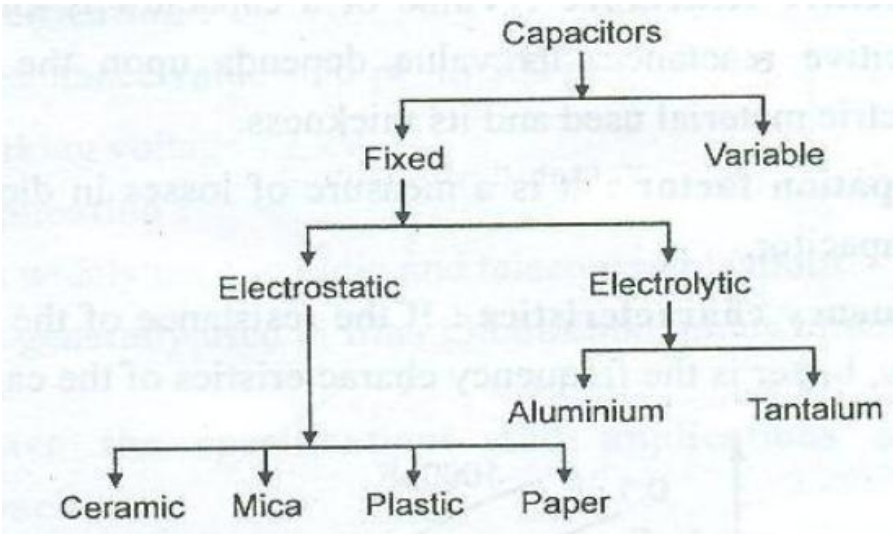
WINTER– 18 EXAMINATION

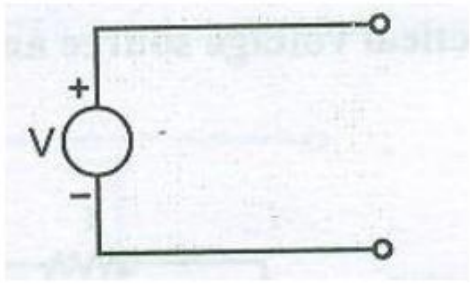
Subject Name: Elements of Electronics **Model Answer** 17215

Important Instructions to examiners:

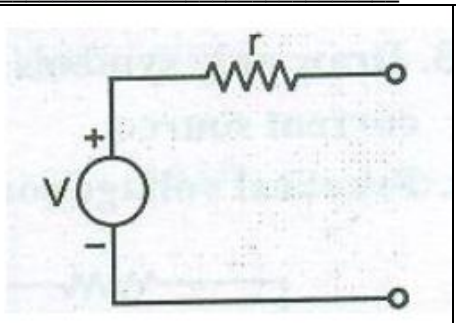
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling 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.

Question No,Sub Q.No	Answer	Marking Scheme
1	**Attempt any TEN**	: 20
a)	Give the detail classification of capacitor. Ans:  	(Classification-2M)
b)	Write two applications of i) LED ii) photodiode. Ans :- LED: (Any Two) 1. In the opto- couplers. 2. In the infrared remote controls. 3. As indicators in various electronic circuits. 4. In seven segment and alphanumeric displays. 5. In optical switching applications. 6. For image sensing circuits in picture phone. 7. In burglar alarm system. Photodiode: (Any Two) 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.	(1M Each)

c)	State maximum power transfer theorem. Ans: The maximum power transfer theorem states that the maximum amount of power will be delivered to the load resistance when the load resistance is equal to the Thevenin / Norton resistance of the network supplying the power. If the load resistance is lower or higher than the Thevenin/ Norton resistance of the source network, then the power delivered to load is less than maximum. That means the condition for maximum power transfer according to maximum power transfer theorem is, $R_L = R_{TH}$	(Statement-2m)
d)	Define active and passive network. Ans: **Active network :**If a network consists of an energy source, then it is called as an active network. The type of energy source can be voltage source or a current source. **Passive network :** If a network does not contain any energy source then it is called as the passive network.	(1M Each)
e)	List four specifications of resistor. Ans: **Specifications of resistor:** • Temperature Coefficient. • Size or value of a resistor • Power Dissipation / wattage • Tolerance • Thermal Stability • Frequency Response. • Power De-rating. • Maximum Temperature. • Maximum Voltage.	(Any Four specifications-2M)
f)	Draw ideal and practical voltage source and current source. Ans: **Voltage Source:**	(1/2 M Each)

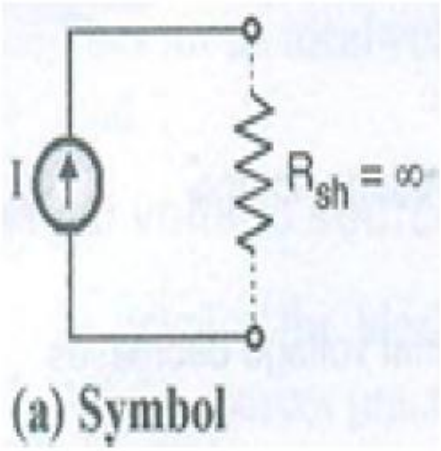


Ideal Voltage Source

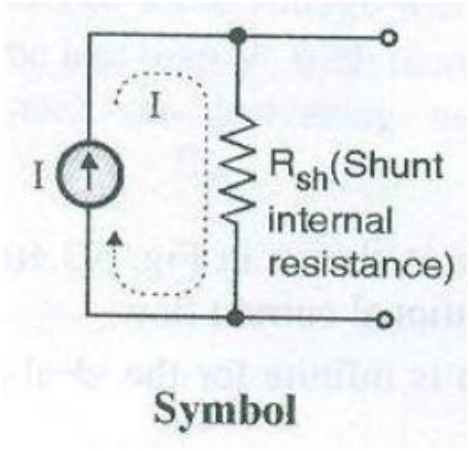


Practical Voltage Source

Current Source:

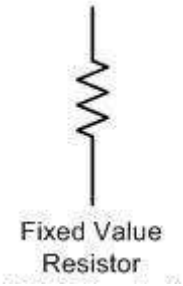


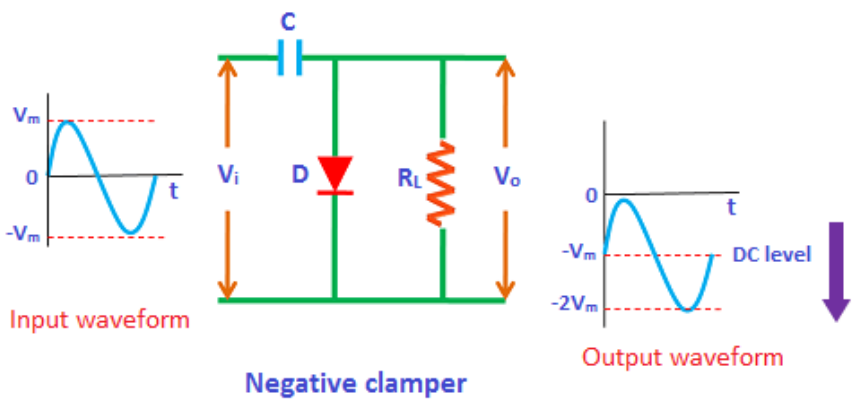
Ideal current source



Practical current source

g	List two applications of i) clipper ii) clamper. Ans: **Clipper: (Any Two)** 1. Diode clamp 2. wave shaping circuits 3. Clippers can be used as voltage limiters and amplitude selectors. **Clamper: (Any Two)** 1. Voltage Multipliers 2. For the protection of the amplifiers from large errant signals clampers are used. 3. Clampers can be used for removing the distortions	(1M Each)

	4. For improving the overdrive recovery time clampers are used.	
h	Draw the symbol of i) Iron core inductor ii) variable capacitor iii) resistor iv) Ferrite core inductor Ans **Iron core inductor:**  **Variable capacitor:**  **(ii) variable capacitor** **Resistor:**  **Ferrite core inductor:** 	:(1/2M Each)
i	State the need of filters. Ans: The output of a rectifier is pulsating D.C. [i.e. it contain A.C along with D.C components]. The A.C. components are undesirable and must be removed from the pulsating D.C to obtain pure D.C. signal. To remove the ripples, filter circuit is used.	(Need-2m)
j	Define ferromagnetic and ferrimagnetic materials. Ans: **Ferromagnetic materials:** The materials which possess magnetism in the absence of applied	(1M Each)

	magnetic field is known as ferromagnetic materials. **Ferrimagnetic materials:**Ferrimagnetic materials are like ferromagnets in that they hold a spontaneous magnetization below the Curie temperature and show no magnetic order (are paramagnetic) above this temperature.	
k	State kirchoff 's current and voltage law (KCL & KVL) Ans**Kirchoff's Current law (KCL):** The algebraic sum of all currents entering or leaving a node must be equal to zero .Therefore, $\Sigma I = 0$ **Kirchoff's Voltage law (KVL):** It states that "Algebraic sum of voltages in a loop or mesh is equal to zero" . That is , Σ voltage= 0	: (1M Each)
l	Define self and mutual induced emf. Ans: **Self-induced emf: Self-induced emf** is the e.m.f induced in the coil due to the change of flux produced by linking it with its own turns. **Mutual induced emf:** The emf induced in a coil due to the change of flux produced by another neighbouring coil linking to it, is called **Mutually Induced emf.**	(1M Each)
2	**Attempt any FOUR :**	**16**
a	Draw negative clamper circuit and explain its working. Ans **Diagram:**  **Working:**	: (Diagram-2M, Working-2M)

During the positive half cycle of the input AC signal, the diode is forward biased and hence no signal appears at the output. In forward biased condition, the diode allows electric current through it. This current will flows to the capacitor and charges it to the peak value of input voltage in inverse polarity $-V_m$. As input current or voltage decreases after attaining its maximum value V_m, the capacitor holds the charge until the diode remains forward biased.

During the negative half cycle of the input AC signal, the diode is reverse biased and hence the signal appears at the output. In reverse biased condition, the diode does not allow electric current through it. So the input current directly flows towards the output.

When the negative half cycle begins, the diode is in the non-conducting state and the charge stored in the capacitor is discharged (released). Therefore, the voltage appeared at the output is equal to the sum of the voltage stored in the capacitor ($-V_m$) and the input voltage ($-V_m$) {I.e. $V_o = -V_m - V_m = -2V_m$} which have the same polarity with each other. As a result, the signal shifted downwards.

b Draw Thevenin's equivalent circuit for the circuit shown in fig.2(b)

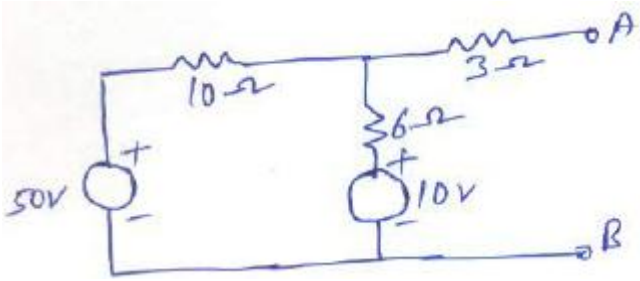
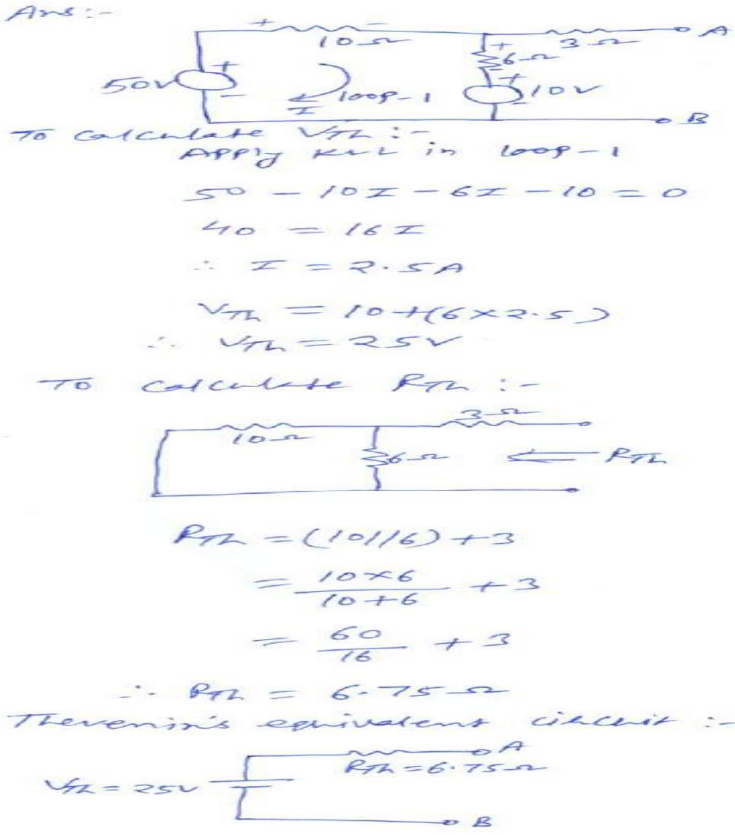
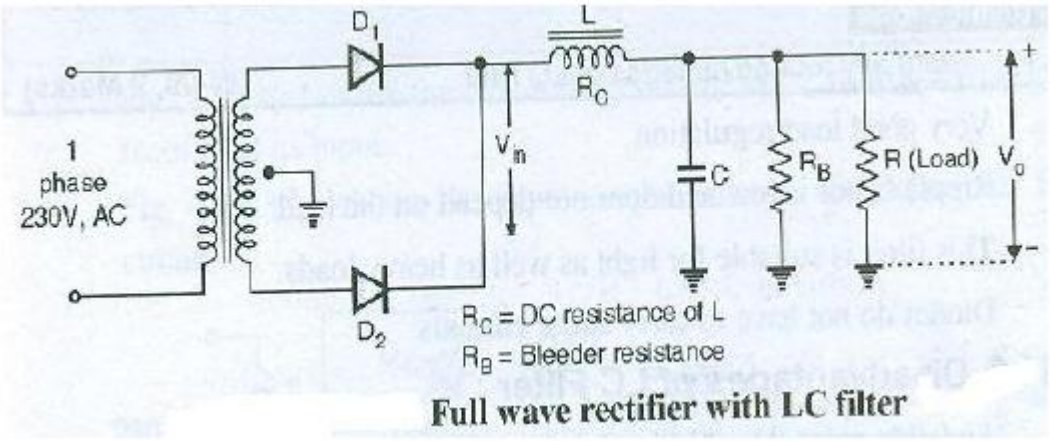
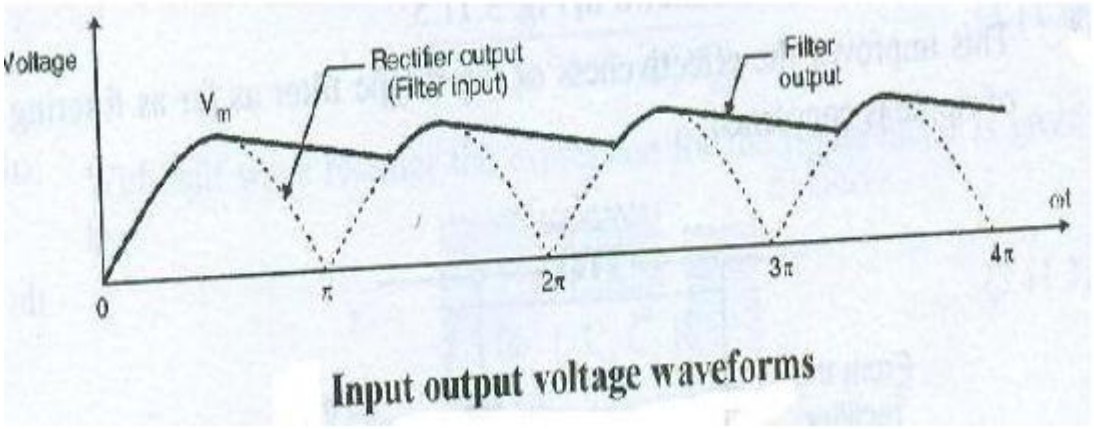


Fig.2(b)

:(Calculate VTh-2M, Calculate RTh-1M, Equivalent Circuit-1M)

Ans

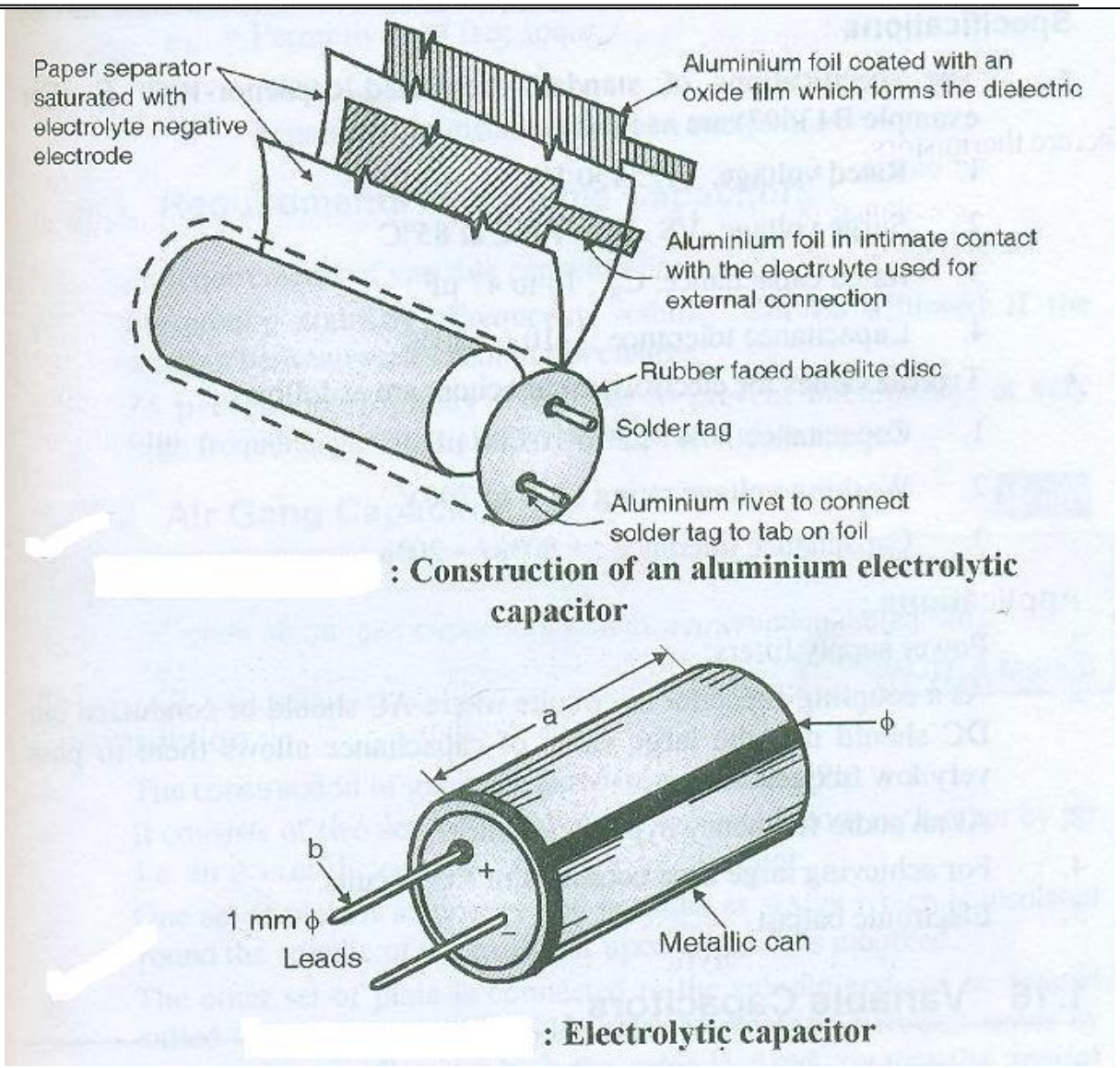


c	Draw and describe circuit diagram of centre tapped rectifier with LC filter along with its input and output waveforms. Ans:  **Full wave rectifier with LC filter**  **Input output voltage waveforms** **Explanation:** A centre- tap full wave rectifier drive produces the rectified voltage and it drives the LC filter. We know that the series inductor filter is preferred for low values of load resistance (i.e. heavy loads) and the shunt capacitor filter is preferred for high values of load resistance (i.e. light loads) Therefore, the LC filter can give low ripple factor irrespective of the load current as it is combination of these two filters. The series connected inductor offers a high reactance to the harmonic components (ripple) in the output and attenuate them. The parallel capacitor C now provides a low reactance by- pass for the ripple and these ripples are grounded. Thus, this reduces the ripple further because they are not allowed to pass through the load RL. The output voltage waveforms are similar to that as shown in figure above.	(Circuit diagram-2M, Explanation-1M, Waveforms-1M)

d	Find resistance value for the given colour codes : i) Red Brown Black Gold ii) Blue Yellow Grey iii) Blue Violet Red Silver iv) Red Red Orange Gold Ans: Red Brown Black Gold $R=21*10^0$, ±5% =21Ω, ±5% i) Blue Yellow Grey $R=64*10^8$, ±20% = 6.4GΩ, ±20% ii) Blue Violet Red Silver $R=67*10^2$, ±10% = 6.7KΩ, ±10% iii) Red Red Orange Gold $R=22*10^3$, ±5% =22KΩ, ±5%	(1M Each)
e	Compare half and full wave bridge rectifier on the basis of : i) DC output voltage ii) Ripple factor iii) Efficiency iv) rms value of voltage Ans:	(1M Each)

Rectifier Parameters	Half-wave Rectifier	Full wave Bridge Rectifier
DC output voltage	Vm/π	$2Vm/\pi$
Ripple factor	1.21	0.482
Efficiency	40.6%	81.2%
rms value of voltage	Vm/2	$Vm/\sqrt{2}$

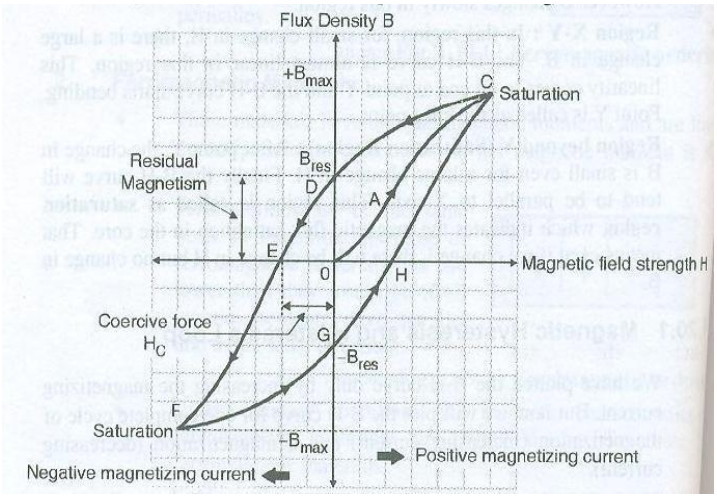
f	Draw and describe constructional diagram of electrolytic capacitor. Ans:	(Diagram-2M, Explanation-2M)

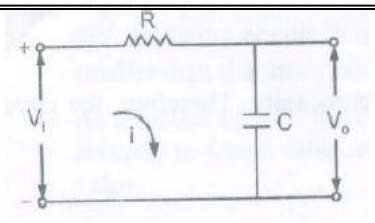


: Construction of an aluminium electrolytic capacitor

: Electrolytic capacitor

- 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 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.

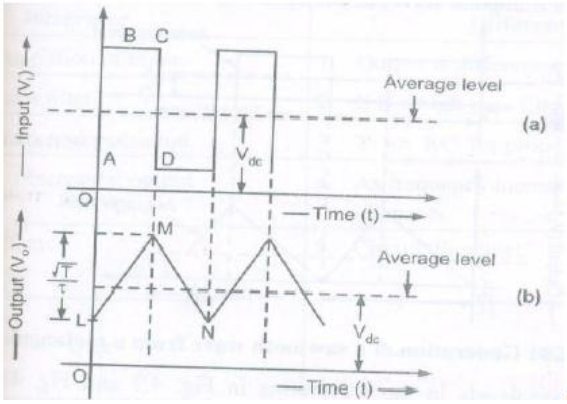
3	**Attempt any four of the following**	
a)	**Draw BH Curve and define coercivity and reluctivity.** **Ans:** **BH Curve:**  **Definitions:** **Coercivity:** For ferromagnetic material the coercivity is the intensity of the applied magnetic field required to reduce the magnetization of that material to zero after the magnetization of the sample has been driven to saturation. Thus **coercivity** measures the resistance of a ferromagnetic material to becoming demagnetized. **Reluctivity:** It is equal to the ratio of intensity of the magnetic field to the magnetic induction of the material.	2M for Diagram & 1M each for correct definitions
b)	**Draw and describe working of RC integrator with output waveform for square wave input.** **Ans:**	2M for RC integrator circuit diagram.1M for working & 1M for output waveform



(2 Marks)

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

(1 Marks)



(1 Marks)

Mathematical Analysis:-

V_i : ac input voltage.
i : Resulting alternating current.
q : Charge on the capacitor at any instant.

Since R is very large as compared to X_C , therefore voltage across R i.e. V_R is equal to the input voltage

i.e. $V_i = V_R$

$$i = \frac{V_R}{R} = \frac{V_i}{R}$$

The charge q on the capacitor at any instant.

$$q = \int i.dt$$

output voltage $V_O = \frac{q}{c}$

$$= \frac{\int i.dt}{c}$$

$$R \frac{\int i.dt}{V} =$$

$$= \frac{1}{RC \int V_i.dt}$$

$$Vo \propto \int V_i.dt$$

Hence, output voltage directly proportional to integration of input voltage.

c) **Compare C,L,LC & π filter (any 4 points)** — 1M each for correct

Ans:

Parameter	C filter	L filter	LC filter	π filter
1.Components used	Only capacitor C	Only capacitor L	One C & One L	Two C & one L
2.Place of filter	Across the load	In series with load	Across the load	Across the load
3.Output DC voltage	Highest	Lowest	High	Higher
4.Ripple content	Low	High	Low	Lowest
5.Ripple factor	Low	High	Lower	Lowest
6.Load regulation	Poor	Moderate	Good	Very Good
7.Applications	Cell charger, small eliminators etc	High current DC power supplies	DC power supplies	DC power supplies

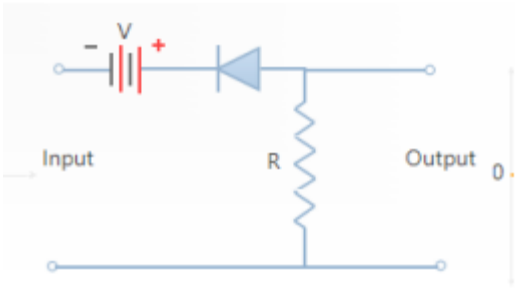
comparison point (any 4 points)

d) **Draw and describe working of series biased clipper with input output waveforms.**

Ans:

Biased series positive clipper:

Clipping of the signal takes place as soon as the input signal goes positive. If we want to change/adjust the clipping level of AC voltage, then external biasing voltage must be used. The figure given below shows a biased (series) clipper



Biased series (positive) clipper

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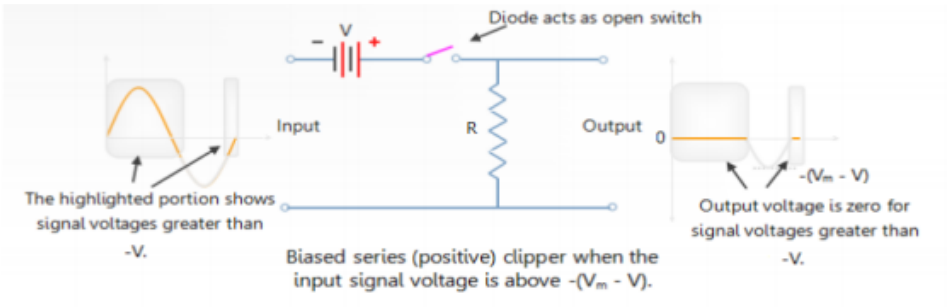
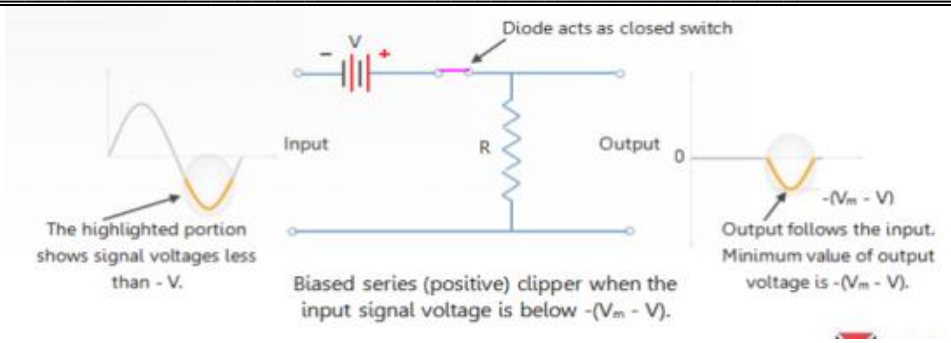


Biased series (positive) clipper when the input signal voltage is above $-(V_m - V)$.

1M for diagram & 2M for explanation & 1M for waveform (Either Biased series positive or Negative clipper)

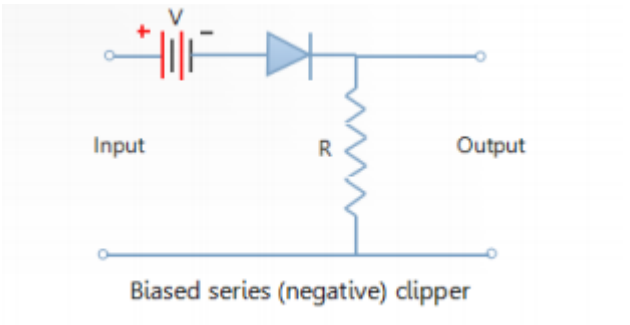


Biased series (positive) clipper when the input signal voltage is below -(V_m - V).

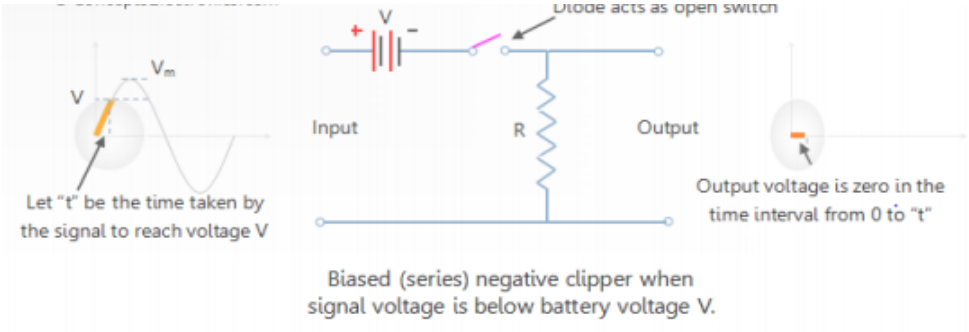
OR

Biased Series negative Clipper:

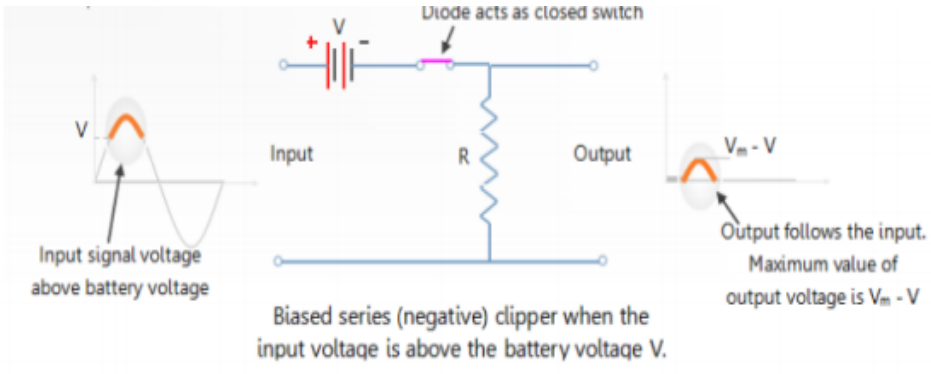
Clipping of the signal takes place as soon as the input signal goes negative. If we want to change/adjust the clipping level of AC voltage, then external biasing voltage must be used. The figure given below shows a biased (series) clipper.



Biased series (negative) clipper

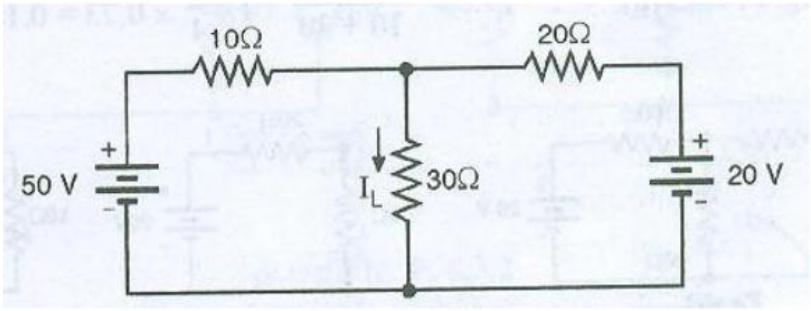


Biased (series) negative clipper when signal voltage is below battery voltage V.



Biased series (negative) clipper when the input voltage is above the battery voltage V.

e)	**Calculate I_L for the network shown in fig.**	calculation of I_L' & I_L'' 1M each &

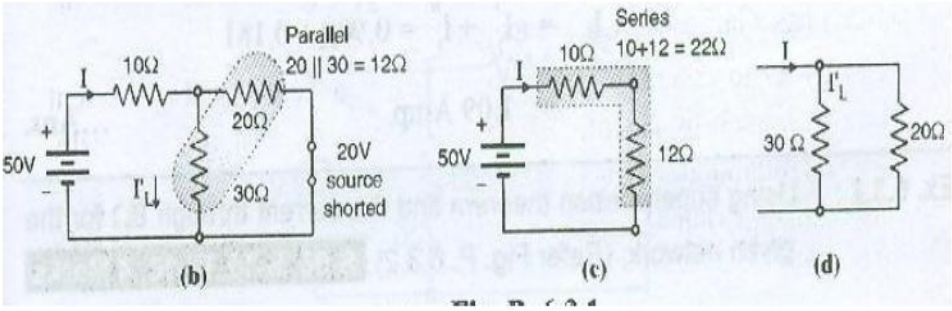


Calculation of I_L 2M

Ans:

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

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



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

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

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

Current division between parallel resistors

I'L = (20/50) X 2.27 = 0.909A .....(1)

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

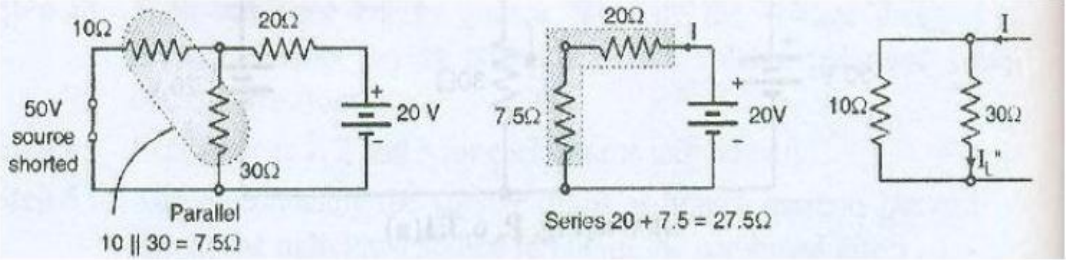
Now assume the 50V source to be shorted and obtain the effect of 20 V source only.

$$R_T = 27.5\,\Omega$$

$$\therefore \quad I = 20\ V / 27.5\ \Omega = 0.73\ Amp.$$

$$I''_L = \frac{10}{10+30} \times I = \frac{1}{4} \times 0.73 = 0.181\ A$$

.....(2)



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

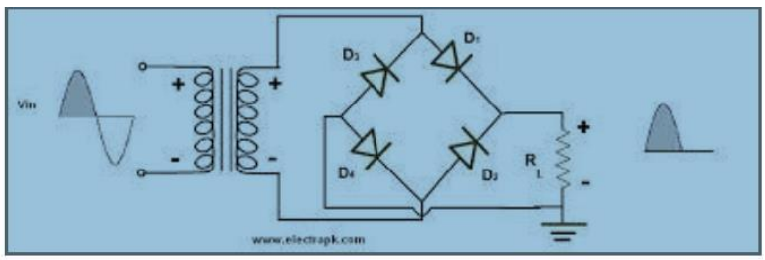
As per the superposition theorem, the total current through the 30Ω resistance is equal to the algebraic sum of the currents due to individual sources(I'_L and I''_L)

Therefore,

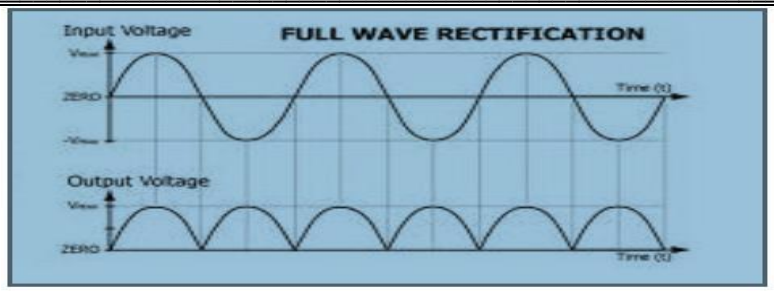
$I_L = I'_L + I''_L = 0.909 + 0.181 = 1.09$ Amp .....Ans

f) **Draw & describe working of bridge rectifier with its input output waveforms**

Ans:



1M each for circuit diagram & waveforms & 2M for explanation



Four diodes are used.
a)In positive half cycle Diodes D1 & D3 becomes forward biased they will conduct & current flows at that time D2 and D4 are reverse biased they will not conduct.
b) In negative half cycle diode D2 and D4 becomes forward biased they will conduct ,current flows in same direction at that time D1 and D3 are reverse biased they will not conduct. we get full cycle rectification.

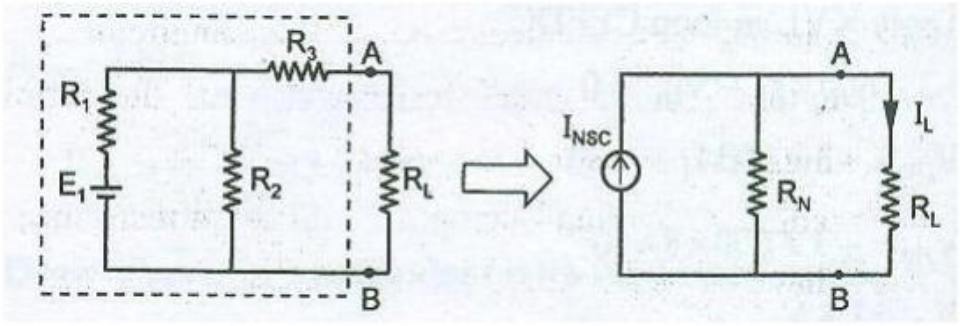
4 a) **Compare PN junction diode with zener diode (any four points)**
Ans:

1M each for correct comparison point

Sr.No.	PN Junction Diode	Zener Diode
1	It is not properly doped to control reverse breakdown.	It is properly doped to control reverse breakdown.
2	It conducts only in one direction.	It conducts in both directions.
3	It is always operated in forward-bias condition.	It is always operated in reverse-bias condition.
4	It has no sharp reverse breakdown.	It has quite sharp reverse breakdown.
5	It burns immediately, if applied voltage exceeds the breakdown voltage.	It will not burn, but functions properly in breakdown region.
6	It is commonly used for rectification purpose.	It cannot be used for rectification, but commonly used for voltage regulation.

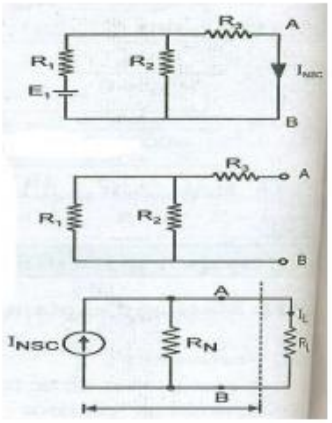
b) **State Norton's theorem with suitable example**
Ans:
Statement:- "Any linear, active, resistive, network containing one or more voltage and / or current sources can be replaced by an equivalent circuit containing a current source called Norton's equivalent current ISC and an equivalent resistance in parallel."

2M for statement & 2M for example



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.

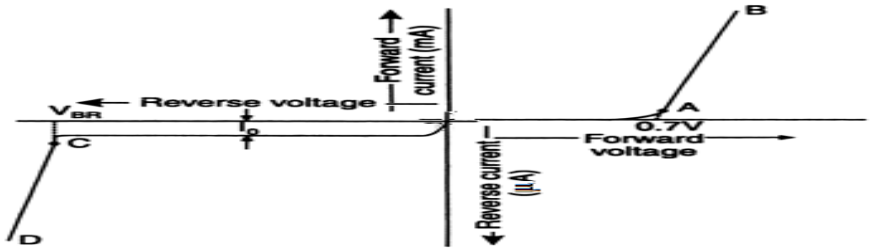


c) **Draw VI characteristics of PN junction diode and define knee voltage, leakage current,reverse saturation current,breakdown voltage**

2M for characteristics & ½ mark each for correct definitions

Ans:

V - I characteristics of P – N junction diode

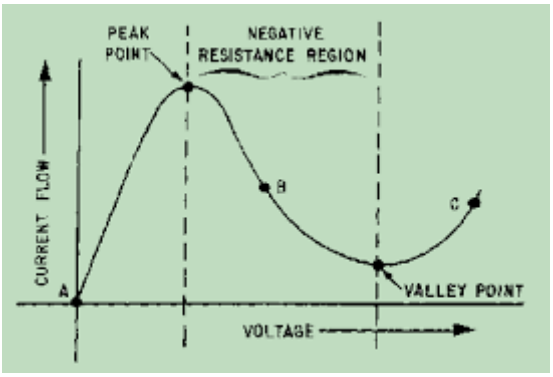
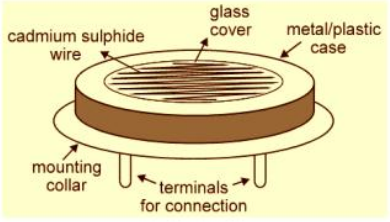


Knee voltage:

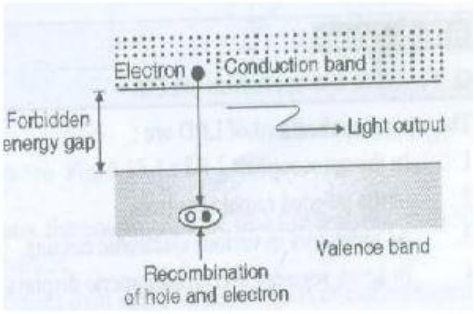
The applied forward voltage at which the PN junctions start conducting is called the cut-in voltage. It is also known as knee voltage (Vk or Vz). The value of cut-in voltage is 0.7 V for Silicon and 0.3 V for Germanium PN junction diodes.

Leakage current:

When a **diode** is reverse biased, the width of the depletion region increases. This **current** is called **leakage current**. **Leakage current** is dependent on minority **current** carriers.

	Reverse saturation current: In reverse bias condition there will be negligible amount of current that will flow through the device due to minority carrier which is called as reverse saturation current. **Breakdown voltage:** The voltage at which the abrupt increase in reverse current through the PN junction occurs is known as breakdown voltage.	
d)	**Draw VI characteristics of Tunnel diode & describe it.** **Ans:** **Tunnel diode characteristics**  a)It is also capable for very fast operations. b)It has heavily doped PN junction of only 10 nm wide . c)It exhibit negative resistance region. d) Applications:microwave applications, ultra high speed switching device,relaxation oscillators. e)The process of penetrating charge carrier directly through potential barrier is called tunneling.	2 M for Diagram & 2M for Explanation
e)	**Draw & describe construction of LDR** **Ans:** **Constructional diagram of light dependent resistor (LDR):**  **Constructional diagram of LDR** **Description:** 1. Photo resistors (or LDR) are manufactured from photo-conductive semiconductor materials such as cadmium sulphide (CdS), cadmium selenide (CdSe) and lead sulphide (PbS). 2. These resistors have a ceramic substrate, over which a layer of cadmium sulphide (CdS) is deposited in zig-zag form to increase the length. This increases the resistance value. 3. Depending upon the thickness, surface area and length of the layer, the resistance value changes. The electrodes are formed by evaporating metal in vacuum. 4. The leads are connected and put in plastic case. These are available in the form of discs with wire lead ends on one side. 5. The resistance of photo resistors may be several mega ohms in total darkness and less	2 M for Diagram & 2M for Explanation

	than100Ω, when well illuminated.	
f)	**Define i)Linear network ii)Non-linear network iii)Bilateral network iv)Unilateral network** **Ans:** **Linear Network:** 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:** 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 **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. **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.	1M each for correct definitions
Q5.	Attempt any Four	16
(a)	Compare clipper and clamper circuit(any four points.)	
	Ans:- 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	(Any four relevant points – 1 Mark each)
(b)	Describe the working principle of LED with neat construction.	(Working figure – 2 Mark, Explanation – 2 Marks)



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)

(i) Rectifier: 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.

(ii) PIV of diode: Peak Inverse Voltage (PIV) is defined as the maximum reverse/negative voltage which appears across non-conducting reverse biased diode without damaging it.

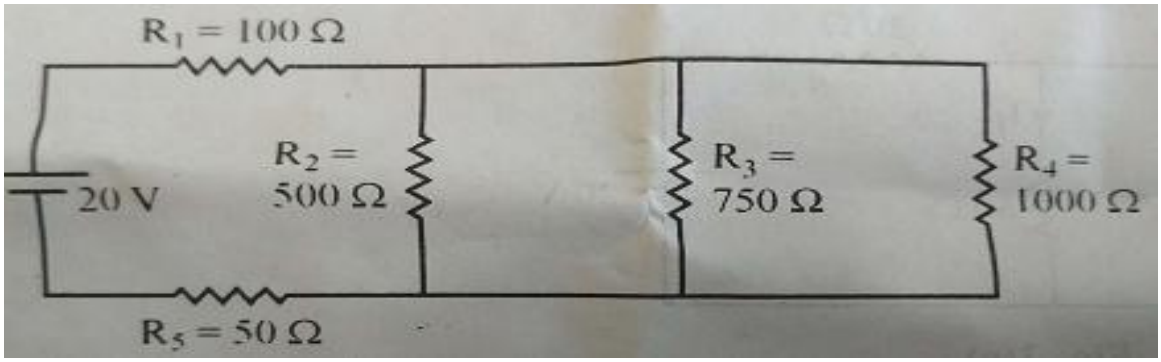
(iii) Ripple factor: Ripple Factor is defined as the ratio of RMS value of the AC component of output to the DC or average value of the output. Mathematically it is expressed as,

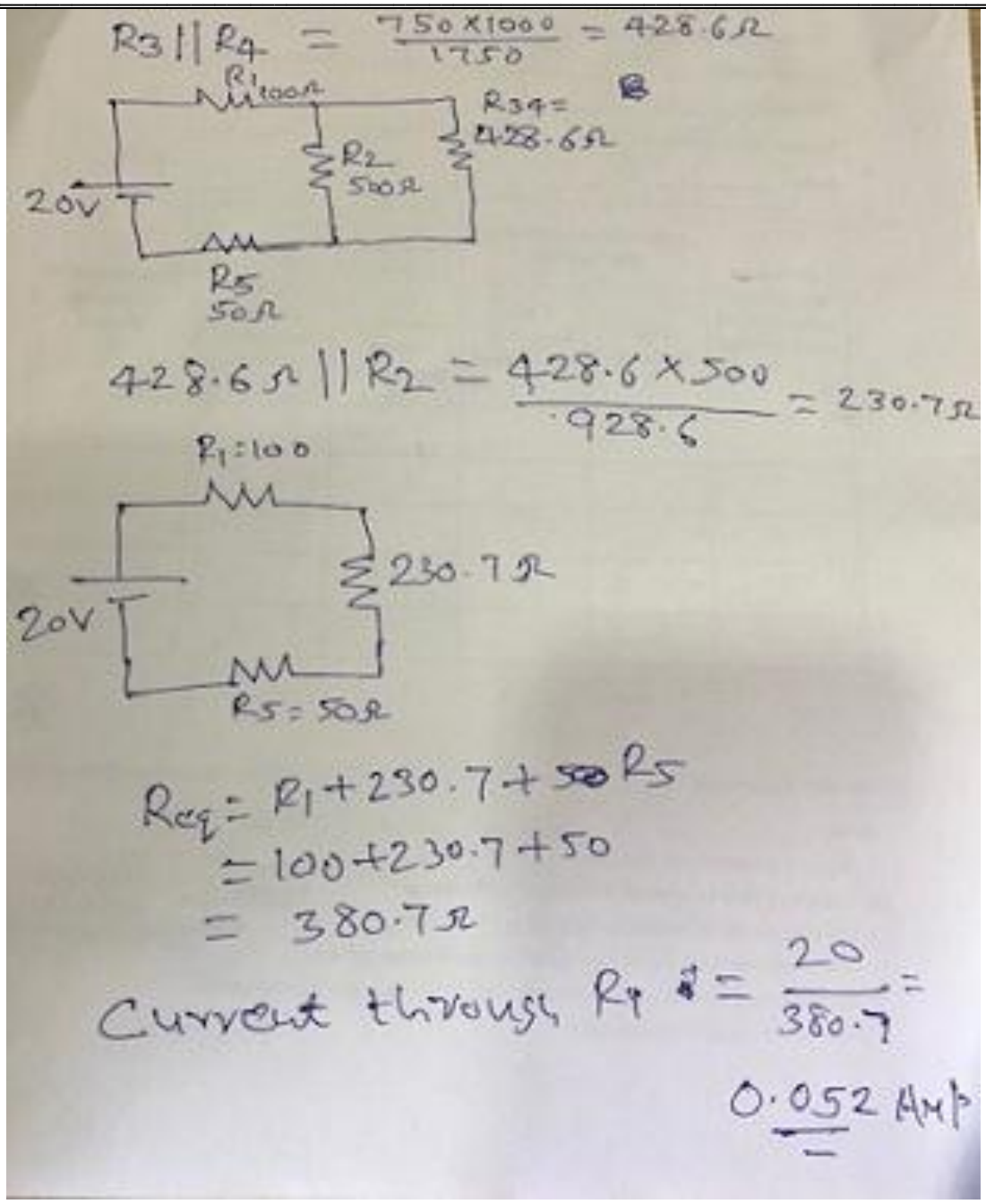
$$\text{Ripple Factor}, \gamma = \frac{\text{RMS value of AC component present in Rectifier Output}}{\text{Average Value of Rectifier Output}}$$

(iv) Rectifier efficiency: Defined as the ratio of DC output power to the AC input power.

η = DC output power/ AC input power = PLdc / Pac

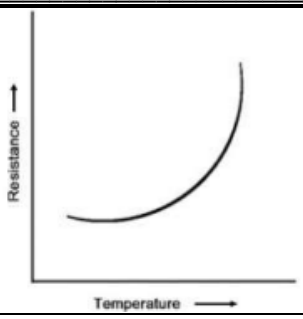
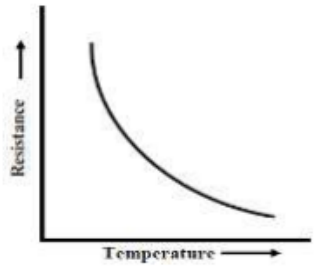
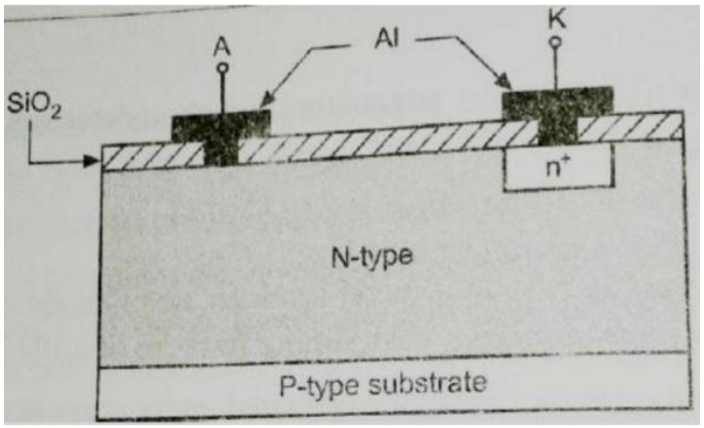
Each definition- 1 mks

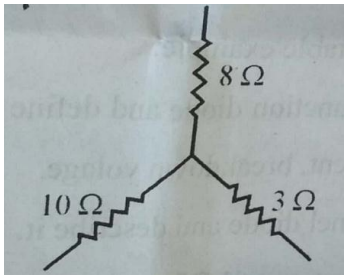
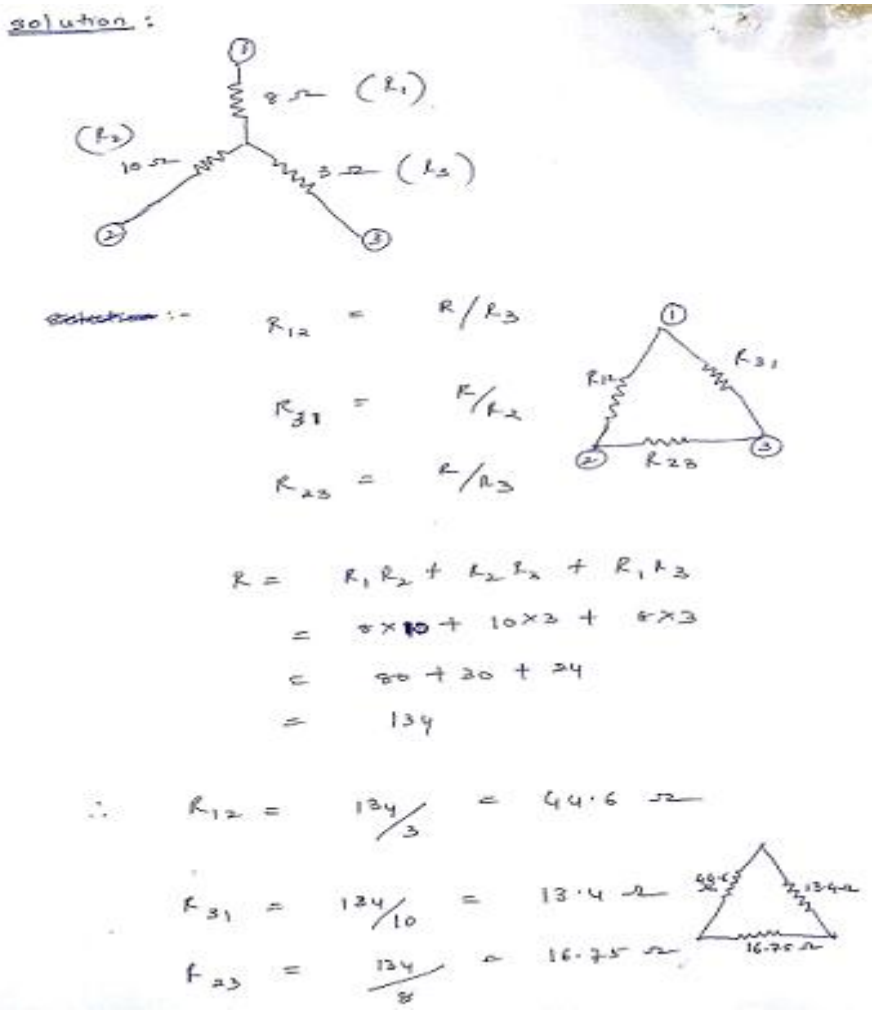
d)	**Soln. :** 1. Secondary voltage (rms) = $V_S = \frac{230}{10} = 23$ V 2. DC output voltage $V_{Ldc} = \frac{V_m}{\pi} = \frac{23\sqrt{2}}{\pi} = 10.35$ V 3. PIV of diode = $V_m = \sqrt{2}\ V_S = 23\sqrt{2} = 32.52$ V	Proper solution with answer- 2 mks each
(e)	Find current through R1 in following circuit: 	4 marks



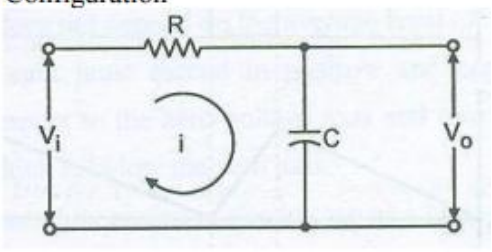
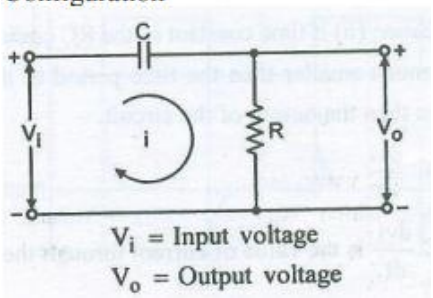
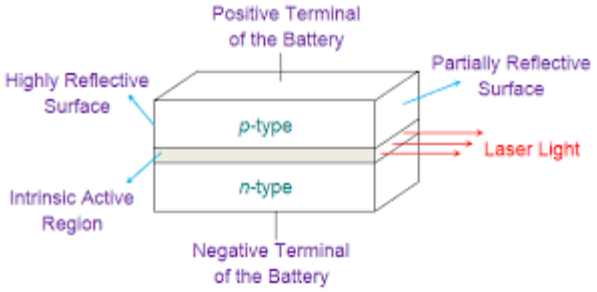
(f)	List types of TDR and compare them.(any two) Proper solution- 4 mks 1. NTC- Negative temperature of coefficient of resistance 2. PTC- Positive temperature of coefficient of resistance	Types of TDR: 2 mks, comparison-2 mks

	PTC	NTC
Materials used	Barium titanate, titanium oxide, powdered barium carbonate	Manganese, nickel, cobalt, titanium

		Characteristics		
		Temperature coefficient	60°C to 180°C	+200°C to +1000°C
		Application (any 1)	1) Temperature sensing in electric motors and transformers for protection. 2) Liquid level sensor 3) To protect solid state fuse against excess current	1) For temperature measurement and control 2) Temperature compensation 3) Fluid flow measurement
6	Attempt any FOUR			16
a	Describe working of schottky diode with neat construction  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		2 mks Diagram , 2marks working

	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.	
b)	Convert the given star network into equivalent delta network.  	Proper conversion 4 mks

<table>
<tr><td>c)</td><td>Compare RC integrator with RC differentiator(any four points)

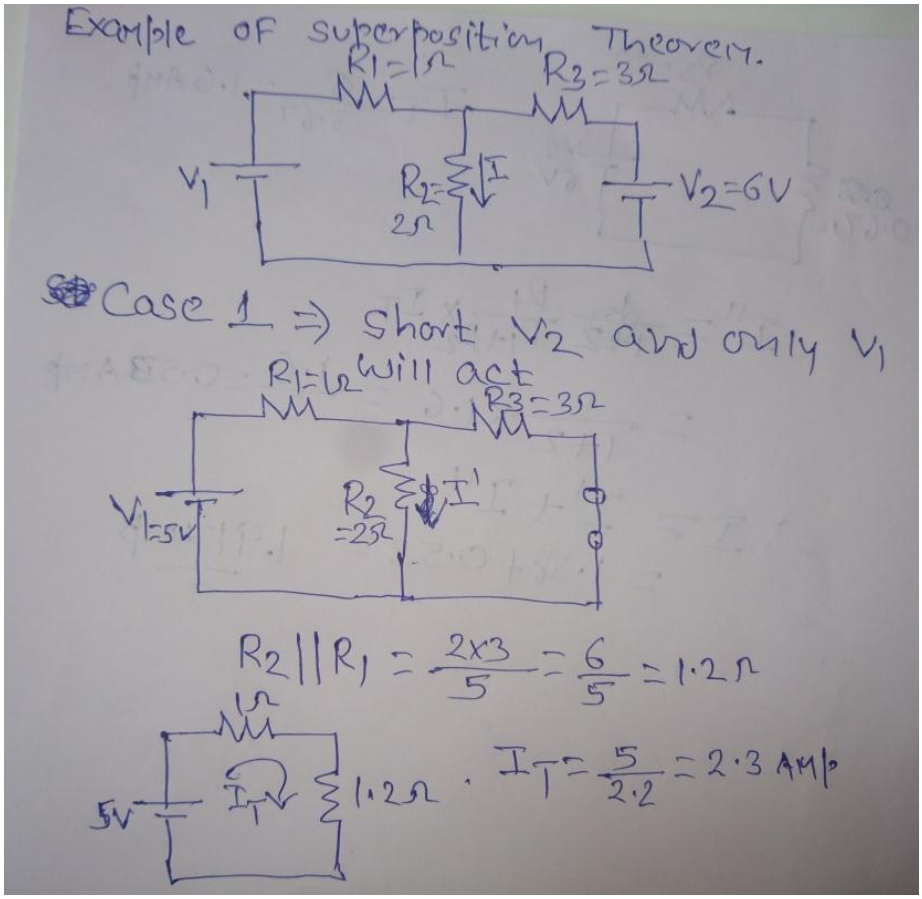
<table>
<tr><td>Sr. No</td><td>RC Integrator</td><td>RC Differentiator</td></tr>
<tr><td>1</td><td>Output is integration of input</td><td>Output is differentiation of input</td></tr>
<tr><td>2</td><td>For proper operation T<< RC</td><td>For proper operation T>> RC</td></tr>
<tr><td>3</td><td>Output decreases as frequency is increased</td><td>Output increases as frequency is increased</td></tr>
<tr><td>4</td><td>It is basically a low pass filter</td><td>It is high pass filter</td></tr>
<tr><td>5</td><td>Configuration
 
</td><td>Configuration
 
</td></tr>
</table></td><td>Any 4 points – 1 mks each</td></tr>
<tr><td>d</td><td>Describe working principle of LASER.
 

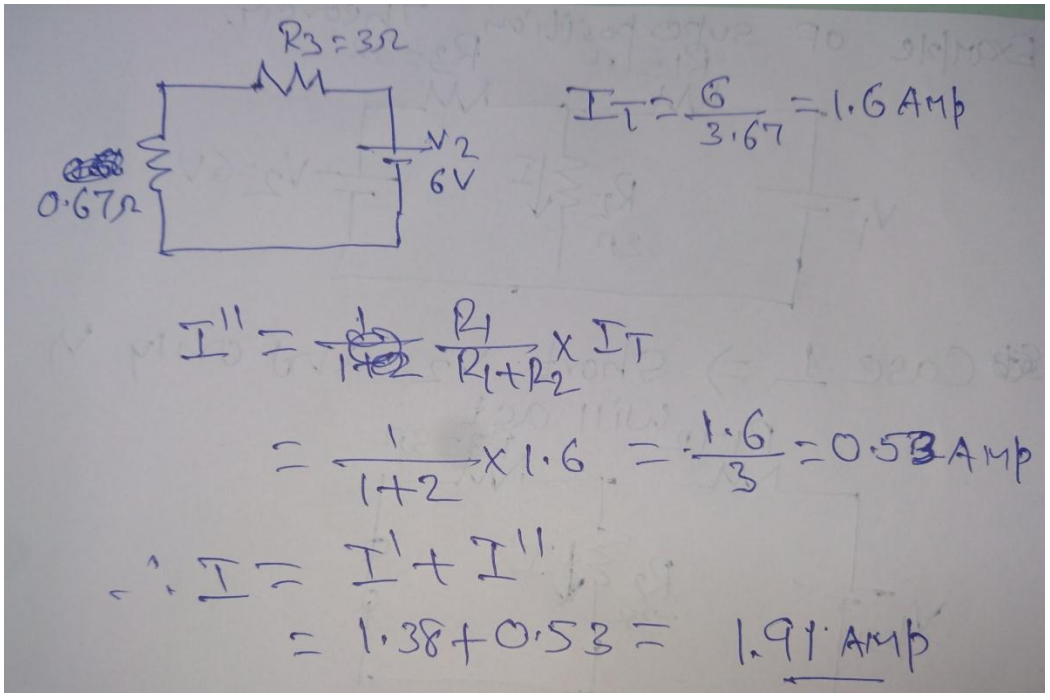
There are three main processes in semiconductors that are associated with light:

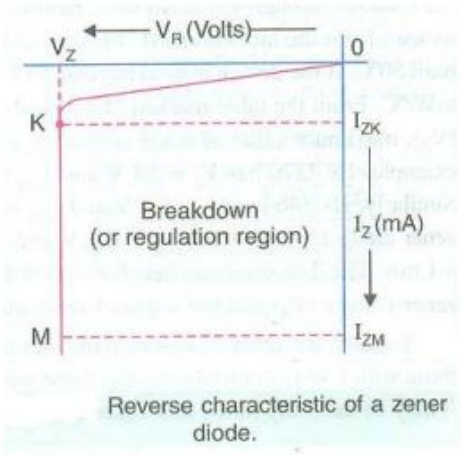
1. Light absorption
2. Spontaneous emission
3. Stimulated emission
• Stimulated emission is different. A light photon entering the semiconductor lattice will strike an electron and release energy in the form of another light photon.
• The way in which this occurs releases this new photon of identical 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 E2 – E1 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</td><td>Diagram – 2 mks, principle - 2 mks</td></tr>
<tr><td>e</td><td>State superposition theorem with suitable example

Superposition theorem states that: In a linear circuit with several sources the voltage and current responses in any branch is the algebraic sum of the voltage and current responses due to each</td><td>Statement – 2 mks, example- 2 mks</td></tr>
</table>

source acting independently with all other sources replaced by their internal impedance.





f)	Draw and describe the VI characteristics of zener diode  Reverse characteristic of a zener diode. A zener diode is operated only in the reverse-bias region. (generally written as VR) is increased, the reverse current (usually called zener current, IZ) remains negligibly small up to the 'knee'of the curve point. At this point, the effect of breakdown process begins. From the bottom of the knee, the breakdown voltage (also called zener breakdown voltage or simply zener voltage VZ) remains essentially constant. This ability of a diode is called regulating ability and is an important feature of a zener diode. It maintains, an essentially a constant voltage across its terminals over a specified range of zener current values. Following two points are important from the characteristics of a zener diode : 1. There is a minimum value of zener current called breakover current designate a IZX or IZ(min) which must be maintained in order to keep the diode in breakdown (or regulation) region. When the current is reduced below the knee of the curve, the voltage changes drastically and the regulation is lost. 2. There is a maximum value of zener current designated as IZM or IZ(max) above which the diode may be damaged. The value of this current is given by the maximum power dissipation of the zener diode. As long as the maximum power dissipation is not exceeded, the diode will not be damaged. It will come out of the breakdown region, when the applied reverse voltage is reduced below the breakdown voltage.	2 mks Characteristics 2marks explanation