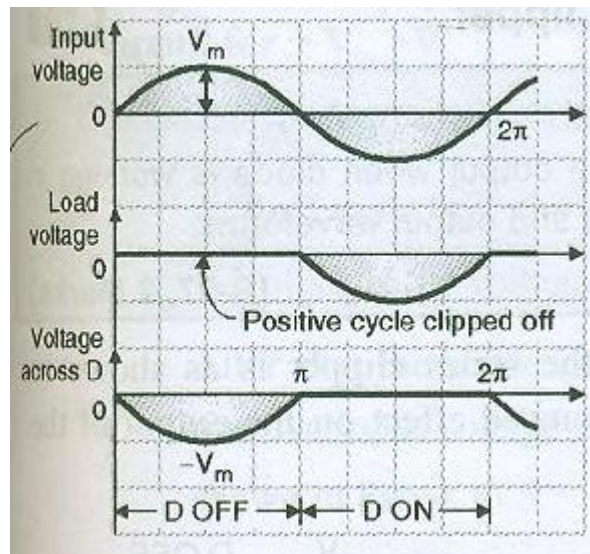
i)

ii)

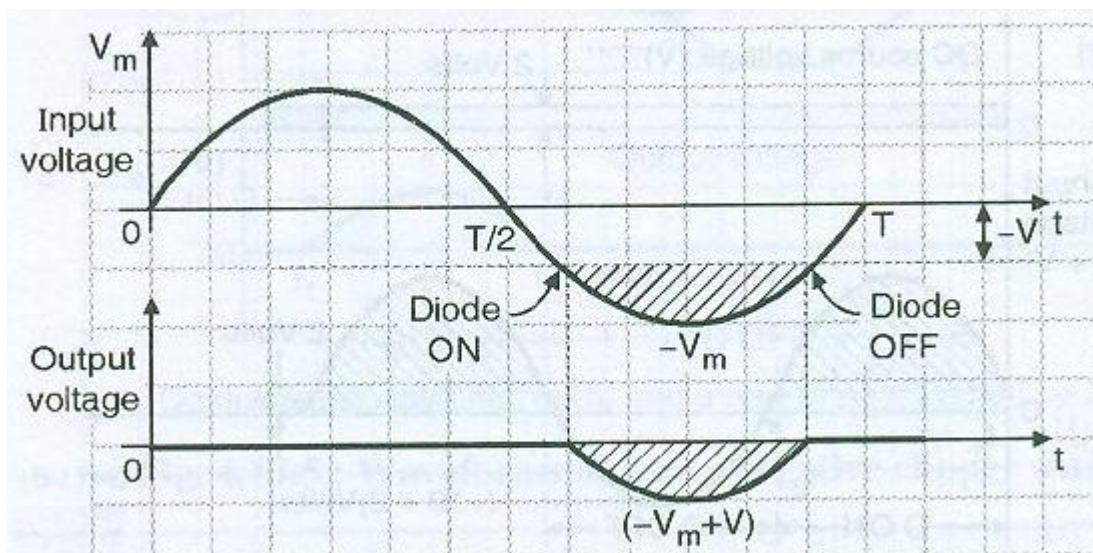


Ans. (Correct Waveform – 2 Marks each)

i)



ii)



b. Compare clipper and clamper.

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

c. Define following terms:

i) Active networks.

ii) Unilateral networks

Ans. (Correct Definitions – 2 Marks each)

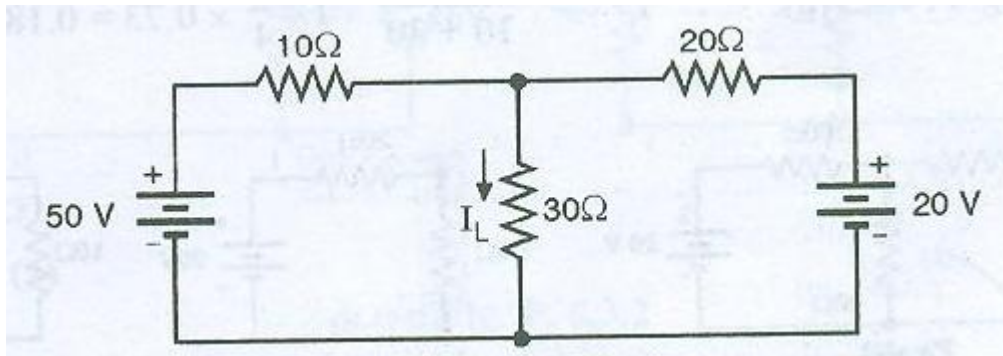
i) **Active networks:**

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.

ii) **Unilateral networks:**

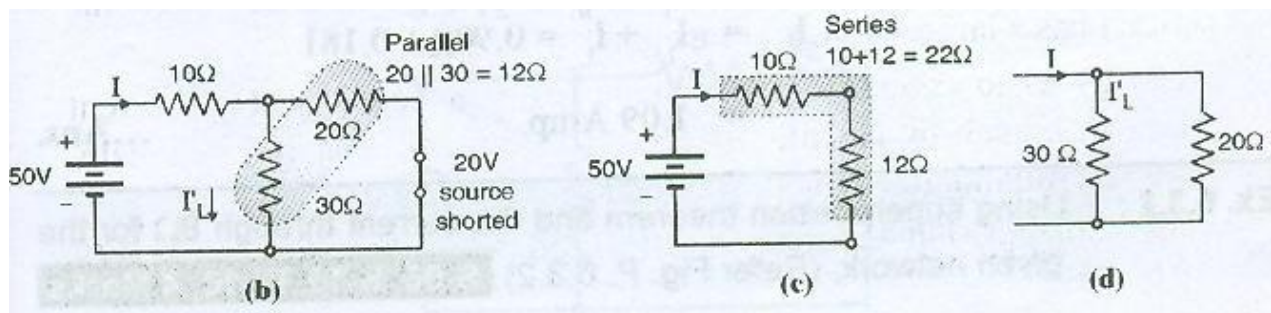
If the characteristics, response or behavior of a network is dependent on the direction of current through its elements in it, then the network is called as a unilateral network.

d. Calculate I_L for the network shown in fig



Ans. (I'_L & I''_L - 2 Marks each)

Step 1: Current through 30Ω resistor due to only 50V source (I'_L)



$$R_T = 10 + 12 = 22 \Omega$$

$$\therefore \text{Total current } I = \frac{50 \text{ V}}{R_T} = \frac{50}{22} = 2.27 \text{ Amp.}$$

$$I'_L = \frac{20}{20 + 30} \times I$$

Current division between parallel resistors

$$I'_L = (20/50) \times 2.27 = 0.909 \text{ A} \dots\dots\dots(1)$$

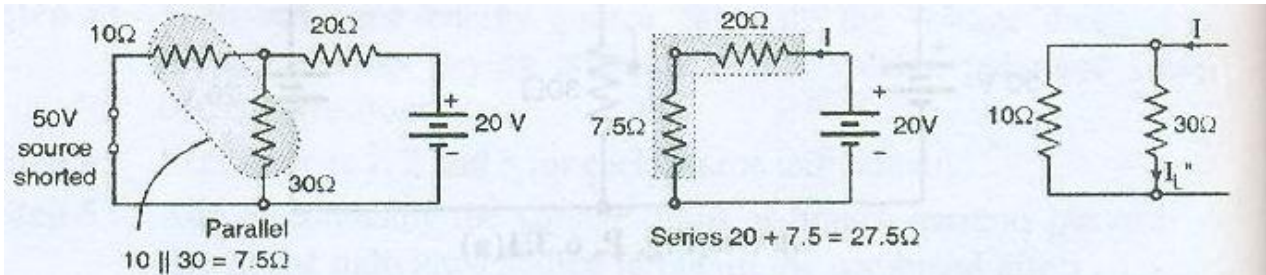
Step 2: Current through 30Ω resistor due to only 20V source (I''_L):

Now assume the 50V source to be shorted and obtain the effect of 20 V source only.

$$R_T = 27.5 \Omega$$

$$\therefore I = 20 \text{ V} / 27.5 \Omega = 0.73 \text{ Amp.}$$

$$I''_L = \frac{10}{10 + 30} \times I = \frac{1}{4} \times 0.73 = 0.181 \text{ A} \dots\dots\dots(2)$$



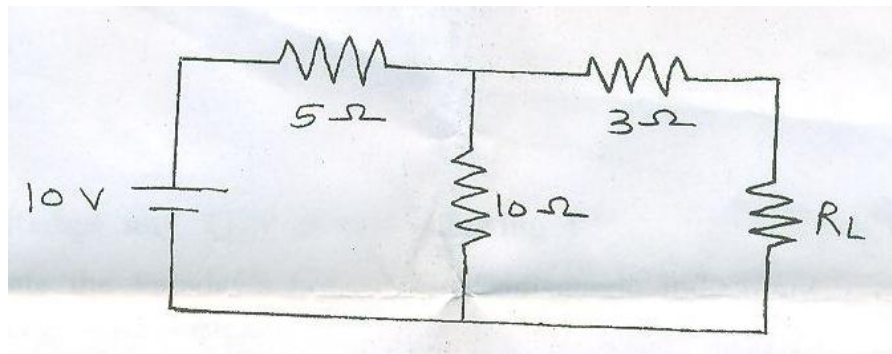
Step 3: Calculate the total current through 30Ω resistor (I_L):

As per the superposition theorem, the total current through the 30Ω resistance is equal to the algebraic sum of the currents due to individual sources (I'_L and I''_L)

Therefore,

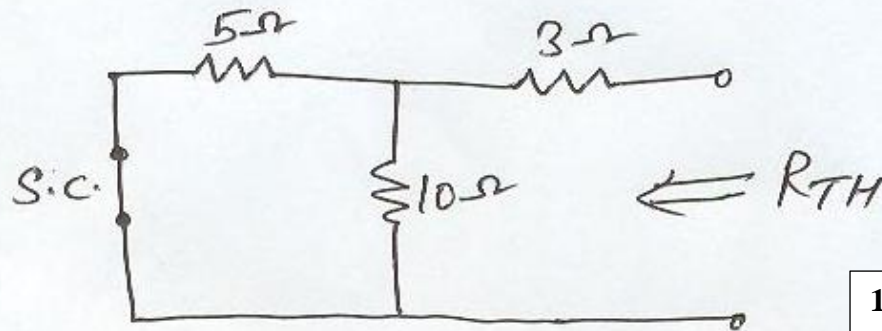
$$I_L = I'_L + I''_L = 0.909 + 0.181 = 1.09 \text{ Amp} \dots\dots\dots\text{Ans}$$

e. Find the value of load resistance R_L to get maximum power transferred to it. Refer below figure



Ans e.

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



1 Mark

$$\begin{aligned} R_{TH} &= (5 \parallel 10) + 3 \\ &= \frac{5 \times 10}{5 + 10} + 3 \\ &= \frac{50}{15} + 3 \end{aligned}$$

$$R_{TH} = 6.33 \Omega$$

1 Mark

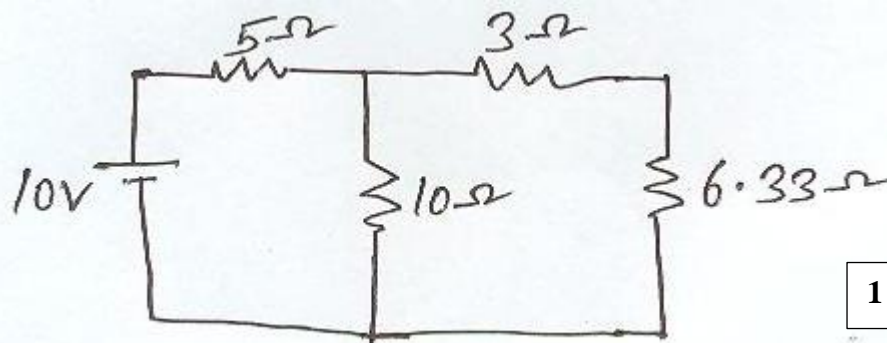
2. For maximum power transfer to take place,

$$R_L = R_{TH}$$

$$\therefore R_L = 6.33 \Omega$$

1 Mark

3. Final circuit



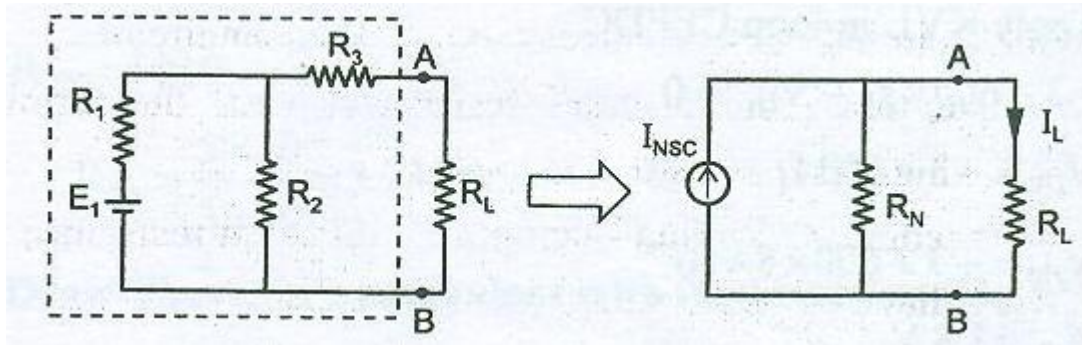
1 Mark

f. State Norton's theorem with suitable example.

Ans. (Statement – 2 Marks, Example – 2 Marks)

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.”



Explanation

1. Remove R_L
2. Short Terminals A&B.
3. Calculate flowing through A &B when short circuited.
This current is I_{NSC}
4. To calculate R_N replace all energy sources by their internal resistance if any and if not then voltage source is replaced by short circuit whereas current source is replaces by open circuit w.r.t terminal A&B.
5. Draw the Norton's Equivalent.

