SUMMER – 13 EXAMINATION

Subject Code: **12025** **Model Answer** 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.

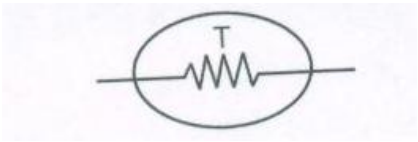
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q1. Attempt any ten of the following (20)

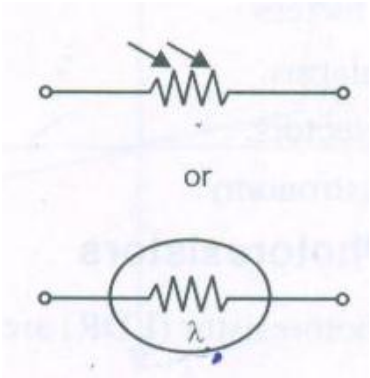
a) Draw the symbol of thermistor and LDR. (1)

Ans :

For Thermistor



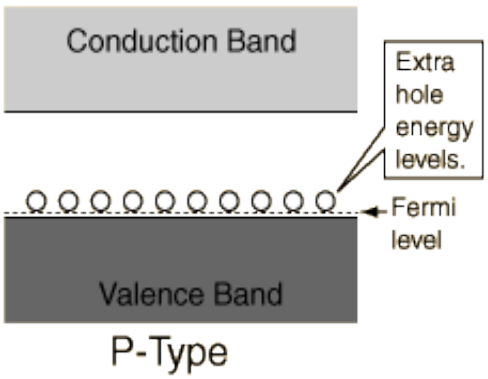
For LDR (1)



b) Draw the energy band diagram for P-type semiconductor. (2)

Ans :

For P-type semiconductor.



c) Write one application of varactor diode and point contact diode.

Ans : (any one from each) (2)

The applications of the **varactor diode** are as given below :

1. It is used in electronic tuners in radio, television and other commercial receivers.

2. It is used in automatic frequency control (AFC) device.
3. It is used in self-balancing bridge circuits.
4. It is used in adjustable band-pass filter.
5. It is used in low noise parametric amplifiers, harmonic frequency generators and frequency converters or mixers.
6. It is used as a voltage variable capacitor.

The applications of the **point contact diode** are as given below :

applications :

1. AM detector in radio receiver.
2. Video detector in TV.
3. Microwave frequency mixer.
4. In pulse circuits.

d) Define PIV and ripple factor.

Ans : PIV (Peak Inverse Voltage) – (1)

The maximum value of reverse voltage that a diode can withstand without destroying its PN junction during the non-conduction period is called peak inverse voltage. The diode should be so chosen as to withstand this reverse voltage.

Ripple factor – (1)

The ripple factor of a rectifier is a ratio of r.m.s. value of the alternating components in the load to the DC components in the load of a rectifier. It is denoted by a letter 'r'.

Mathematically, it is given by ,

$$r = \frac{\text{RMS value of AC components in the load}}{\text{Average or d.c. components in the load.}}$$

e) What is rectifier ? What is regulator ?

Ans : **Rectifier** - (1)

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.

Regulator – (1)

The electronic device or circuit which maintains the output DC constant across the load of a DC power supply under all the operating conditions is called a regulator.

f) Define current gain and voltage gain for CE configuration.

Ans : **Current gain (A_i)** (1)

The ratio of output current to input current of a BJT amplifier is called current gain. It is denoted by a letter 'A_i'

$$A_i = \frac{\text{Output current}}{\text{Input current}} = \frac{I_o}{I_i}$$

For CE amplifier, the current gain is given by,

$$A_i = \frac{I_c}{I_b} = \beta$$

Voltage gain (Av) (1)

The ratio of output voltage to input voltage of a BJT amplifier is called voltage gain.

It is denoted by a letter 'A_v'

$$A_v = \frac{\text{Output voltage}}{\text{Input voltage}} = \frac{V_o}{V_i}$$

For CE amplifier, the voltage gain is given by,

$$A_v = \frac{V_{CE}}{V_{BE}}$$

g) State applications of cascade amplifier.

Ans : (Any two) (2)

i) It is widely used as voltage amplifier.

ii) It is also used in radio and television receivers.

iii) It is used in Power amplifier also.

iv) It is mostly used for impedance matching between the individual stages.

v) It is used in liner integrated circuit.

h) List the applications of FET.

Ans : (Any two) (2)

1) FET can be used as an amplifier.
2) FET can be used as a switch.
3) It can be used as analog switch in circuits like sample and hold, amplitude modulation, ADC/DAC (analog to digital or digital to analog) converters.
4) As a voltage variable resistor (VVR)
5) In digital circuits.

i) List two doping materials for P-type and N-type semiconductor.

Ans : For a P-Type semiconductor – (1)

- Trivalent impurity atom such as **Boron, Gallium or Aluminium**
- For N-type semiconductor – (1)
- Pentavalent impurity **Phosphorus , Arsenic or Antimony**

j) List the advantages of Integrated Circuits.

Ans : Advantages of Integrated Circuits : (any 2) (2)

1. The physical size of an IC is extremely small (generally thousand times smaller) than that of discrete circuits.
2. The weight of an IC is very less as compared to that of an equivalent discrete circuits.
3. The reduction in circuit cost has become possible due to the processing of large quantities of identical ICs fabricated simultaneously on a single chip, i.e. batch processing.
4. The reduction in power consumption is achieved due to extremely small size of IC.
5. Interconnection errors are non-existent in practice.
6. Temperature differences between components of a circuit are small.

k) Write the value of resistance having colour code as – Red, Black, Blue, Gold. (2)

Ans :

Red	Black	Blue	Gold
2	0	10^6	$\pm$ 5%

$= 20 \times 10^6 \pm 5\%$

$= 20\ M\Omega \pm 5\%$

l) List the types of coupling amplifiers. (2)

Ans :

1. Resistance – capacitance (RC) coupling.
2. Transformer coupling
3. Direct coupling (DC).

Q2 . Attempt Any FOUR (16)

a) Explain the effect of temperature in semiconductor. (4)

Ans :

- As far as the electronic components are concerned, semiconductors are the most important type of materials.
- They have conduction properties which are in between those of conductors and insulators.
- We can say that semiconductors are neither conductors nor insulators. The forbidden gap is very narrow as compared to that of the insulator.
- At very low temperatures of the order of 0°K (- 273°C), semiconductors act like insulators.

- However with increase in temperature the valence electrons start acquiring additional energy and they can cross the narrow forbidden gap to enter into the conduction band.
- Thus at temperatures close to 20°C the conduction begins in semiconductors.
- **The conduction increases with increase in temperature**.
- The most widely used semiconductor materials are Silicon and Germanium.

b) Compare intrinsic and extrinsic semiconductor.

Ans : Any Four (4)

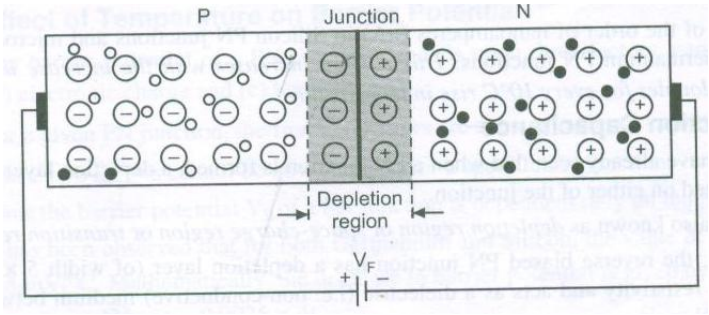
Sr. No.	Intrinsic Semiconductor	Extrinsic Semiconductor
1	It is an extremely pure form of semiconductor.	It is a doped semiconductor.
2	The number of free electrons and holes generated due to thermal energy are equal.	The number of free electrons and holes generated due to thermal energy are not equal.
3	The current conduction is due to electrons and holes.	The major part of current conduction is due to either holes or free electrons.
4	The Fermi level is at the centre of forbidden energy gap and is unchanged with change in temperature.	The Fermi level shifts upward or downward with change in temperature.
5	The electrical conductivity is very poor at room temperature.	The electrical conductivity is comparatively high at room temperature.

c) What is the barrier potential ? Show diagrammatically, the effect of forward and reverse biasing of barrier potential.

Ans : Barrier Potential: (2)

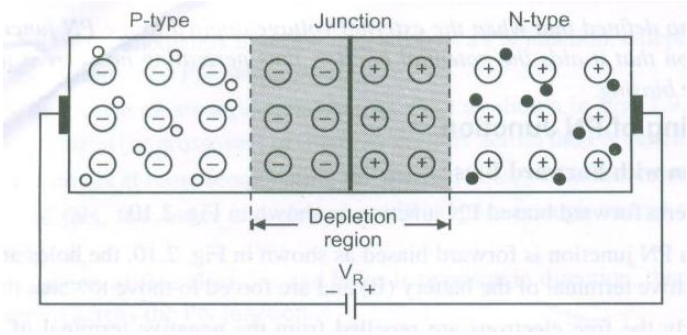
Due to the presence of immobile positive and negative ions on opposite sides of the junction, an electric field is created across the junction. This electric field is known as the 'barrier potential'or 'junction potential'.

In forward bias: (1)



The barrier potential decreases in forward bias .

In reverse bias (1)



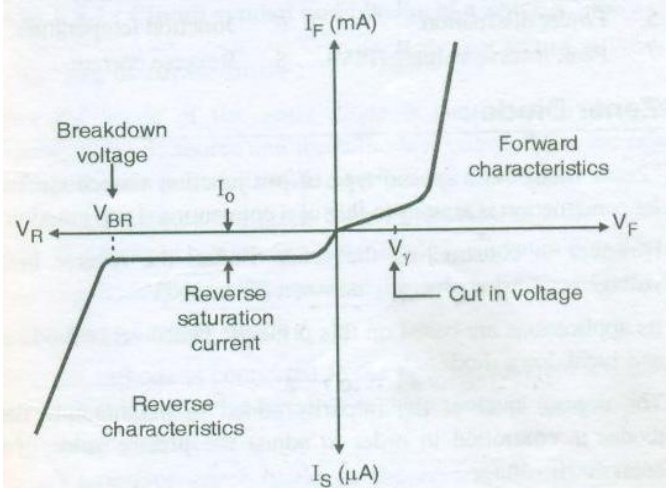
The barrier potential increases in reverse bias.

d) Explain the V-I characteristics of P-N junction diode.

Ans : (2)

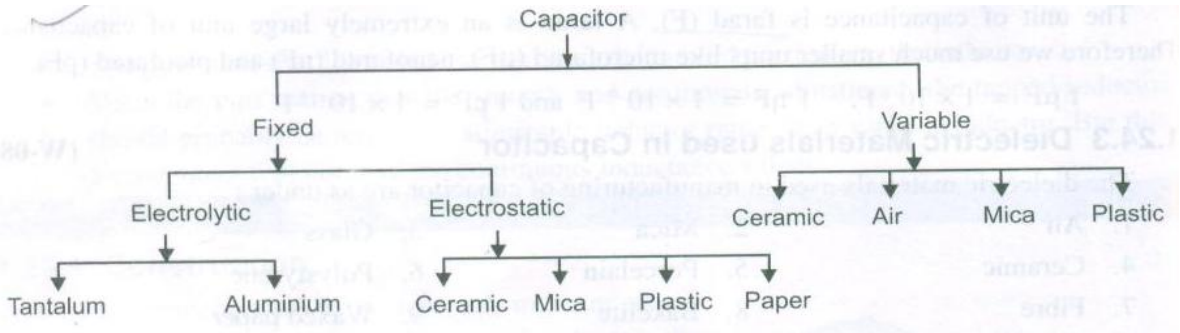
- The complete V-I characteristics is shown in figure. It is obtained by combining the forward and the reverse characteristics of the diode.
- A Graph between the forward voltage across the terminals of a PN junction diode and the current flowing through it is known as forward characteristics.
- It is observed that the PN junction conducts the forward current only after cut-in (i.e knee) voltage.
- A Graph between the reverse voltage across the terminals of a PN junction diode and the current flowing through it is known as reverse characteristics.
- In reverse bias V_{BR} is the reverse breakdown voltage. It is the reverse voltage at which the breakdown occurs.
- The reverse current I_o up to V_{BR} is practically constant and negligibly small. So we can neglect it at low operating temperatures.

(2)



e) List the different types of capacitors. Draw the construction diagram of electrolytic capacitor.

Ans : Classification of Capacitors (2)



Construction diagram of Electrolytic Capacitor (2)

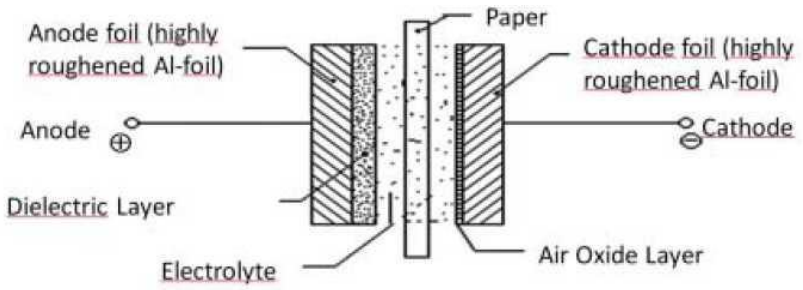
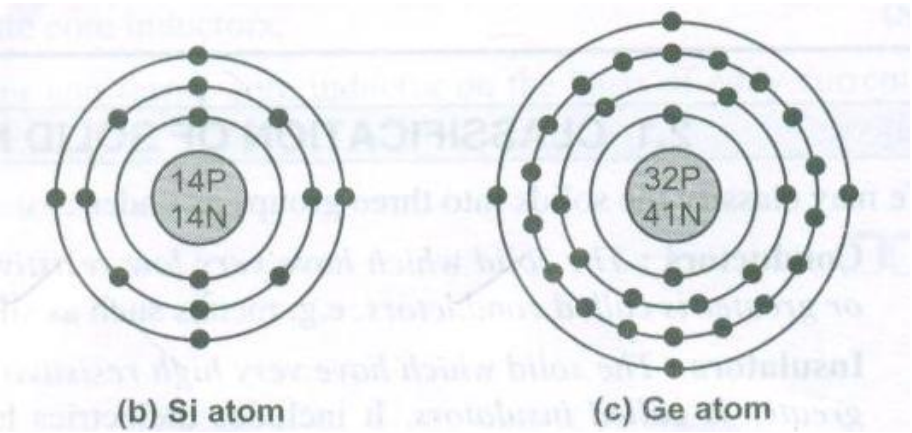


Figure 1: Electrolytic capacitor construction

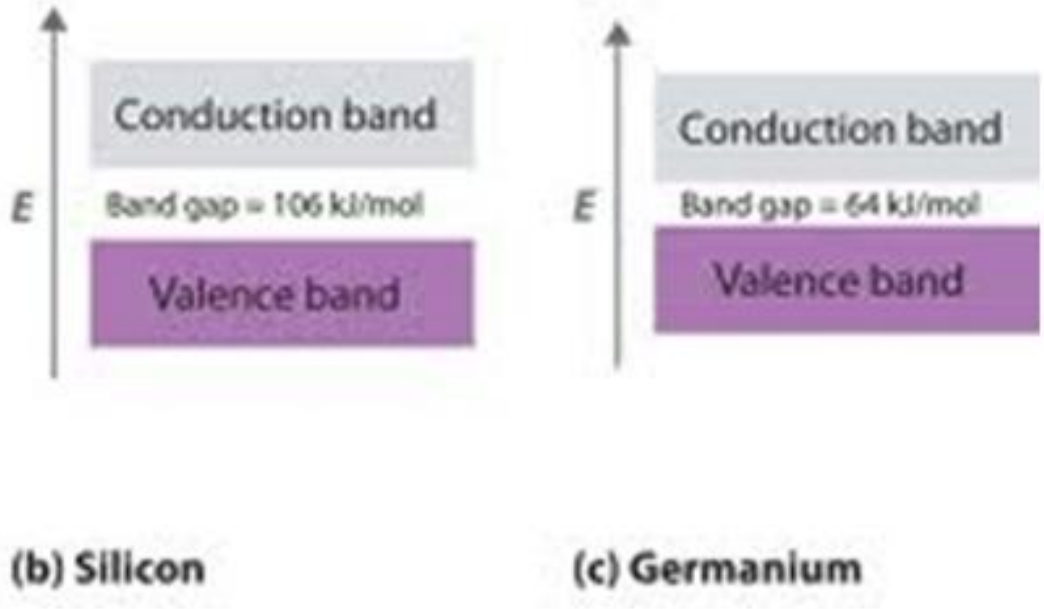
f) Draw the structure of an atom Si and Ge. Draw their energy band diagram.

Ans :

Structure of an atom Si and Ge (2)



Energy Band Diagram (2)

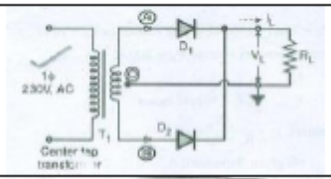
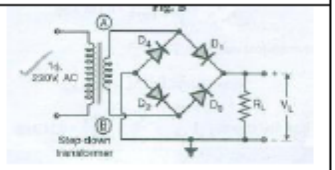
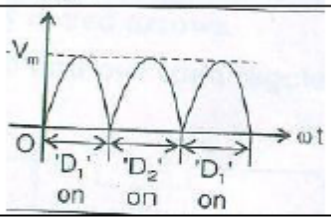
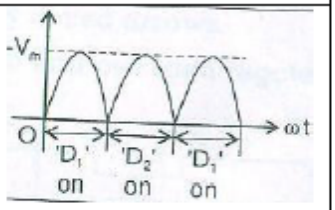


(b) Silicon **(c) Germanium**

Q3 . Attempt Any FOUR **(16)**

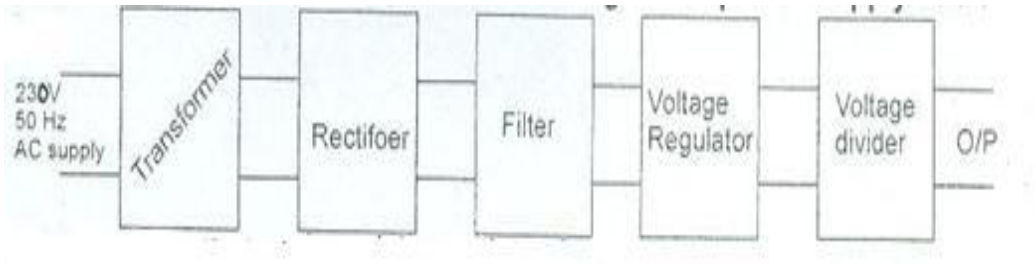
a) Compare centre-tapped full wave rectifier and bridge full wave rectifier.

Ans : Compare Centre tapped rectifier and Bridge rectifier (any four) **(4)**

Sr. No	Parameter	Centre tapped rectifier	Bridge rectifier
1	Circuit diagram		
2	Wave forms		
3	DC or average load current I_{Ldc}	$2I_m/\pi$	$2I_m/\pi$
4.	Maximum average load voltage	$2V_m/\pi$	$2V_m/\pi$
5.	RMS load Current I_{Lrms}	$I_m/\sqrt{2}$	$I_m/\sqrt{2}$
	RMS load voltage V_{Lrms}	$V_m/\sqrt{2}$	$V_m/\sqrt{2}$
5.	DC load power P_{dc}	$4I^2_m R_L/\pi^2$	$4I^2_m R_L/\pi^2$
6.	Maximum rectification efficiency	81.2%	81.2%
7.	TUF	69.3%	81.2%
8.	Ripple factor	48%	48%
9.	Ripple frequency	100Hz	100Hz
10.	Number of diodes used	Two	Four
11.	Centre tap transformer	Very much required	Not required
12.	Transformer core Saturation	Not Possible	Not Possible
13.	PIV	$2V_m$	V_m
14.	Expression for the peak load current	$I_m=V_m/(R_s+R_f+R_L)$	$I_m=V_m/(R_s+2R_f+R_L)$

b) Draw the block diagram of regulated power supply and explain its working brief.

Ans. Block Diagram of Regulated Power Supply. (2)



Working : (2)

There are four basic blocks of a d.c. regulated power supply. They are 1) Step down transformer 2) Rectifier 3) Filter 4) Voltage Regulator.

Functions of each block are as follows :

Step down transformer : Reduces 230 volts 50Hz ac voltage to required ac voltage level.

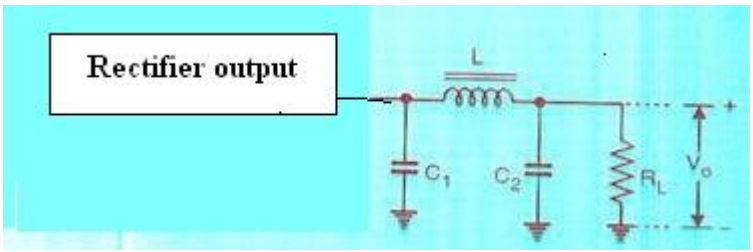
Rectifier : Rectifier converts ac voltage to dc voltage. Typically bridge full wave rectifier is widely used.

Filter : Filter is a circuit used to remove fluctuations (ripple or ac) present in dc output.

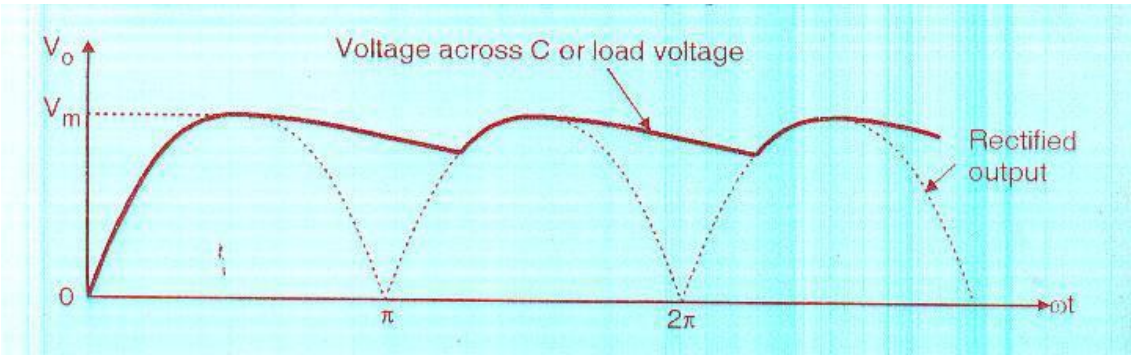
Voltage Regulator : Voltage regulator is a circuit which provides constant dc output voltage irrespective of changes in load current or changes in input voltage. **Voltage divider** is a passive circuit used for providing different dc voltages required by different electronic circuits.

c) Describe the working of π-filter with diagram.

Ans. π Filter Diagram (2)



Waveforms for filter circuit



Working (2)

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Rectified o/p of a bridge rectifier is shown in dashed wave forms.

π Filter consists of two capacitors C_1 & C_2 and one inductor L.

Capacitor filter bypasses unwanted ac through it and blocks dc through it as it is connected in parallel with the load R_L .

Inductor filter passes dc through it and blocks ac through it, as it is connected in series with the load R_L.

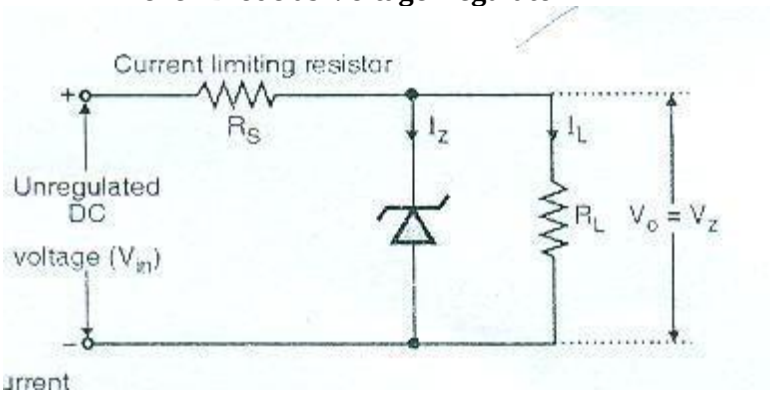
The filter capacitor C_2 bypasses the AC component which the C_1 has failed to block.Therefore ,only DC components appear across load.

π Type filter can be considered as combination of shunt capacitor filter and LC filter.

Due to the use of three filtering elements (C_1, L & C_2) the ripple factor of π type filter is very low as compared to the other filters.

d) Explain the working of zener diode as regulator.

Ans. **Zener Diode as Voltage Regulator** **(2)**



Working : **(2)**

A Voltage Regulator circuit provides constant output voltage inspite of changes in its input voltage or load current.

- The Series Resistance Rs is connected to limit the total current drawn from the unregulated power supply.
- Zener diode is a shunt type voltage regulator because the zener diode is connected in parallel with the load resistance and is connected in reverse biased condition.
- If Vin is higher than Vz and if the Iz is between Izmin & Izmax then the voltage across zener will remain constant equal to Vz irrespective of any changes in Vin & I_L. As output voltage is constant and equal to Vz, a regulated output voltage is obtained.

- **When Vin varies**

Assume R_L constant, Vin is varying

So, I_L is also constant as $I_L = V_Z/R_L$

But Vin changes & supply current also changes

$I = \frac{Vin - Vz}{R_S}$ Also $I = Iz + I_L$

If Vin is increased, then current I will increase. But as Vz is constant & R_L is also constant, the I_L will remain constant.

- The increase in current I will increase Iz but Iz is less than Iz (max).
- Thus the **output voltage** will **remain constant**.

- **When I_L varies**

Assume Vin constant, R_L is variable.

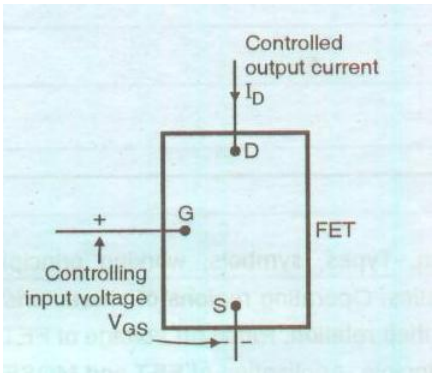
If R_L increases, I_L will decrease. But I is constant.

$I = \frac{Vin - Vz}{Rs}$ Also $I = Iz + I_L$

Therefore with decrease in I_L, Iz will increase. This can be continued without damaging the Zener diode as long as I_Z is less than I_Z max., the **output voltage** will **remain constant.**

e) What is FET ? Why it is called as unipolar device ?

Ans. FET (Field Effect Transistor) is a three terminal device .Three terminals of FET are Gate (G) , Drain (D) , Source (S) out of which gate as a controlling terminal. (2)
Whenever a voltage is applied across the terminals , a current flows through the channel. The current consists of only one type of charge carriers (i.e. electrons or holes), therefore FET is unipolar device. (2)



f) Define the terms w.r.t. FET :

1) Drain Resistance.
2) Pinch off voltage.

Ans.

Drain Resistance (rd): (2)

It is defined as the ratio of change in drain to source voltage to the corresponding change in the drain current, at a constant value of gate to source voltage.

rd =[ΔVDS /ΔID]constant VGS

Pinch off Voltage (2)

The Pinch off Voltage is the value of V_{DS} , at which the drain current reaches its constant saturation value. Any further increase in V_{DS} doesnot have any effect on the value of I_D.

Q4. Attempt any four of the following :

a) Explain the need of biasing of transistor.

Ans. Any four points (4)

Need of transistor biasing:

1. The transistor should be biased in the active region if it is to be used for amplification and in saturation and cut off if it is used as a switch.
2. The Q point should be adjusted approximately at the center of the load line for voltage amplifier application.
3. The value of stability factor (S) should be as small as possible.
4. Q point should be stabilized by introducing a negative feedback in the biasing circuit.
5. The Q-point should not be affected due to temperature changes or device to device variation.
6. Bypass capacitor should be included to avoid reduction in voltage gain due to negative feedback.
7. Transistor should be biased in the linear region of the transfer characteristics.

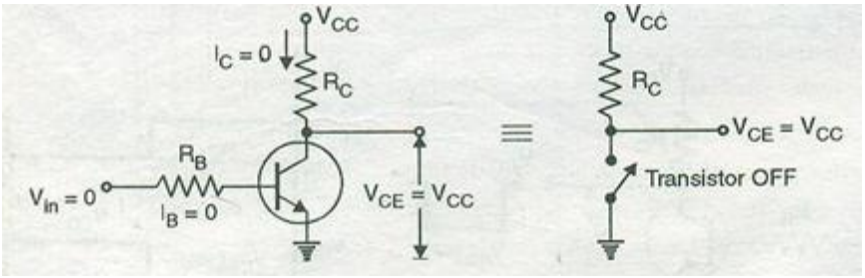
b) Describe the working of transistor as a switch.

Ans :

Transistor as a switch

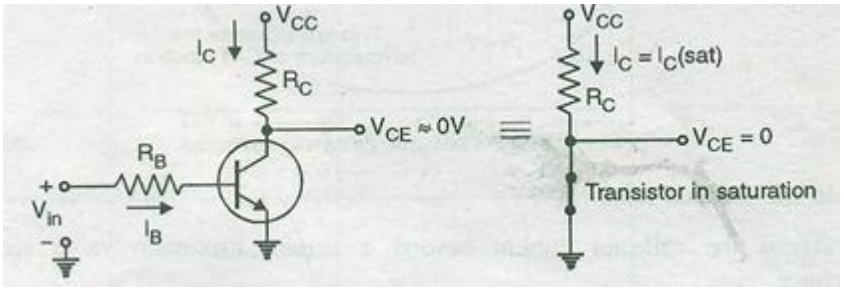
Transistor in cut off region (Open Switch) (2)

- In the cut-off region both the junctions of a transistor are reverse biased and a very small reverse current flows through transistor.
- The voltage drop across the transistor (V_{CE}) is high. Thus in the cut off region the transistor is equivalent to an open switch as shown in fig.



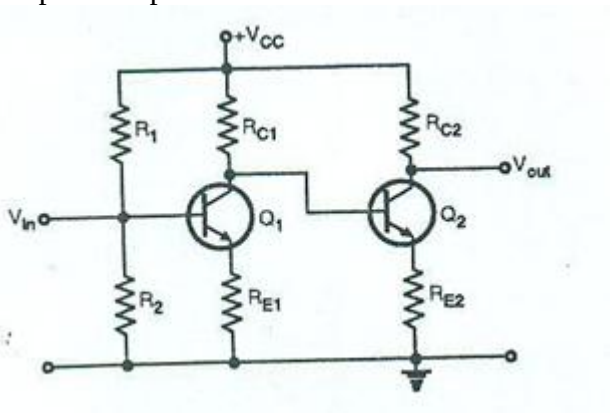
Transistor in the saturation region (close switch) (2)

- When Vin is positive, a large base current flows and the transistor saturates.
- In the saturation region both the junctions of a transistor are forward biased. The voltage drop across the transistor (V_{CE}) is very small of the order of 0.2V to IV depending on the type of transistor and the collector current is very large.
- In saturation the transistor is equivalent to a closed switch as shown in fig.



Qc) Draw the circuit diagram of direct coupled amplifier and state its application.

Ans : Two stage Direct Coupled Amplifier (2)

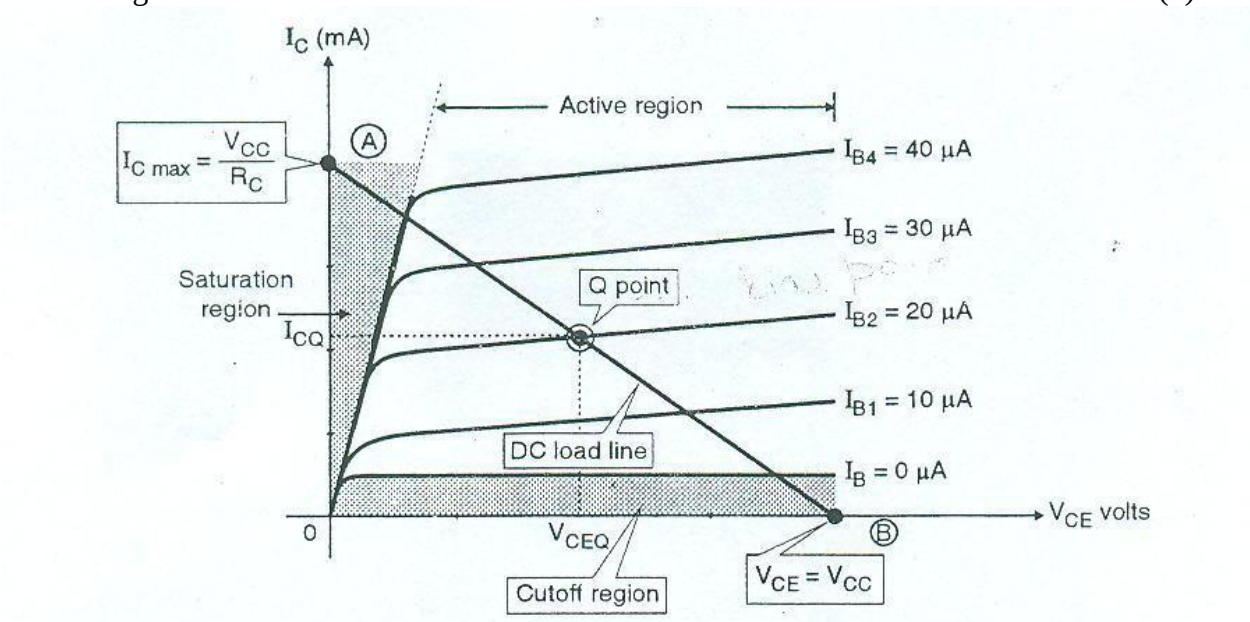


Applications (2)

1. Used in operational amplifiers.
2. Used in Analog computation
3. Used in the linear power supplies (voltage regulators).

d) Draw the dc load line and show the different points on the characteristics transistor.

Ans Diagram (4)



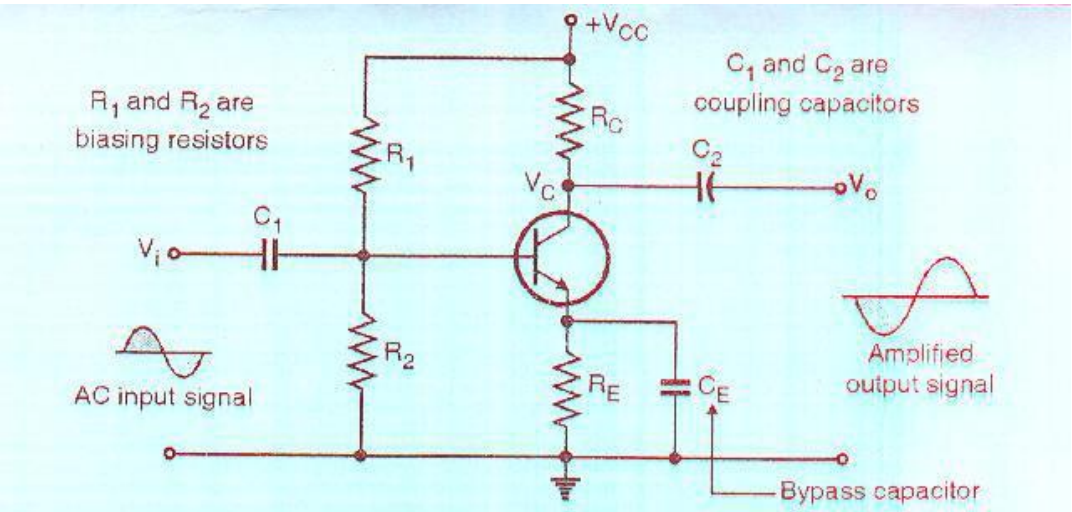
e) Compare CB, CE, CC configurations for four points.

Ans. Comparison between CB, CE and CC (Any 4 points) (4)

Sr. No.	Parameters	CB	CE	CC
1	Common terminal between input and output	Base	Emitter	Collector
2	Input Current	I_E	I_B	I_B
3	Output Current	I_C	I_C	I_E
4	Current gain	α dc = IC/IE	β dc = IC/IB	= IE/IB
5	Input Voltage	V_{EB}	V_{BE}	V_{BC}
6	Output Voltage	V_{CB}	V_{CE}	V_{EC}
7	Voltage gain	Medium	Medium	Less than 1
8	Applications	As preamplifier	Audio Amplifiers	For impedance matching.

f) i) Draw the circuit diagram of single stage CE amplifier.

Ans : Circuit Diagram of Single Stage CE amplifier (2)



f (ii) If $\alpha = 0.992$, find β of a transistor.

Ans : $\alpha = 0.992$ (2)

$$\beta = \frac{\alpha}{1 - \alpha}$$

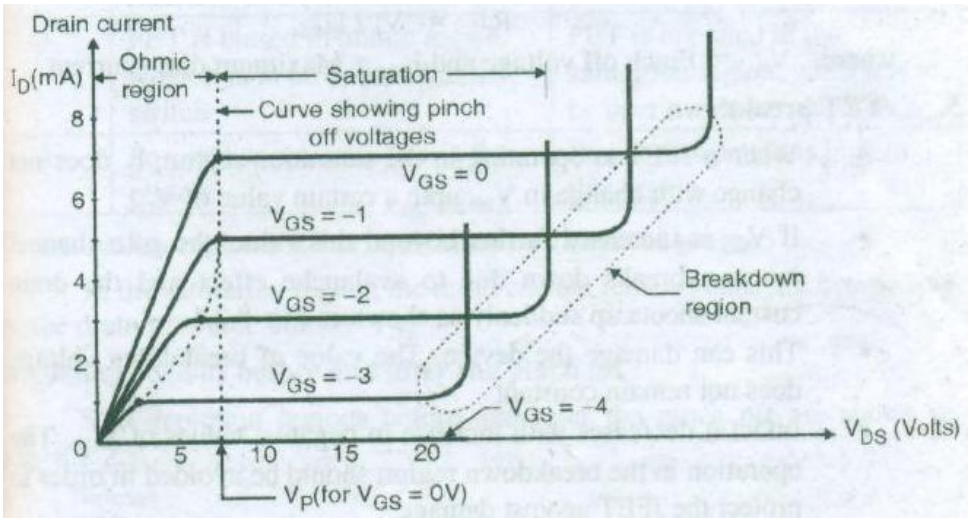
$$\beta = \frac{0.992}{1 - 0.992}$$

$$\beta = 124$$

Q.5) Attempt any four of the following (16)

a) Draw the static characteristics of FET. Show Pinch-off voltage and gate-source cut-off voltage.

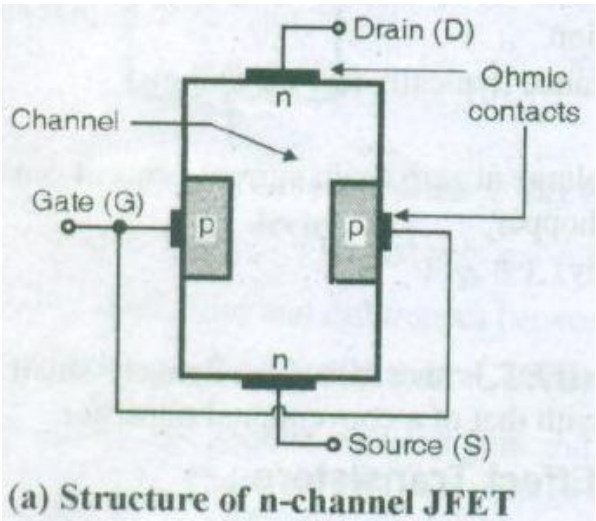
Ans : (4)



Static Characteristics of FET

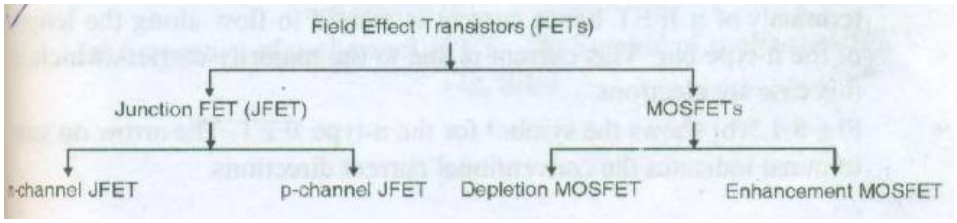
b) Draw the construction diagram of n-channel JFET. Write the classification of FET.

Ans : (2)



(a) Structure of n-channel JFET

(2)



Classification of FET

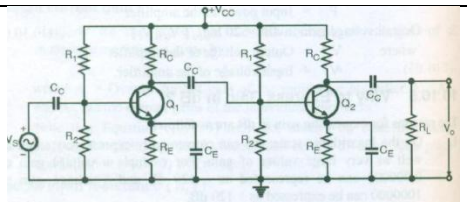
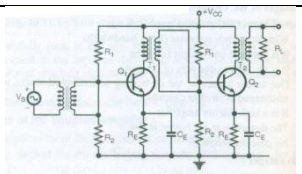
c) Compare FET and BJT (4 points)

Ans : The comparison of FET and BJT is given below : (4)

Sr. No.	FET	BJT
1	It is a voltage controlled device.	BJT is a current controlled device.
2	FET is a unipolar device i.e. current flows only due to the majority carriers.	BJT is a bipolar device (Minority and majority carriers both contribute to the current flow.)
3	Thermal runaway does not take place.	Thermal runaway can damage the BJT.
4	Input impedance is high.	Low input impedance.
5	Noise generated by FET is low.	Noise generated by BJT is high.
6	Transfer characteristics is non linear.	Transfer characteristics is linear.
7	FET is less sensitive to make changes in the applied signal.	BJT has a much higher sensitivity to make changes in the applied signal.

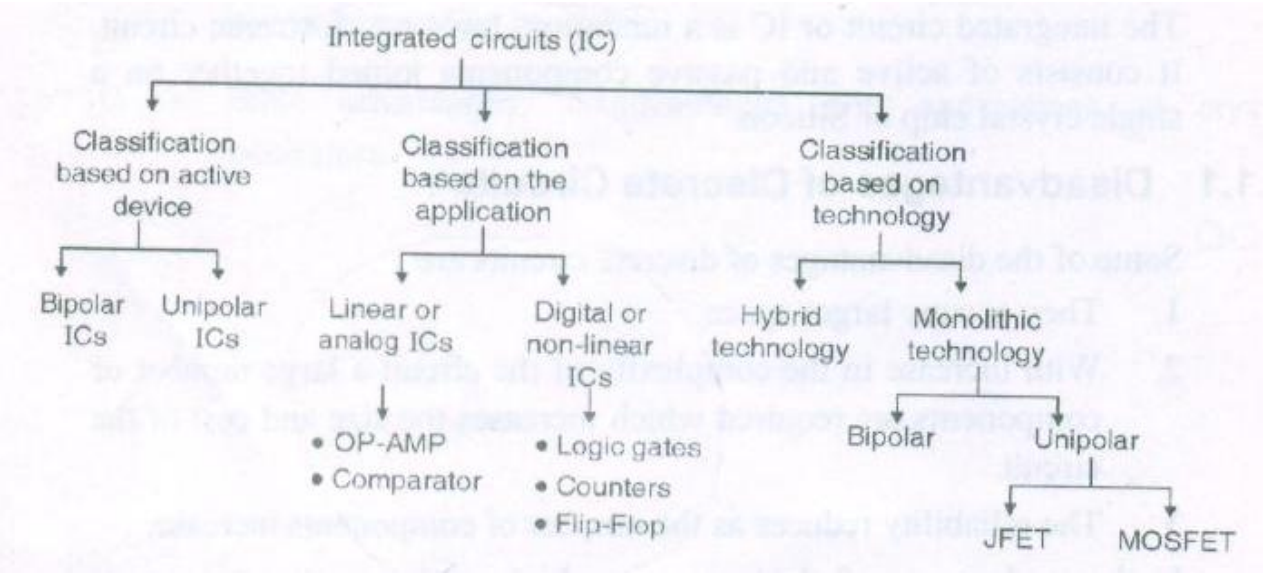
d) Compare RC Coupling and transformers coupling for Circuit diagram and application.

Ans : (4)

Sr. No.	Parameter	R-C coupling	Transformer coupling
1	Circuit diagram.		
2	Application area	AF amplifiers, PA systems, tape recorders, radios and TVs.	Power amplifiers, RF amplifier stage of radio and TV.

e) Write the classification of ICs.

Ans : (4)

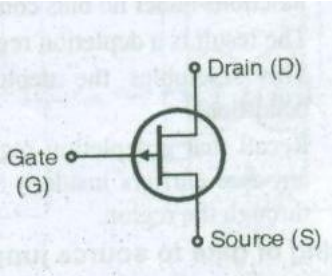


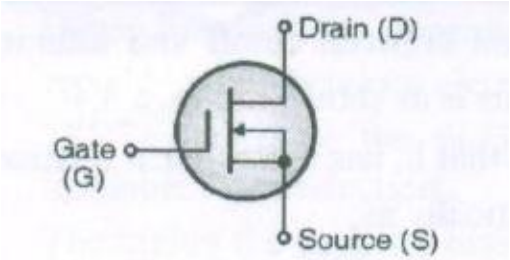
f) Write the four applications of FET. Draw the symbol of p-channel JFET and n-channel MOSFET.

Ans : Applications of FET (2)

1. FET can be used as an amplifier.
2. FET can be used as a switch.
3. It can be used as analog switch in circuits like sample and hold, amplitude modulation, ADC/DAC (analog to digital or digital to analog) converters.
4. As a voltage variable resistor (VVR)
5. In digital circuits.

Symbols (1 each)



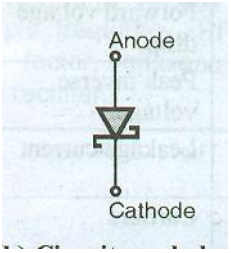


Q6) Attempt any four of the following **(16)**

a) Draw the symbol of Schottky diode and photo-diode. Write the application of each one.

Ans :

Schottky diode (2)



Applications of schottky diodes :

1. Switching Mode Power Supplies (SMPS).
2. AC to DC converters.
3. Radar Systems.
4. Schottky TTL logic for computers.
5. Mixers and detectors in communication equipment.

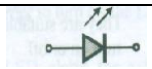
Photo diode (2)

Applications of photo-diode.

- A popular application of the photodiode is an object counting system.
- This system is used for counting the number of objects that are passing on a conveyor belt. A light beam is focused continuously on the photodiode and the reverse photocurrent is flowing through it.
- As soon as an object passes and interrupts the beam of light, the photocurrent flowing through the photodiode will reduce to zero. This will be counted by a counting mechanism to count the number of objects.
- In general the applications of photodiode are same as those of an LDR. In addition they can be used in optical measurement system and fibre optic communication.

b) Compare LED and P-N Junction diode

Ans : (Any four) (4)

Sr. No.	Parameter	LED	P-N Junction diode
1	Symbol		
2	Material used	Gallium Arsenide	Silicon or Germanium
3	Capacity to emit light	Can emit light when excited electrically.	Cannot emit light
4	On state voltage drop	Ranges between 1.2 to 2 volts.	0.7 V for silicon, diode 0.3 V for germanium diode.
5	Reverse breakdown voltage	Very low	High
6	Applications	As a light source in optical fibre applications. As indicator, in 7 segment displays.	Rectifier, clipper, clamper, etc.

c) Compare Zener breakdown and Avalanche breakdown.

Ans : (4)

Sr. No.	Zener breakdown	Avalanche breakdown
1	This is observed in zener diodes having Vz between 5 to 8 volts.	This is observed in zener diodes having Vz greater than 8 volts.
2	The valence electrons are pulled into conduction band due to very intense electric field appearing across the narrow depletion region.	The valence electroncs are pushed into conduction band due to the energy imparted by colliding accelerated minority carriers.
3	V-I characteristics with the zener breakdown is very sharp.	The V-I characteristics with the avalanche breakdown increases gradually. It is not as sharp as that with the zener breakdown.
4	The breakdown voltage decreases with increase in temperature.	The breakdown voltage increases with increase in temperature.

d) Compare L and C filters for two points.

Ans : (Any two) (4)

Sr. No.	Parameter	L filter	C – filter
1	Place of filter.	In series with the load.	Across the load
2	Useful in	Reducing the ripple in the load current.	Reducing ripple in load voltage.
3	Lowest ripple in the load voltage at	Heavy loads	No load or light loads
4	Suitable for	Heavy load applications	Light load applications
5	Surge current through diodes	Low and need not be controlled.	Very high and must be controlled
6	Expression for ripple factor	$RF = \frac{R}{3\sqrt{2}\,\omega L}$	$RF = \frac{1}{4\sqrt{3}\,fCR}$
7	Size of filter.	Bulky	Small and compact

e) Compare line and load regulation for two points. (4)

Ans : **Load Regulation** - 1) It is defined as the change in output voltage when the load current is changed from zero (no load) to maximum (full load) value.

2)It is calculated as

$$\% \text{ Load Regulation} = \frac{V_{NL} - V_{FL}}{V_{FL}} \times 100 \quad \Big| \text{ Vin Constant}$$

Where V_{NL} = No load voltage ($I_L = 0$)

V_{FL} = Full load voltage ($I_L = I_L$ Max)

3) The percentage of load Regulation of a power supply should ideally be equal to zero & practically it should be as small as possible.

Line Regulation : 1) It is defined as the change in output voltage due to change in input voltage with load R_L constant (I_L constant)

2) Therefore % Line Regulation $= \frac{\Delta V_O}{V_O} \times 100 \quad \Big|$ R_L = constant or I_L constant.

V_O - Output voltage

OR Line Regulation = $V_{LH} - V_{LL}$

V_{LH} = Load voltage with high line voltage

V_{LL} = Load voltage with low line voltage

- 3) Ideally the line Regulation should be zero & practically it should be as small as possible.

f) What is the difference between linear and non-linear ICs.

Ans : (Any four) (4)

Sr. No.	Parameter	Linear ICs	Nonlinear ICs
1	Examples	Operational amplifiers, comparators.	Digital ICs such as gates, flipflops, counters etc.
2	Power Supply.	Single polarity or dual polarity.	Single polarity
3	Signals processed	Analog signals	Digital signals
4	Effect of noise	More	Less
5	Effect of temperature	More	Less
6	Applications	Amplifiers, signal generators, filters.	Microprocessors, Digital clocks, Rolling displays, etc.