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Basic Electronics

- **2 Marks**

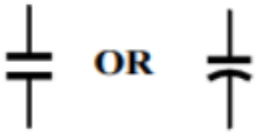
1)Draw the symbols of resistor & capacitor. State the unit of measurement of

Ans:

Symbol of resistor:

Symbol of resistor

Symbol of capacitor



Unit of resistance: ohm (Ω)

Unit of capacitance: farad (F)

2)Give two points of distinction between half wave & full wave rectifier.

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Parameter	Half wave rectifier	Full wave rectifier	
		Centre tapped	**Bridge**
No. of diode	1	2	4
PIV	Vm	2Vm	Vm
Rectification efficiency	40.6%	81.2%	81.2%
Ripple frequency	f	2f	2f
Ripple factor	1.21	0.482	0.482
TUF	0.287	0.693	0.812
DC voltage	Vm/π	2Vm/π	2Vm/π
DC load current	Im/π	2Im/π	2im/π

3)Define α & β of a transistor.

Ans:

COMMON BASE D.C CURRENT GAIN (α): `

The ratio of collector current I_C to emitter current I_E in the CB configuration is called alpha (α)

$$\alpha = I_C / I_E$$

COMMON EMITTER D.C CURRENT GAIN (β) :

The ratio of collector current I_C to base current I_B in the CE configuration is called beta (β)

$$\beta = I_C / I_B$$

4)Draw the symbols of N channel & P channel JFET.

Ans:

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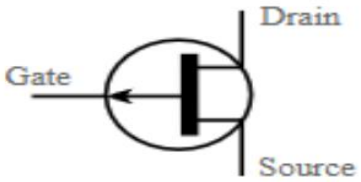
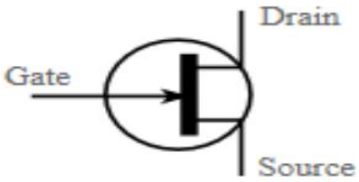


P-Channel



N-Channel

5)Give two points of distinction between active & passive components.

Ans:

Passive components	Active components
Components which are not able to amplify or processing electrical signals are called passive components	Components which are able to amplify or processing electrical signals are called active components
They do not introduce any gain	They may introduce gain
They are bidirectional	They are unidirectional
Eg. Resistor, capacitor, inductor, sensors, transformer	Eg: diode, transistor, IC, FET, MOSFET, logic gates, triode vacuum tubes (valves)

6)Give two points of distinction between active & passive transducers.

Ans:

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Parameter	Active transducer	Passive transducer
Working Principle	It operates under energy conversion principle.	It operates under energy controlling principle.
Advantages	They do not require external power supply for their operation	They require external power supply for their operation
output	They produce voltage/current proportional to the physical quantities	They produce change in resistance, capacitance in the response to the physical quantity.
Example	Eg. Thermocouple, photocell, piezoelectric transducer, Photovoltaic cell	Eg. Thermistor, LVDT, LDR, phototransistor, capacitive transducer
Application	Used for measurement of Surface roughness in accelerometers and vibration pickups.	Used for measurement of power at high frequency

7)State the selection criterion of transducers.

Ans:

- Operating Principle
- Operating range
- Accuracy
- Range
- Sensitivity
- Loading effect
- Errors
- Environmental compatibility
- Frequency response: Usage and Ruggedness
- (Or any relevant point)

8)Define Active and Passive Components

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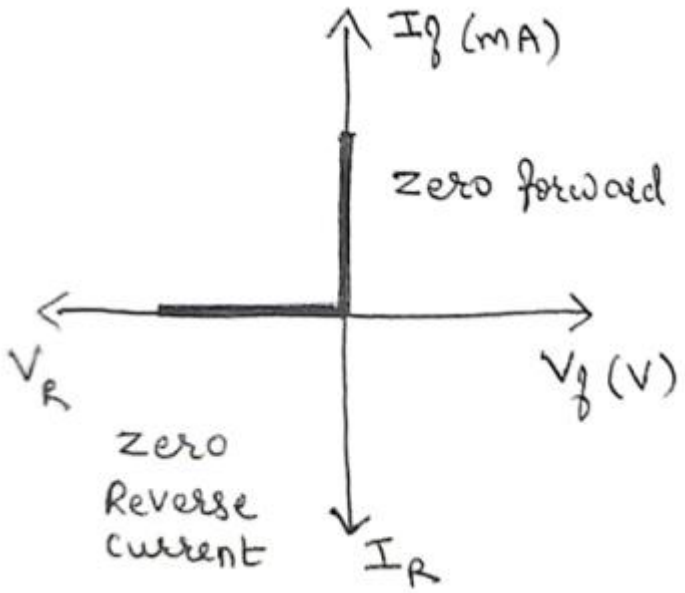
Ans:**Active Components :-** A circuit component which can deliver power or power gain in an electric circuit for infinite duration of time is known as active component.

Passive Components :- A circuit element which only absorbs the power and convert it in heat or stores in electric field or magnetic field is known as passive component.

9)Draw V-I characteristics of an ideal P-N junction diode

Ans:



10)Define Rectifier. List the types of Rectifiers .

Ans:

Definition:

A rectifier is an electrical device that converts an Alternating Current (AC) into a Direct Current (DC) by using one or more P-N junction diodes.

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Types of Rectifiers:

- Half wave rectifier
- Full wave rectifier
- Centre-tapped full wave rectifier
- Bridge full wave rectifier

11)Define α and β of Transistor

Ans:

α : Alpha of a transistor is defined as the ratio of change in the collector current to change in the emitter current.

β : Beta of a transistor is defined as the ratio of the change in collector current to the change in base current.

12)Define transducers and name any two active transducers

Ans:

Definition: A transducer is an electronic device that converts energy from one form to another.

Active transducers :

Piezoelectric, Photo Electric ,thermocouple, Thermo Electric and photovoltaic cell transducers.

13)Draw constructional diagram of a photodiode.

Ans:

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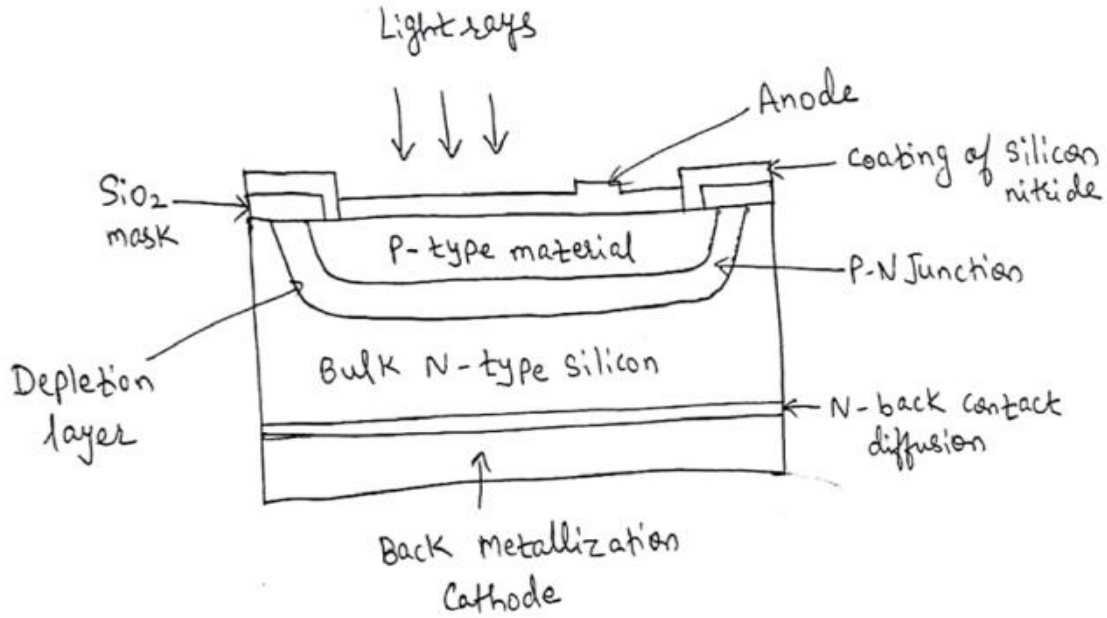

14)State two advantages of Integrated circuits

Ans:

1. The advantages of ICs :
2. Extremely small in size
3. Low power consumption
4. Reliability
5. Reduced cost
6. Very small weight
7. Easy replacement.

15)List any four specifications of resistors.

Ans:

- Specifications of resistors:
- Resistance Value / Resistivity
- Tolerance
- Power Rating

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- Thermal Stability
- Maximum operating temperature
- Maximum operating voltage

16)State the need of filters in a regulated DC power supply.

Ans:

Need of filters:

The output of a rectifier contains dc component as well as ac component. The presence of the ac component is undesirable and must be removed so that pure dc can be obtained. Filter circuits are used to remove or minimize this unwanted ac component of the rectifier output and allows only the dc component to reach the load.

17)List the types of signals.

Ans:Types of signals:

- Analog signal
- Digital signal
- AC signal
- DC signal
- Sinusoidal signal
- Triangular signal
- Square signal

18)Draw the symbol of N-channel and P-channel enhancement type

MOSFET.

Ans:

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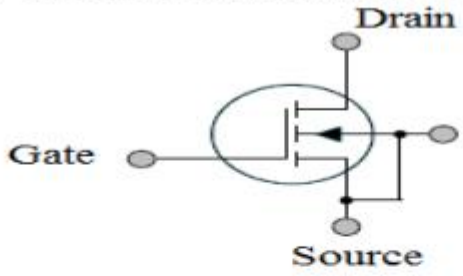
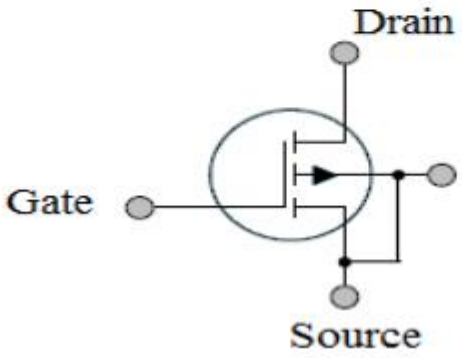
Symbol of N- Channel Enhancement MOSFET:



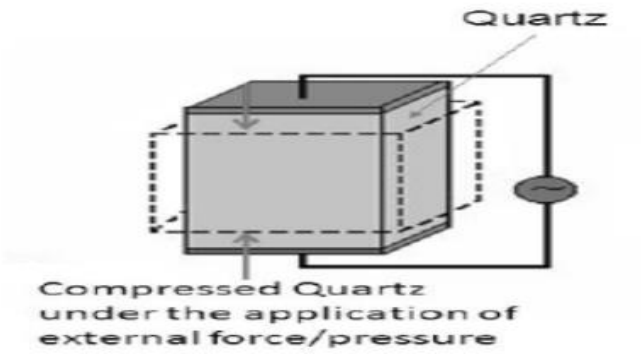
Symbol of P- Channel Enhancement MOSFET:



19)Draw constructional diagram of piezoelectric transducer.

Ans:

Constructional diagram of piezoelectric transducer:



20)State the function of proximity sensors and photodiode.

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Functions of Proximity Sensors:

1. Detect the presence of an object through change in the current in its coil.

2. Measure the small changes in displacement/ movement through changes in current.

Function of Photodiode:

It converts the light energy into current or voltage in reverse bias condition.

21)Define resistor and draw symbol of variable resistor.

Ans:

Resistor:

A resistor is an electrical component that limits or regulates the flow of electrical current in an electronic circuit.

Symbol of variable resistor:

22)State need of regulated power supply.

Ans:

A regulated power supply is used to ensure that the output remains constant even if the input changes. But sometimes main supply voltage, load, and surrounding temperature keep changing and altering the component parameters and hence changing the output voltage. Output voltage changes are undesirable. Hence the regulated power supply is needed that will accept an AC input and give a constant DC output.

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23)List specification of BJT.

Ans:

- The bipolar junction transistor (BJT) has small signal current gain, α (hfb).
- Maximum collector current Ic (max).
- Maximum collector to emitter voltage, VCE (max).
- Collector to emitter breakdown voltage, BVCBO.
- Collector cut off current, ICEO.
- Maximum collector dissipation, PD.
- Collector saturation voltage, VCE (sat).
- Collector to emitter cut off voltage, VCEO.
- Base emitter saturation voltage, VBE (sat).

24)State advantages of MOSFET.

Ans:

Advantages of MOSFET

- MOSFETs provide greater efficiency while operating at lower voltages.
- Absence of gate current results in high input impedance.
- High switching speed.
- They operate at lower power and draws no current.
- They have high drain resistance due to lower resistance of channel.
- They are easy to manufacture.
- They are portable.

25)Give different types of IC.

Ans:

- Analog IC
- Digital IC
- Thin and thick film ICs
- Monolithic ICs

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- Hybrid or multichip ICs

26)Define Analog Transducer and give examples of it

Ans:

Analog Transducer:

An analog transducer is a device that converts the input signal into a continuous DC signal of voltage or current.

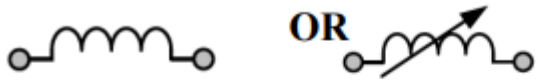
Examples:

- Strain gauge
- L.V.D.T
- Thermocouple

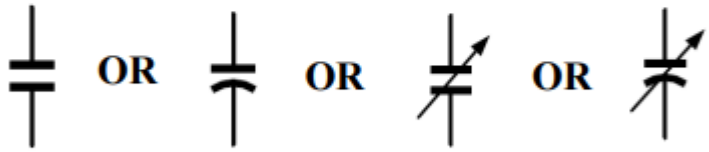
27)Draw the symbol of inductor and capacitor. State the unit of inductor and capacitor.

Ans:

Symbol of Inductor:



Symbol of Capacitor:



Unit of Inductance : Henry OR H
Unit of capacitance : farad OR F

28)Define amplification factor and trans-conductance of JFET.

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Amplification factor:

Amplification factor (μ) of a JFET is the ratio of change in drain voltage to gate voltage keeping constant drain current. This indicates how much more control the gate voltage has over drain current compared to the drain voltage.

$\mu = \frac{\Delta V_{DS}}{\Delta V_{GS}}$ keeping I_D constant.

Transconductance:

The transconductance g_m is the change in the drain current for a given change in gate to source voltage with constant drain to source voltage.

$g_m = \frac{\Delta I_D}{\Delta V_{GS}}$ keeping V_{DS} constant.

29)State the two advantages and disadvantages of integrated circuits.

Ans:

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Advantages of Integrated circuits:

- Small in size due to the reduced device dimension.
- Low weight due to very small size.
- Low power requirement due to lower dimension and lower threshold power requirement.
- Low cost due to large-scale production.
- High reliability due to the absence of a solder joint.
- Increased speed.
- Easy replacement instead of repairing as it is economical.
- Higher yield, because of the batch fabrication.

Disadvantages of Integrated circuits:

- IC resistors have a limited range.
- Generally inductors (L) cannot be formed using IC.
- ICs are delicate and cannot withstand rough handling
- Limited amount of power handling.
- Lack of flexibility.
- Higher value capacitors cannot be fabricated.

30)State seebeck and Peltier effect.

Ans:

Seebeck effect: This states that whenever two dissimilar metals are connected together to form two junctions out of which, one junction is subjected to high temperature and another is subjected to low temperature then e.m.f is induced and it is proportional to the temperature difference between two junctions.

Peltier effect: This states that for two dissimilar metals in a closed loop, if current is forced to flow through, then onejunction will be heated and other will become cool.

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Basic Electronics

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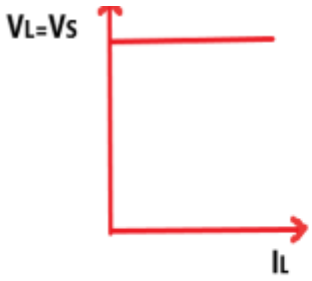
- **4 Marks**

1) With suitable graph, define voltage source & current source.

Ans :

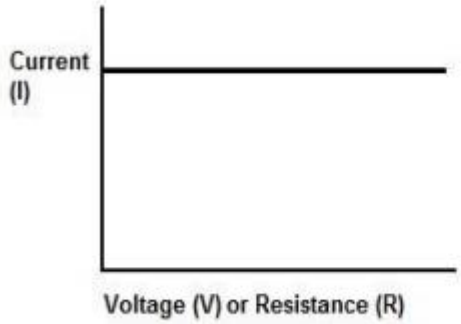
Voltage Source: It is the source which supplies electrical energy in the form of a voltage. OR It is a device which delivers variable or constant voltage

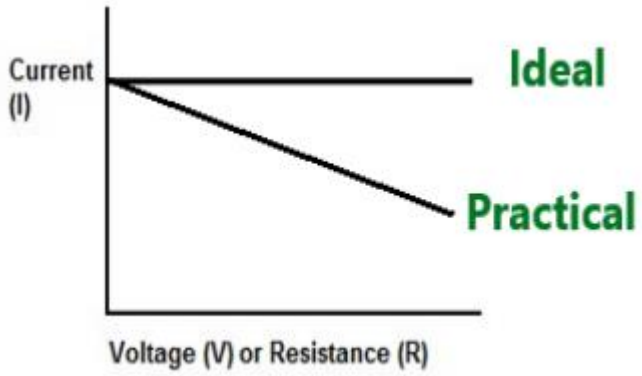


Ideal voltage source

Practical voltage source

Current Source: It is the source which supplies electrical energy in the form of an electrical current. OR It is a device which produces variable or constant current.





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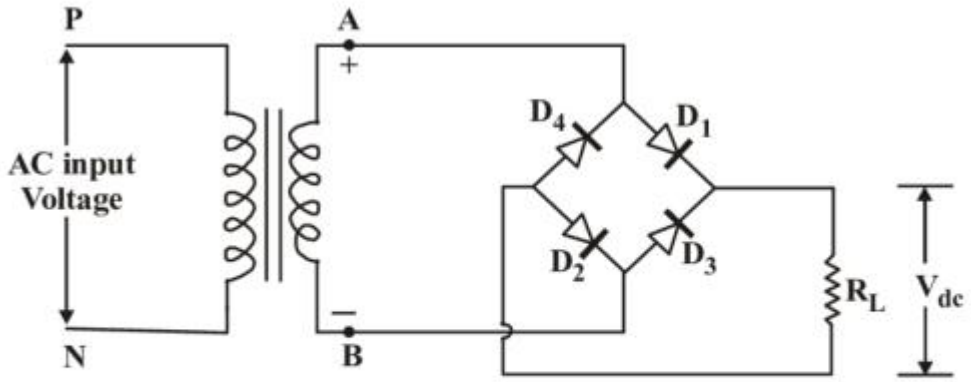
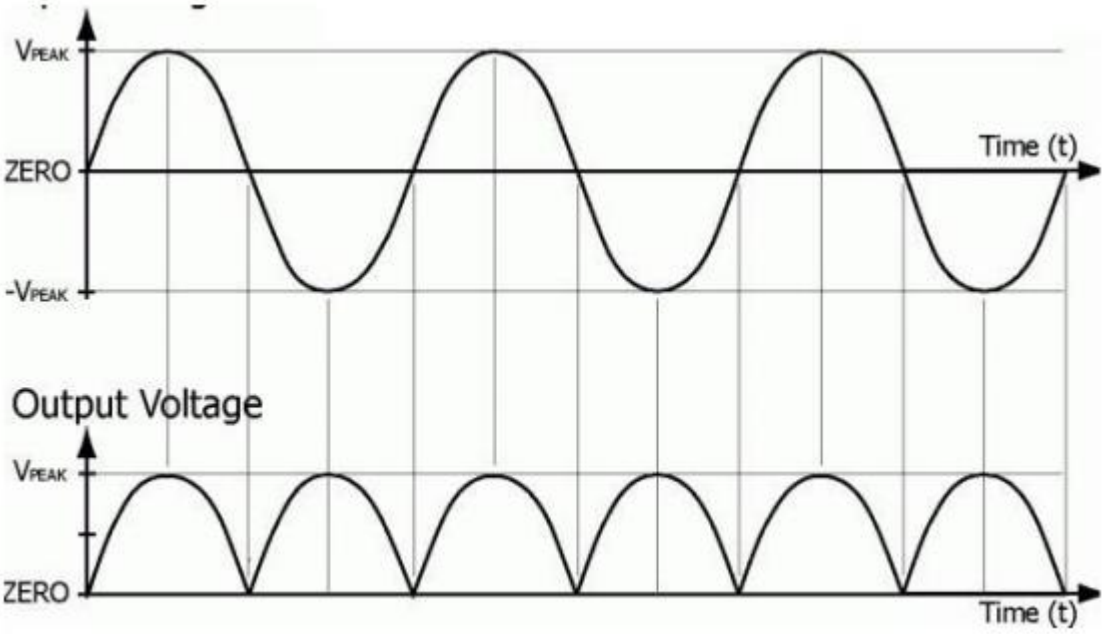
2) Draw a neat diagram of bridge rectifier. Draw input & output waveforms.

Ans:





3) With suitable diagram, explain the working of P-N junction diode

Ans:

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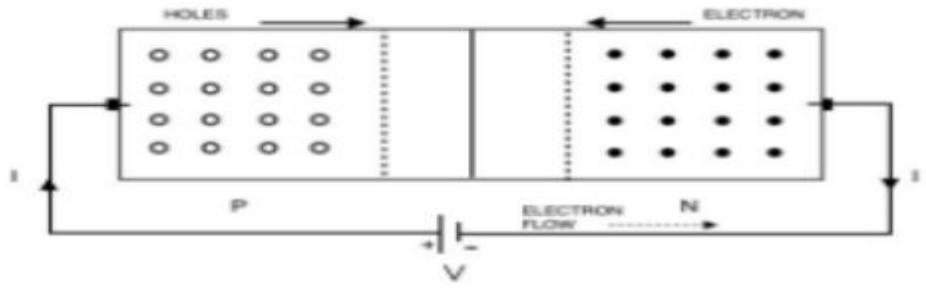
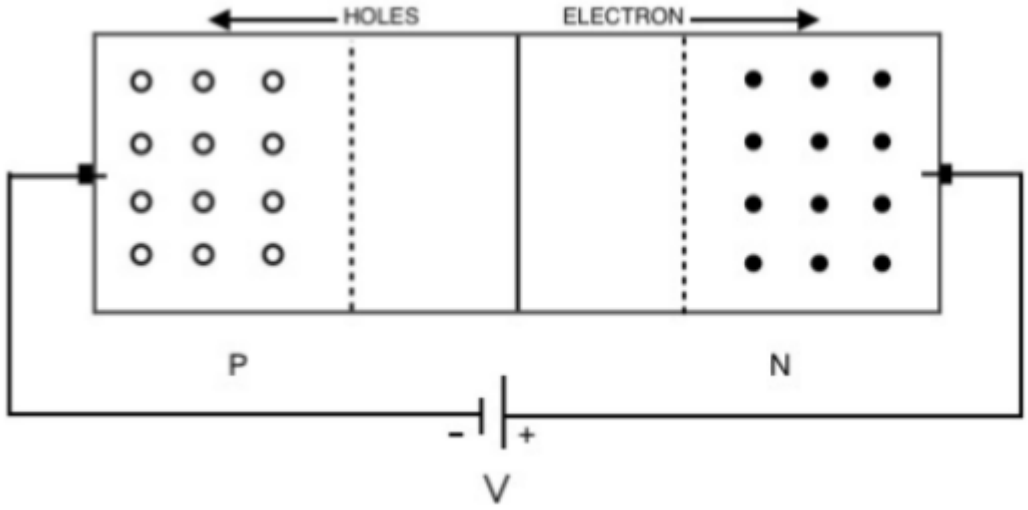


PN junction diode operated in forward bias and reverse bias condition.
Forward Bias: In forward bias condition positive terminal of the battery is connected to P-side and negative terminal to N-side of the diode. Electrons from N-side and holes from P-side are pushed towards the junction. Due to this the depletion layer's width decreases, and the current starts flowing through the diode. The Diode conduct current if applied voltage is above 0.7V for silicon and 0.3V for germanium.



Reverse Bias: In reverse bias condition, positive terminal of the battery is connected to N-side and negative terminal to P-side of diode. Free electrons and holes move away from the junction. Hence, increasing the width of depletion layer. There is no current flowing in the PN junction diode. As the applied reverse voltage is increased, very small amount of current flows through the diode due to the minority charge carrier. This current is called reverse saturation current.

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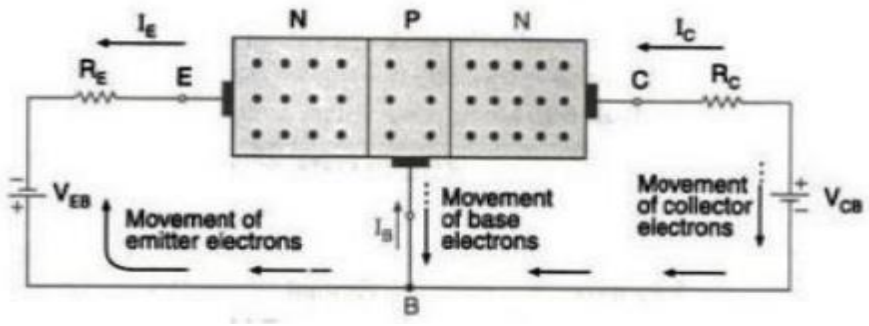
4) With suitable diagram, explain the working of NPN transistor.

Ans:



1. In this emitter-base junction is forward biased and collector-base junction is reverse biased. The forward bias causes the electrons in the emitter to flow towards the base. This constitutes the emitter current IE.

2. As these electrons flow through the base they tend to combined with holes. As the base is lightly doped and very thin therefore only a few electrons (2%) combine with holes to constitute base current IB. The remaining electrons (98%) cross over into the collector region to constitute collector current IC. This collector current is also called injected current.

3. The emitter current is sum of collector and base current.

$$I_E = I_B + I_C$$

$$I_E = I_C \qquad (I_B = \text{small})$$

5) Draw the drain & transfer characteristics of JFET.

Ans: Drain characteristics of JFET

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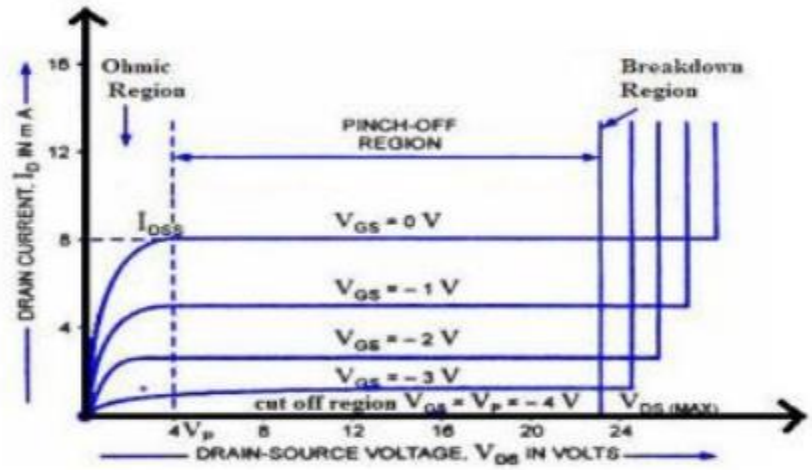
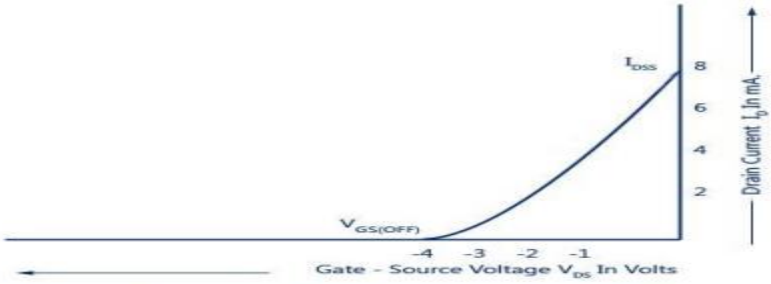


Transfer characteristics of JFET



Transfer Characteristics of JFET

6) Give the steps followed to measure temperature of metal using given transducer. Draw suitable diagram.

Ans:

Note: Any other diagram with similar concept shall be considered It is a mechanical device in which heat energy is converted into electrical energy.

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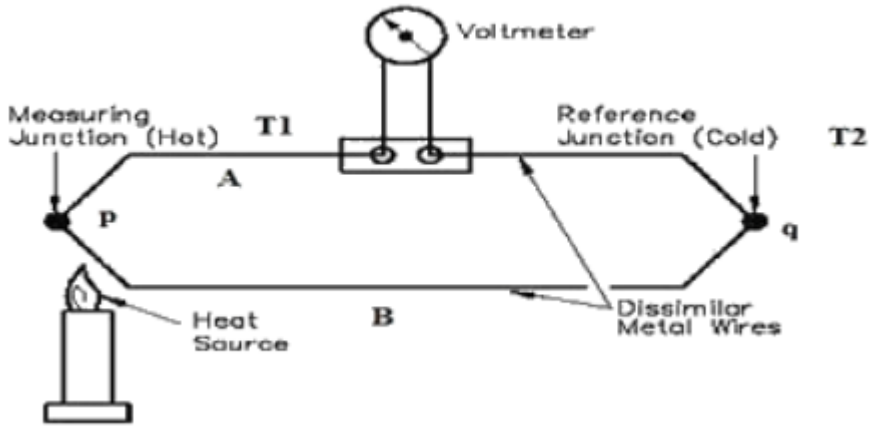

Construction

- It consists of two different metal wires which are connected together so as to form two junctions.
- One junction is kept at constant temperature (cold junction) and other is heated (hot junction).
- Hot junction is called measuring junction and cold junction is called reference junction.
- The whole arrangement is enclosed in a tube made up of glass i.e., quartz.
- Materials used Bismuth-lead, iron constantan, bismuth-silver, copper-constantan alloy. Its working principle is based on seeback effect and peilter effect.

7) List two advantages of Integrated Circuits. Distinguish between analog & digital ICs.

Ans:

- Its size is thousand times smaller than a discrete circuit.
- Its weight is very less as compared to that of equivalent discrete circuits
- In case of circuit failure, it is easy to replace Ic by new one
- Due to smaller size, power consumption is less

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Items	Analog IC	Digital IC
Signal Characteristics	Continuous, such as light, sound, speed, temperature, etc.	Discrete, 0 and 1.
Technological Complexity	High entry barrier with 10~15 years learning curve	Relying on Computer Aided Design (CAD) tools with 3~5 year learning curve
Product Accreditation	More than 1 year	3~6 months
Substitution	Low	High
Product Portfolio	Low volume, High variety	High volume, Low variety
Applications	Power management, Audio amplification, Signal transformation and monitoring	Logic computation, Control, Digital signal coding/decoding
Price	Stable	Volatile

8) With suitable diagram, explain the working of transistor as an amplifier.

Ans:

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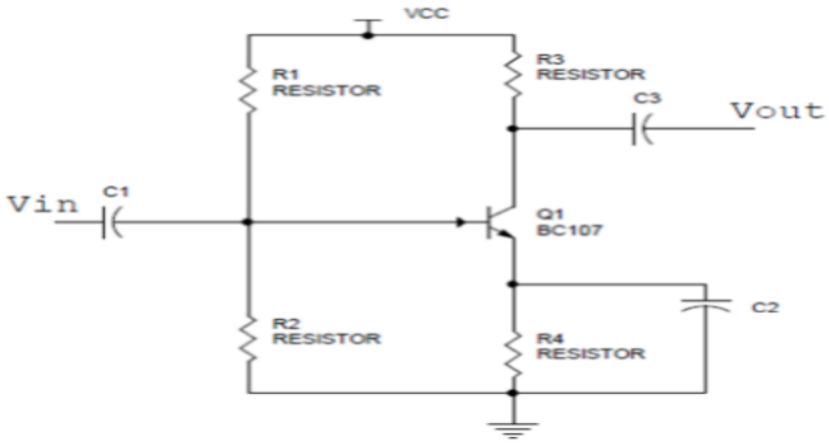

The signal is fed at the input terminal and output is taken from collector end. The total instantaneous output voltage Vce is given by

Vce=Vcc-Ic Rc -----(1)

When the signal voltage increases in the positive half cycle, the base current also increases.

The result is that collector current and hence voltage drop IcRc increases.

As Vcc is constant, therefore output voltage Vce decreases.

As the signal voltage is increasing in the positive half cycle, the output voltage is increasing in the negative sense i.e. output is 180 degree out of phase with input.

Therefore in a CE amplifier the positive half cycle of the signal appears as amplified negative half cycle in the output and vice versa.

9**) Explain:**

(i) Seebeck effect

(ii) Peltier effect

Ans:

Seebeck effect: This states that whenever two dissimilar metals are connected together to form two junctions out of which, one junction is subjected to high temperature and another is subjected to low temperature then e.m.f is induced and it is proportional to the temperature difference between two junctions.

Peltier effect: This states that for two dissimilar metals in a closed loop, if current is forced to flow through, then one junction will be heated and other will become cool.

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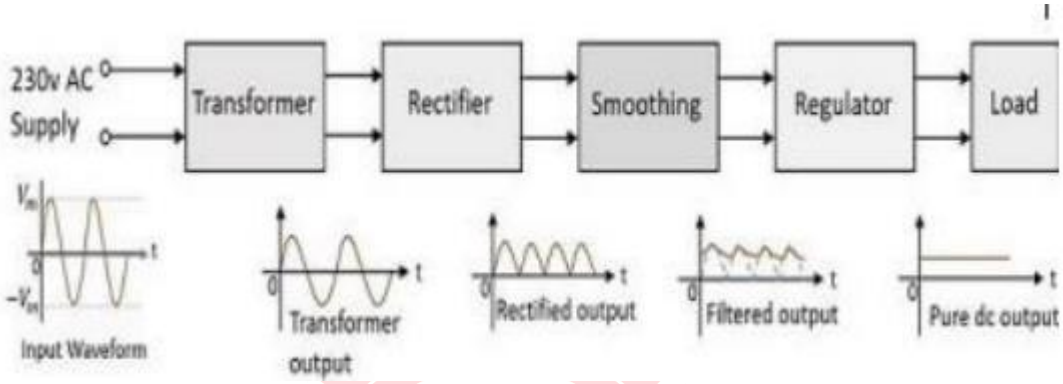
10) Draw block diagram of regulated power supply. Explain function of each block.

Ans :

Note: Any other block diagram with similar blocks shall be considered.

The block diagram of a Regulated Power supply unit is as shown below.



A typical Regulated Power supply unit consists of the following.

Transformer – An input transformer for the stepping down of the 230v AC power supply.

Rectifier – A Rectifier circuit to convert the AC components present in the signal to DC components.

Smoothing/Filter – A filtering circuit to smoothen the variations present in the rectified output.

Regulator – A voltage regulator circuit in order to control the voltage to a desired output level. Load − The load which uses the pure dc output from the regulated output.

11) With suitable diagram, explain the working of transistor as a switch.

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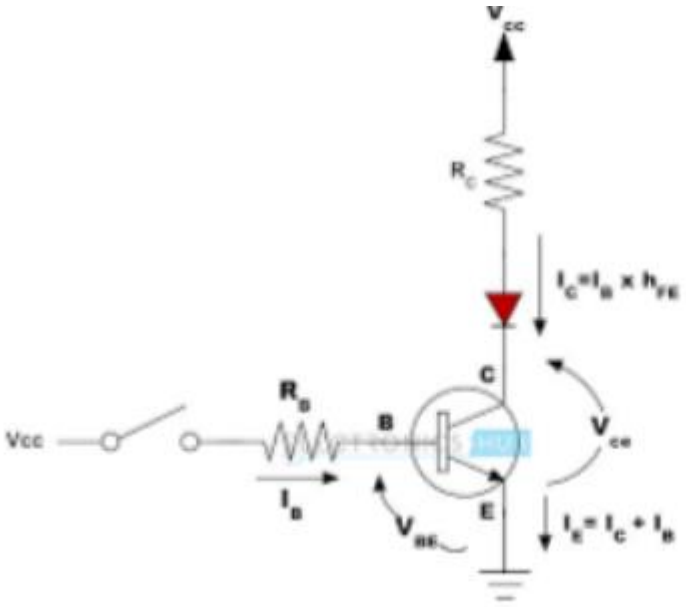

a) When both junctions are forward bias, it works in saturation region & act as closed switch. b) When both junctions are reverse biased, it works in cutoff region & act as open switch.
c) If input is not given to base, transistor remains off. Diode will be off. IC=0, Acts as open switch.
d) When input is applied to base above 0.7V, transistor becomes ON, Diode is ON. Current starts flowing, Transistor acts as close switch.

12) A JFET has a drain current of 3 mA. If IDss is 10 mA & VGS (OFF) is –6V. Find VGS & Vp.

Ans:

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Given

$I_{DSS} = 10mA$

$V_{GS(OFF)} = -6V$

Find

V_{GS} ? Vp ?

$$ID = IDSS\left(1 - \frac{VGS}{VGS(OFF)}\right)^2$$

$$VGS = \left(1 - \frac{\sqrt{ID}}{\sqrt{IDSS}}\right) \times V_{GS(OFF)}$$

$$VGS = \left(1 - \frac{\sqrt{3mA}}{\sqrt{10mA}}\right) \times (-6)$$

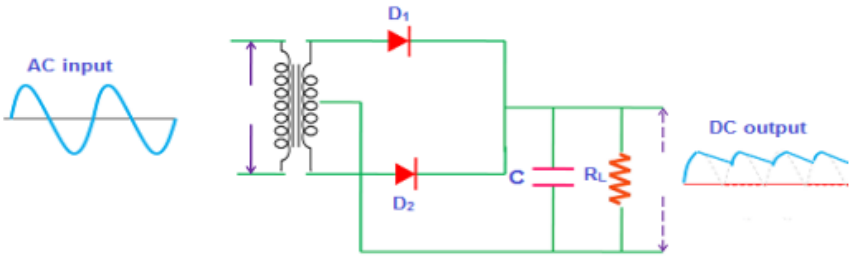
$V_{GS} = 2.7136V$

$Vp = V_{GS(OFF)}$

$\therefore Vp = -6V$

13) With suitable diagram, explain the working of capacitor filter with full wave rectifier. Draw i/p & o/p waveforms.

Ans:



Full wave rectifier with capacitor filter

During the positive half cycle, the diode (D1) current reaches the filter and charges the capacitor. However, the charging of the capacitor happens only when the applied AC voltage is greater than the capacitor voltage.

Initially, the capacitor is uncharged. That means no voltage exists between the plates of the capacitor. So when the voltage is turned on, the charging of the capacitor happens immediately.

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During this conduction period, the capacitor charges to the maximum value of the input supply voltage. The capacitor stores a maximum charge exactly at the quarter positive half cycle in the waveform. At this point, the supply voltage is equal to the capacitor voltage.

When the AC voltage starts decreasing and becomes less than the capacitor voltage, then the capacitor starts slowly discharging.

The discharging of the capacitor is very slow as compared to the charging of the capacitor. So the capacitor does not get enough time to completely discharged. Before the complete discharge of the capacitor happens, the charging again takes place. So only half or more than half of the capacitor charge get discharged.

When the input AC supply voltage reaches the negative half cycle, the diode D1 is reverse biased (blocks electric current) whereas the diode D2 is forward biased (allows electric current).

During the negative half cycle, the diode (D2) current reaches the filter and charges the capacitor. However, the charging of the capacitor happens only when the applied AC voltage is greater than the capacitor voltage.

The capacitor is not completely uncharged, so the charging of the capacitor does not happens immediately. When the supply voltage becomes greater than the capacitor voltage, the capacitor again starts charging. In both positive and negative half cycles, the current flows in the same direction across the load resistor RL.

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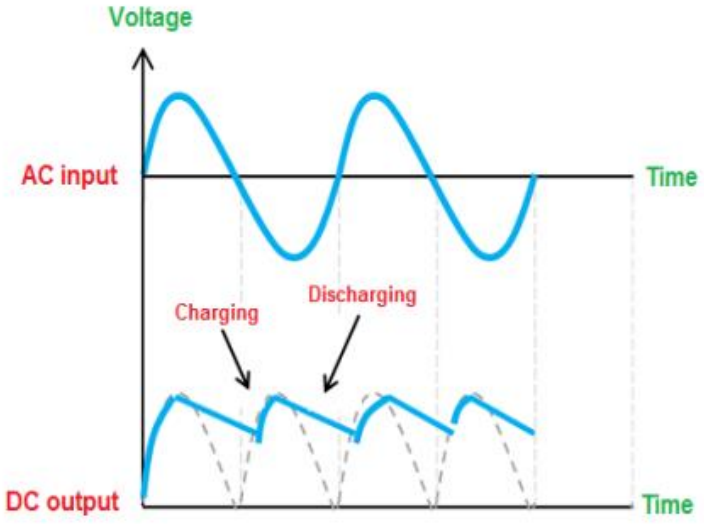

14) List the types of signals. State the expression for frequency f and wavelength λ of an A.C. signal.

Ans: Types of signals:

1. Analog signal
2. Digital signal
3. AC signal
4. DC signal
5. Sinusoidal signal
6. Triangular signal
7. Square signal

Expression for frequency f and wavelength λ of an A.C. signal.

$$\lambda = \frac{c}{f}$$

Where λ=wavelength in meters, c=speed of light in m/s and f=frequency in Hz

15) Derive the relationship between α and β of transistor.

Ans:

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Relation between α & β:

We know that; $I_E = I_B + I_C$.....(i)

Dividing equation (i) by I_C .

$I_E / Ic = (I_B / I_C) + (I_C / I_C)$

Therefore, $\frac{1}{\alpha} = \frac{1}{\beta} + 1$ (Since $\alpha = I_C / I_E$, $\beta = I_C/I_B$

Therefore $\frac{1}{\alpha} = \frac{1+\beta}{\beta}$

Therefore $\alpha = \frac{\beta}{1+\beta}$

16) State and explain the operating principle of P-N junction diode under forward bias condition.

Ans:

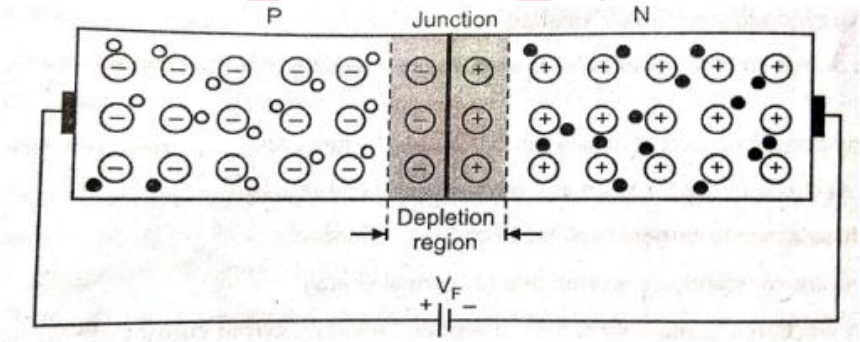

Fig. 2.3 : Forward biased P-N junction

Working Principle:

1. A p-n junction diode is said to be forward biased if the positive plate of battery is connected to the p side and negative plate to the n side. A forward biased diode is shown in figure above.
2. Since p and n sides are connected to positive & negative plate of battery respectively, the positive plate will force the holes in p side toward n side and attract the electrons in n side toward p side.
3. Similarly, the negative plate will push the electrons in n side and will attract the holes in p side. Thus both the positive and negative plates are exerting a force for the flow of holes and electrons.

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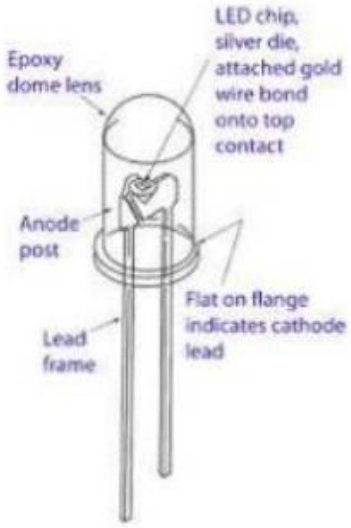
4.If the battery voltage is more than the barrier potential, the holes and electrons will have enough energy to cross the p-n junction. Subsequently flow of current will start through the p-n junction diode. It should also be noted that the width of depletion region will decrease under forward biased condition. Thus in forward biased diode, current flows from anode to cathode or from p side to n side

17) Draw the construction of Cup Type LED. List any two applications of it. **Ans:**



Constructional diagram of LED

Applications of LED:

1. Infra-red LEDs are used in burglar alarm systems.
2. For solid state video displays which are rapidly replacing CRT.
3. An image sensing circuit for picture phones.
4. In array of different types for displaying alpha-numeric characters.
5. Displays.

18) Compare FET and BJT

Ans:

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Sr. no	BJT	FET
1	It is referred to be as a transistor with bipolar junction.	It is a transistor with unijunction.
2	This device is known for its current control.	This device is known for its voltage control.
3	Consumption of power is more.	Consumption of power is less.
4	The gain is more in this type of transistor.	These transistors gain will be less.
5	The offset voltage is required.	There is no requirement of offset voltage.
6	It is more noisy	It is less noisy
7	Input resistance is very low	Input resistance is very high

19) Explain the working principle of phototransistor. State any two advantages of phototransistor

Ans:

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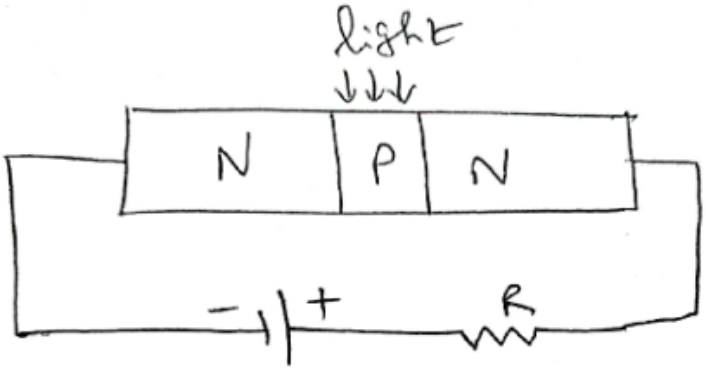

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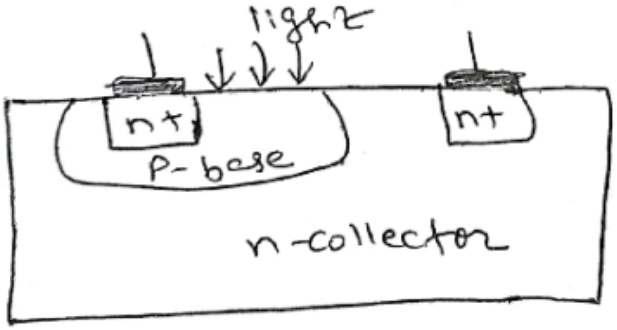

• Phototransistors semiconductor devices which have a light-sensitive base region. The phototransistor effectively converts light energy to an electrical signal.

• In a phototransistor the base current is produced when light strikes the photosensitive semiconductor base region.

• The collector-base pn junction is exposed to incident light through a lens opening in the transistor package.

• When there is no incident light, there is only a small thermally generated collector-to-emitter leakage current, ICEO; this dark current is typically in the nA range.

• When light strikes the collector-base pn junction, a base current, is produced that is directly proportional to the light intensity. This action produces a collector current that increases with light intensity.

Advantages of phototransistor

• Phototransistor is more responsive to light.

• Phototransistors are cheaper.

• The dark current of a phototransistor is much higher

• Output current of phototransistor is easily obtainable.

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• Phototransistors are very fast and are capable of providing nearly instantaneous output.

20) Determine the value of resistance with following colour code:
i) Brown Black Black Sliver
ii) Red Red Orange Gold

Ans:

i) Brown Black Black Sliver
Resistor value : 10 Ohms 10%
ii) Red Red Orange Gold
Resistor value : 22k Ohms 5%

21) State any four selection criteria for transducers.

Ans:

1. Operating Principle : The transducers are selected on the basis of operating principle it may be resistive, inductive, capacitive, optical etc.
2. Operating range: The range of transducer should be appropriate for measurement to get a good resolution.
3. Accuracy: The accuracy should be as high as possible or as per the measurement.
4.Range : The transducer can give good result within its specified range, so select transducer as per the operating range.
5. Sensitivity : The transducer should be more sensitive to produce the output or sensitivity should be as per requirement.
6. Loading effect : The transducer's input impedance should be high and output impedance should be low to avoid loading effect. 7. Errors: The error produced by the transducer should be low as possible.
8.Environmental compatibility : The transducer should maintain input and output characteristic for the selected environmental condition.

22) Define the following terms with respect to rectifier:

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i) Ripple Factor
ii) Rectification Efficiency(h)
iii) Transformer Utilization Factor(TUF)
iv) Peak Inverse Voltage (PIV)

Ans:

(i) **Ripple factor:** The factor which represents ac component present in the rectifier output, with respect to dc component is called Ripple Factor.

OR

The ratio of r.m.s. value of a.c. component to the d.c. component in the rectifier output is known as ripple factor. Mathematically,

$$\gamma = \text{rms value of ac component / dc component}$$
$$\gamma = Vrms/Vdc$$
$$= Irms/Idc$$

(ii)Rectification efficiency (η): This is defined as the ratio of dc power delivered to the load to the ac input power from the secondary winding of the transformer. Mathematically,

$$\eta = \text{dc power delivered to the load/ac input power from the transformer secondary}$$
$$= Pdc/Pac$$

(ii) Transformer Utilization Factor (TUF): It is the ratio of dc power delivered to the load and the ac rating of the transformer secondary.

$$TUF = \text{dc power delivered to the load/ac rating of the transformer secondary}$$
$$= Pdc/Pac\ rated$$

(iii) **Peak Inverse Voltage (PIV):** Peak Inverse Voltage (PIV) is the maximum reverse voltage that the diode of a rectifier can withstand without being damage.

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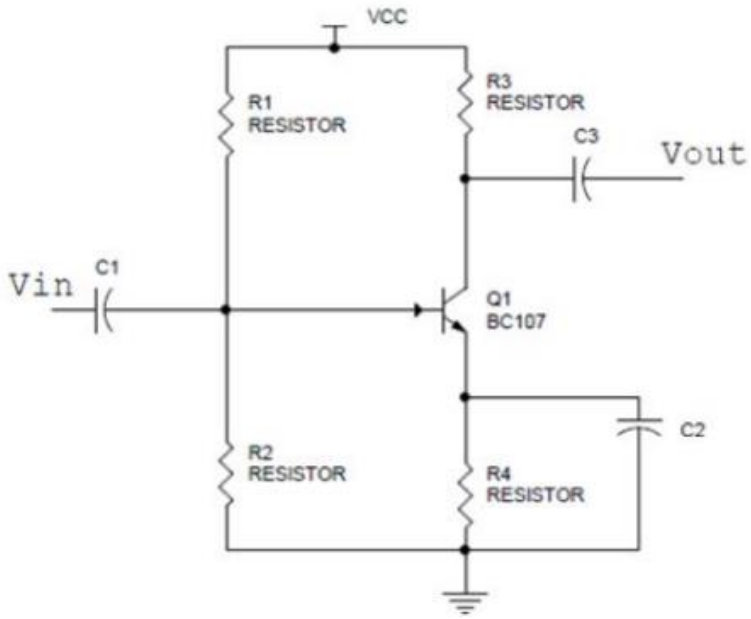
23) Draw the circuit diagram of single stage RC coupled CE amplifier. State any two advantages of it.

Ans:

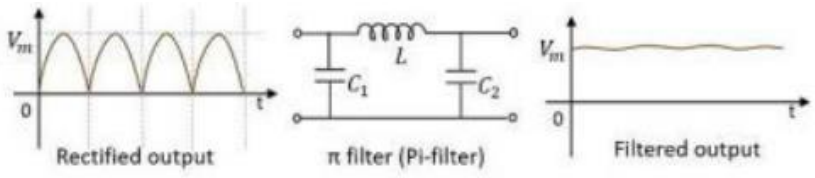


Advantages of single stage RC coupled amplifier:

1. It has low cost.
2. The circuit is very compact and extremely light.
3. The frequency response of RC coupled amplifier is excellent.
4. It offers a constant gain over a wide frequency band.

24) Draw and explain the working of CLC filter.

Ans:



Working of a Pi filter:

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In this circuit, we have a capacitor in parallel, then an inductor in series, followed by another capacitor in parallel.

1.Capacitor C1 – This filter capacitor offers high reactance to dc and low reactance to ac signal. After grounding the ac components present in the signal, the signal passes to the inductor for further filtration.

2.Inductor L – This inductor offers low reactance to dc components and offers high reactance to the ac components which remains to pass through the capacitor C1.

3.Capacitor C2 – Now the signal is further smoothened using this capacitor C2. It allows any ac component present in the signal to pass through it, which the inductor has failed to block.

25) State the advantages of integrated circuits over circuits with discrete components.

Ans:

Advantages of Integrated circuits:

• Small in size due to the reduced device dimension.

• Low weight due to very small size.

• Low power requirement due to lower dimension and lower threshold power requirement.

• Low cost due to large-scale production.

• High reliability due to the absence of a solder joint.

• Increased response time and speed.

• Easy replacement instead of repairing as it is economical.

• Higher yield, because of the batch fabrication.

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26) Draw construction of LED and explain working principle.

Ans:

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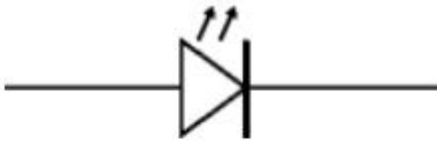
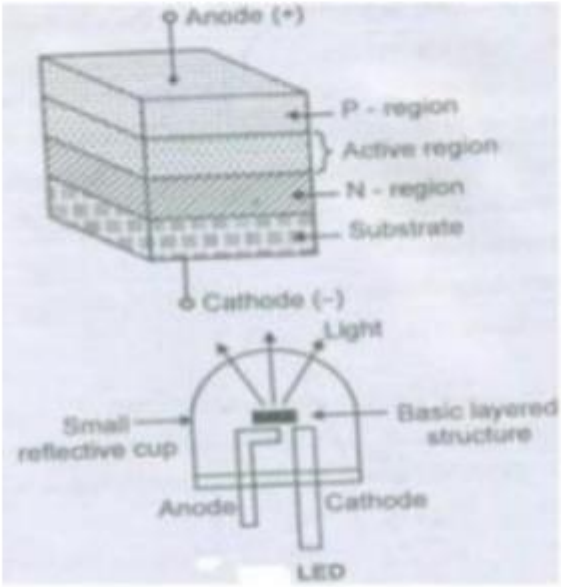
Working principle:

A PN junction diode, which emits light when forward biased, is known as a Light Emitting Diode (LED). The emitted light may be visible or invisible. The amount of light output is directly proportional to the forward current. Thus, higher the forward current, higher is the light output.





When the LED is forward biased, the electrons and holes move towards the junction and the recombination takes place. After recombination, the electrons, lying in the conduction bands of N region, fall into the holes lying in the valence band of a P region. The difference of energy between the conduction band and valence band of a P region is radiated in the form of light energy. The semiconducting materials used for manufacturing of Light Emitting Diodes are Gallium Phosphide and gallium Arsenide Phosphide. These materials decide the colour of the light emitted by the diode.

27) Compare CB, CE and CC configuration on the basis of:

(i) Input impedance

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(ii) Output impedance

(iii) Current gain

(iv) Application

Ans:

Factor	CB	CE	CC
Input Impedance	Low **OR** 50Ω	Medium **OR** 600 Ω to 4K Ω	High **OR** 1M Ω
Output Impedance	High **OR** 50 K Ω	Medium **OR** 10K Ω to 50K Ω	Low **OR** 50 Ω
Current Gain	Less than or equal to 1 **OR** $\alpha = \frac{I_C}{I_E}$	High (100) **OR** $\beta = \frac{I_C}{I_B}$	High (100) **OR** $\gamma = \frac{I_E}{I_B}$
Application	High frequency Circuits	Audio frequency circuits (Amplifiers)	Impedance Matching

28) Draw and explain the construction of N-channel JFET.

Ans:

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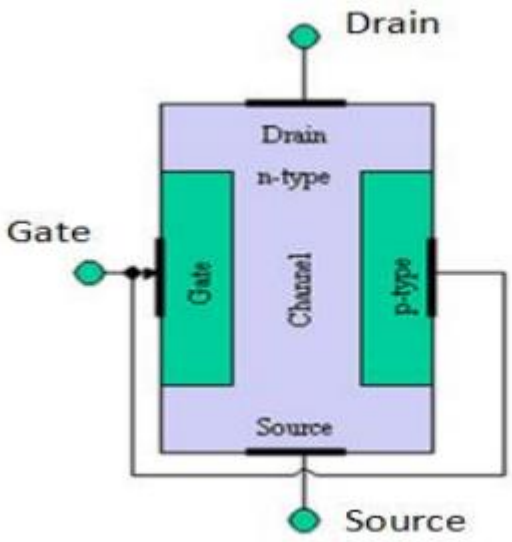

Construction Details:

A JFET consists of a p-type or n-type silicon bar containing two PN junctions at the sides as shown in fig. The bar forms the conducting channel for the charge carriers. If the bar is of p-type, it is called pchannel JFET and if the bar is of n-type, it is called n-channel JFET as shown in fig. The two PN junctions forming diodes are connected internally and a common terminal called gate is taken out. Other terminals are source and drain taken out from the bar as shown in fig.1.Thus a JFET has three terminals such as, gate (G), source (S) and drain (D)

29) State any four selection criteria for transducers.

Ans: Selection criteria for transducers are:

1. Operating range
2. Operating principle
3. Sensitivity
4. Accuracy
5. Frequency response and resonant frequency
6. Errors

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7. Environmental compatibility

8. Usage and ruggedness.

9. Electrical aspect.

10. Stability and Reliability

11. Loading effect

12. Static characteristics

13. General selection criteria

30) Determine the value of resistance with the following colour code:

(i) Red, Red, Orange, Gold (ii) Brown, Black, Black, Silver

Ans: (i) Red, Red, Orange, Gold

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Red	Red	Orange	Gold
↓	↓	↓	↓
2	2	x 1000	± 5%

= 22 x 1000± 5%

Value of resistor is 22 KΩ + 5% OR 22000Ω + 5%

(ii) Brown, Black, Black, Silver

Brown	Black	Black	Silver
↓	↓	↓	↓
1	0	x 1	±10%

= 10 x 1 ± 10%

Value of resistor is 10 Ω ± 10%

31) Explain the concept of DC load line and operating point for biasing circuit.

Ans: DC load line: The straight line drawn on the characteristics of a BJT amplifier which give the DC values of collector current IC and collector to emitter voltage VCE corresponding to zero signal i.e. DC conditions is called DC load line.

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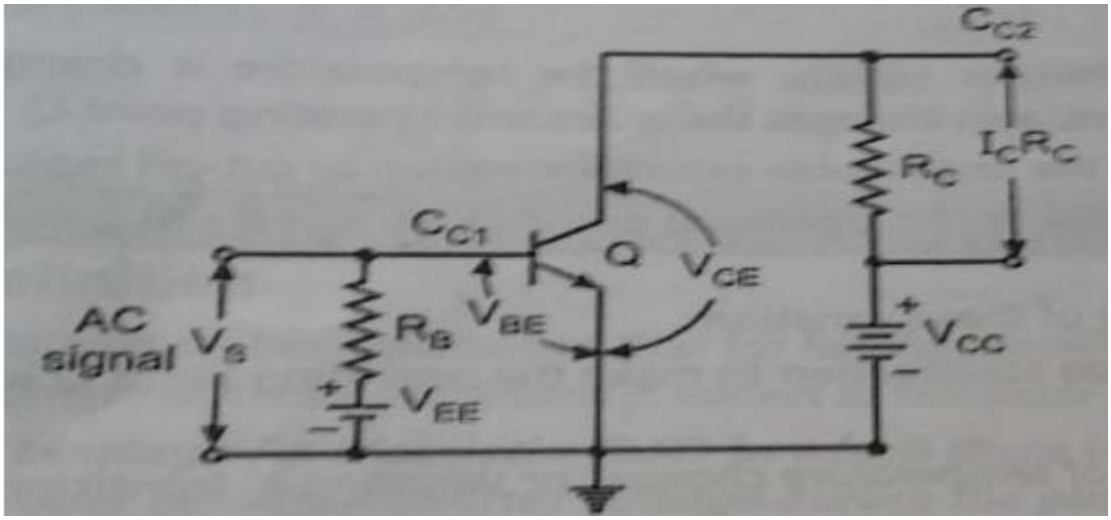

To plot $I_{C(MAX)}$, $V_{CE\ (MAX)}$ on output characteristics:

Get $V_{CE\ (MAX)}$ by putting $I_c = 0$

$$V_{CE} = V_{CC} - I_c \ R_c$$

$$V_{CE\ (MAX)} = V_{CC} \qquad \text{since } I_c = 0$$

Get $I_{C(MAX)}$ by putting $V_{CE} = 0$

$$I_{C(MAX)} = \frac{V_{CC}}{R_C}$$

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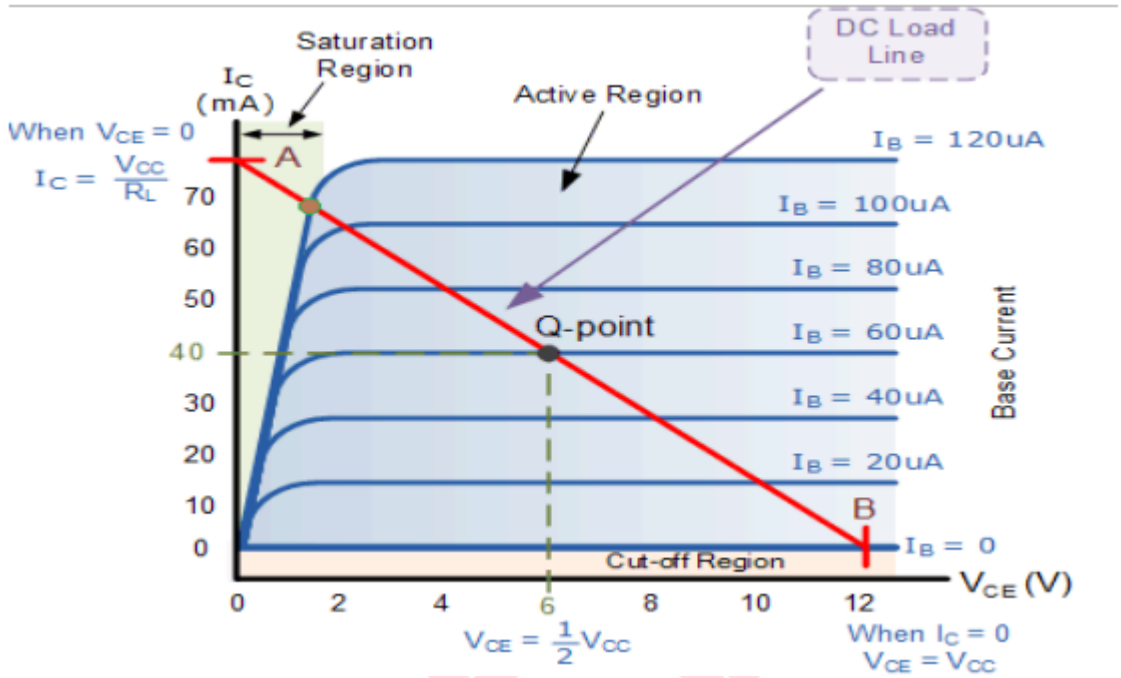

Operating point or Q- point: The fixed levels of certain currents and voltages in a transistor in active region defines the operating point on the DC load line.

For normal operation of the transistor, the Q- point is to be selected at the center of the load line.

32) Explain:

(i) Seebeck effect

(ii) Peltier effect

Ans: Seebeck effect states that whenever two dissimilar metals are connected together to form two junctions out of which, one junction is subjected to high temperature and another is subjected to low temperature then e.m.f is induced proportional to the temperature difference between two junctions.

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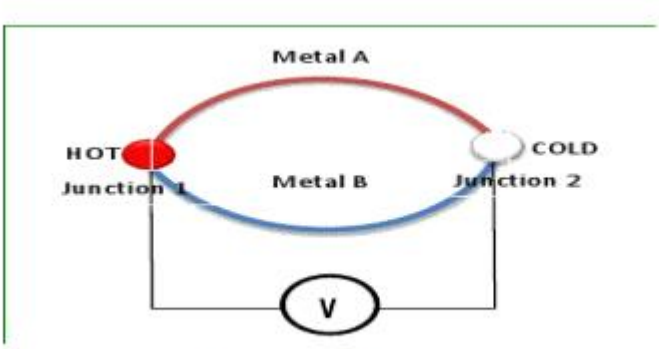
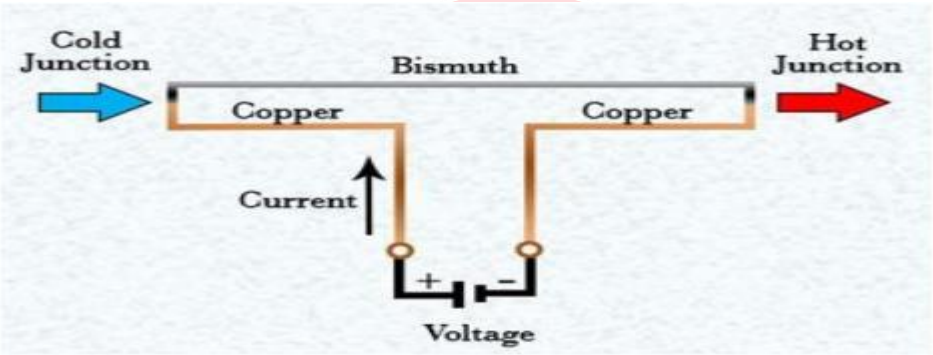


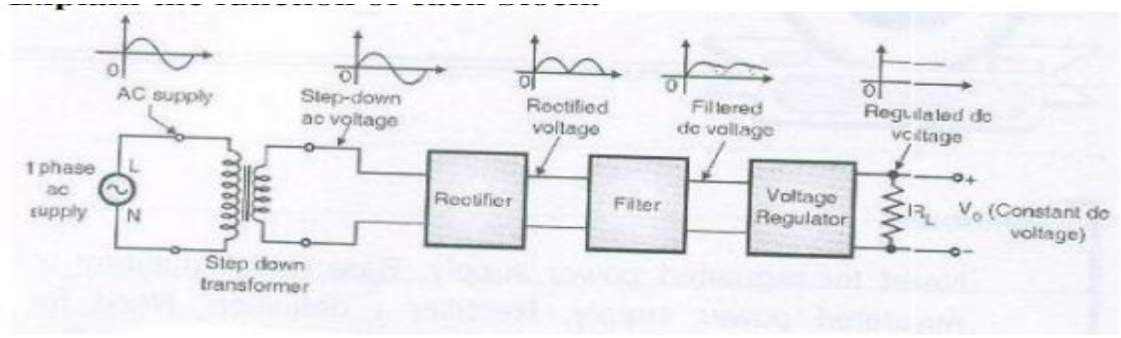
Fig. Seedback effect

(ii) Peltier effect: Peltier effect state that for two dissimilar metals closed loop, if current forced to flow through the closed loop then one junction will be heated and other will become cool.



33) Draw the basic block diagram of regulated DC power supply. Explain the function of each block.

Ans:



Block diagram of regulated power supply

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1.TRANSFORMER:

Transformer works on the basis of ELECTROMAGNETIC INDUCTION and they are mainly classified into two: i. STEP UP TRANSFORMER ii. STEPDOWN TRANSFORMER Step up transformer up convert the input voltage where step down transformer down converts. For a DC Power Source we have to use step down transformers, to covert the high voltage AC supply to low voltage DC.

2. RECTIFIER:

Rectifiers are used to convert the sinusoidal AC voltage to non-sinusoidal pulsating DC. The main component used in Rectifiers are diodes due to its switching action. They will conduct Current only in one direction, hence the voltage. So we can use them as rectifiers to make the alternating Current unidirectional.

Rectifiers are classified into Three :-

i. HALF WAVE RECTIFIERS

ii. FULL WAVE RECTIFIERS

iii. BRIDGE RECTIFIERS

3. FILTERS:

Filters are used to eliminate or filter-out the unwanted ripples from the rectified output. Filters play an important role in dc Power supplies, they make the pulsating dc steady.

4. VOLTAGE REGULATOR:

Voltage Regulators are used to regulate the output Voltage over load. They make the Voltage unvaried with load connected to it. This will eliminates the remaining ripples from the filter output. The output from Voltage Regulator may be the required DC. Voltage Regulators includes some safety measures such as Current Limiting, short circuit etc.

34) Describe the working of transistor as a switch with circuit diagram.

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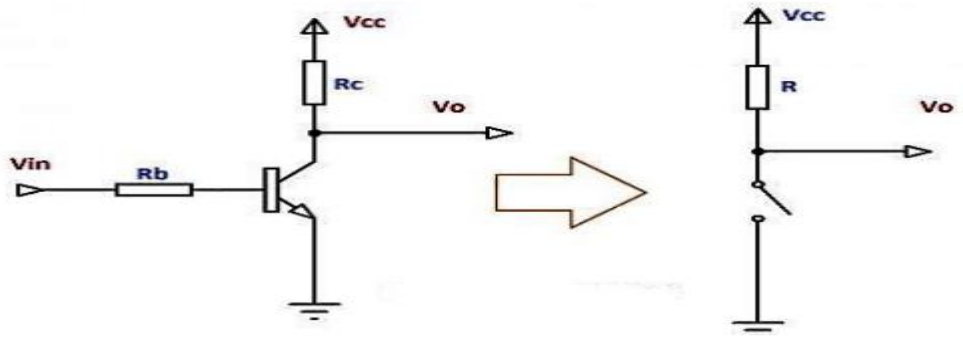
Ans:



Transistor as a Switch Circuit Diagram

From the above circuit we can see that the control input Vin is given to base through a current limiting resistor Rb and Rc is the collector resistor which limits the current through the transistor. In most cases output is taken from collector but in some cases load is connected in the place of Rc.

- ON = Saturation
- OFF = Cutoff

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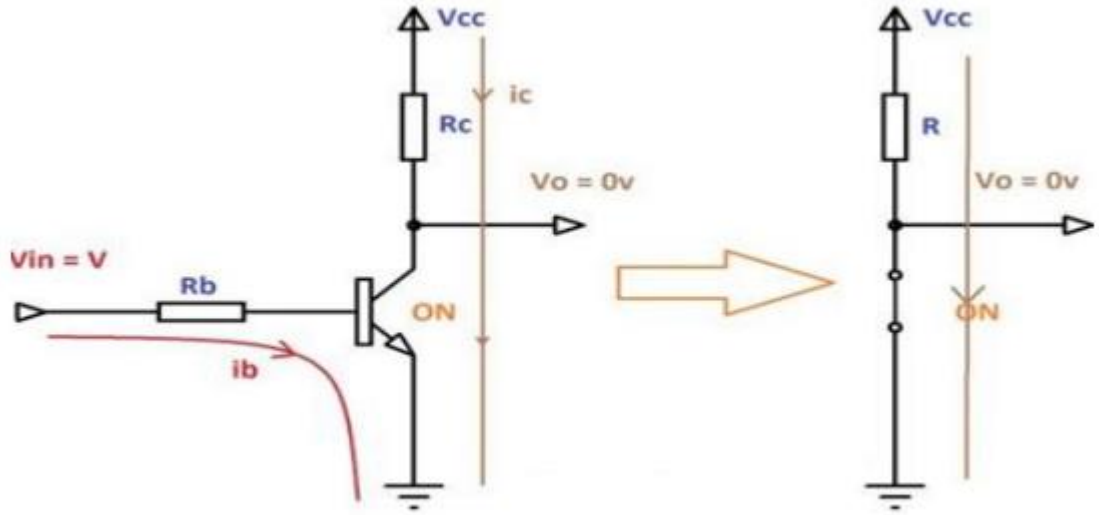
Transistor as a Switch – ON:



Transistor as a Switch ON

Transistor will become ON (saturation) when a sufficient voltage V is given to input. During this condition the Collector Emitter voltage Vce will be approximately equal to zero, ie the transistor acts as a short circuit. For a silicon transistor it is equal to 0.3v. Thus collector current Ic = Vcc/Rc will flows.

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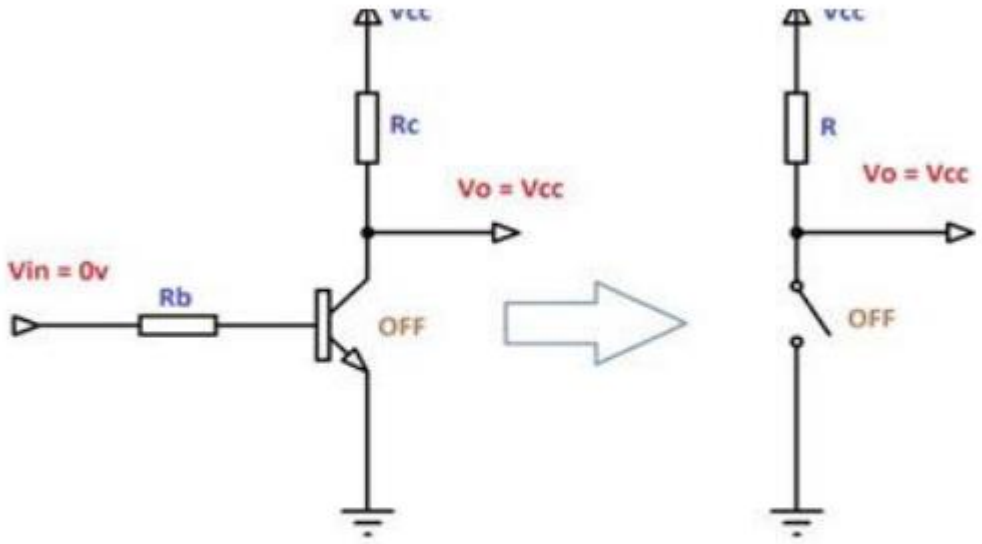
Transistor as a Switch – OFF:



Transistor as a Switch OFF

Transistor will be in OFF (cutoff) when the input Vin equal to zero. During this state transistor acts as an open circuit and thus the entire voltage Vcc will be available at collector.

35) A JFET has a drain current of 5 mA. If IDSS = 10mA and VGS(OFF) = -6V.

Find the value of

(i) VGS

(ii) VP

Ans:

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Given:

$I_D = 5mA$

$I_{DSS} = 10mA$

$V_{GS(OFF)} = -6V$

$V_{GS} = ?$

$V_P = ?$

$$I_D = I_{DSS} \cdot \left(1 - \frac{V_{GS}}{V_{GS\ (OFF\ )}}\right)^2$$

$$V_{GS} = \left(1 - \frac{\sqrt{I_D}}{\sqrt{I_{DSS}}}\right) X\ V_{GS\ OFF}$$

$$V_{GS} = \left(1 - \frac{\sqrt{5mA}}{\sqrt{10mA}}\right) X - 6$$

$$\boxed{V_{GS} = -1.756V}$$

$$V_P = V_{GS(OFF)}$$

$$\therefore \quad \boxed{V_P = -6V}$$

36) Compare P-N junction diode and zener diode on the basis of

(i) Symbol (ii) Direction of conduction

(iii) Reverse breakdown (iv) Application

Ans:

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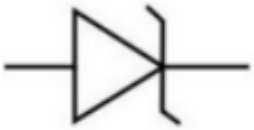
Parameter	Zener Diode	PN Diode
Symbol		
Direction of conduction	It conducts in both directions.	It conducts only in one direction.
Reverse breakdown	It has quite sharp reverse breakdown.	It has no sharp reverse breakdown.
Application	Commonly used for voltage regulation	commonly used for rectification

37)State different types of electrical signal and draw all types of waveforms.

Ans : Types of electrical signals

1) Sine wave

2) Triangular wave

3) Square wave

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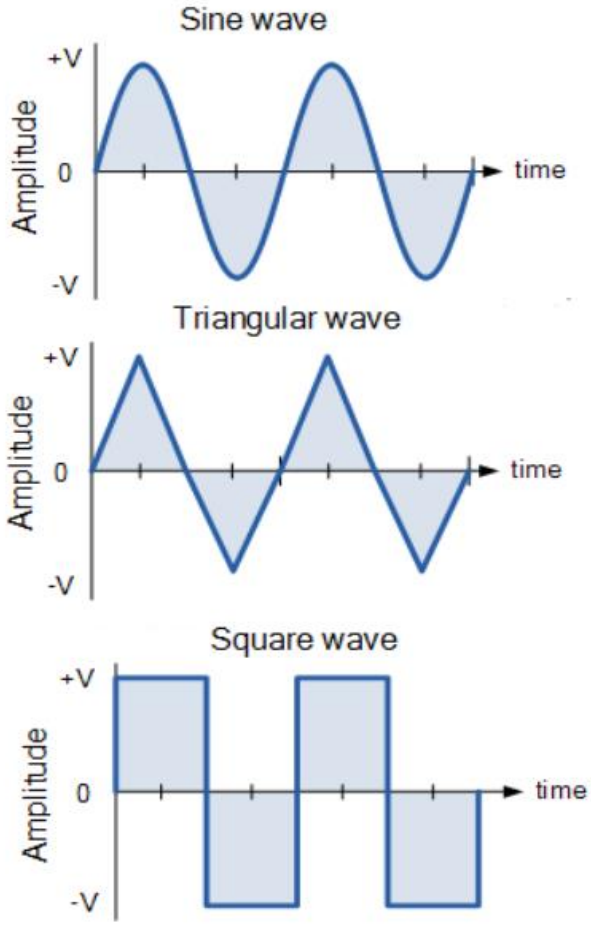
Waveforms



38)Sketch N-Channel MOSFET and describe its working.

Ans : Note: N channel Depletion MOSFET also can be consider.

Sketch N-Channel MOSFET:

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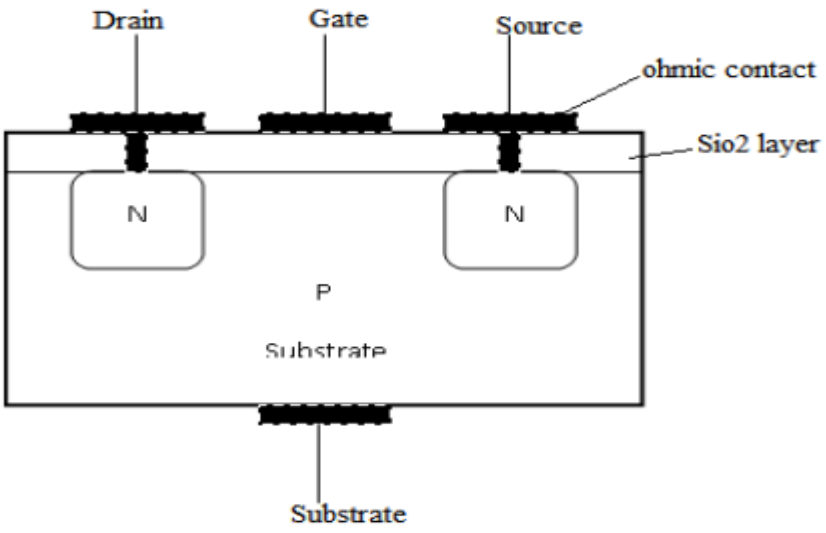
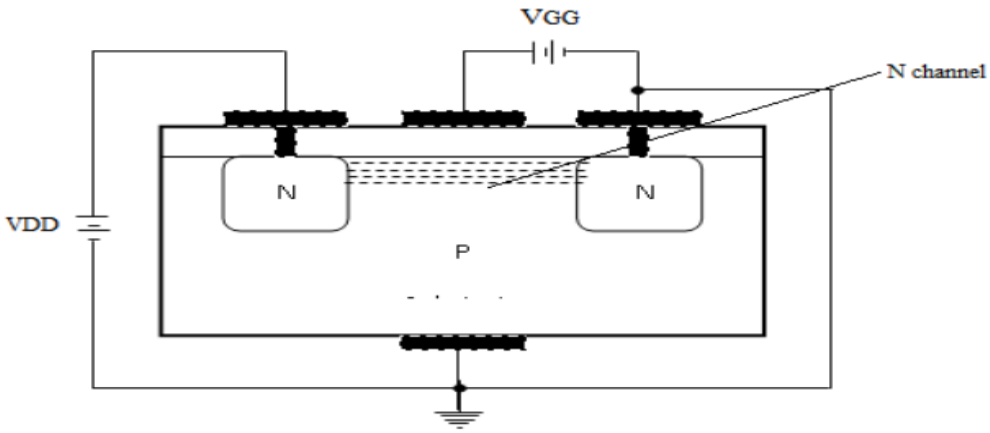


Working:



In fig. both VGS (VGG)& VDS (VDD) have been set at positive with respect to the source. The positive potential at the gate will attract the electrons from the P substrate & accumulated in the region near to the surface of Sio2 layer. The Sio2 layer & its insulating qualities will prevent the negative carrier (i.e. electron) from being absorbed at the gate.

As VGS increase by increasing VGG the concentration of electron near the Sio2 surface increases & there is formation of channel & the current starts following through the circuit for further applied voltage.

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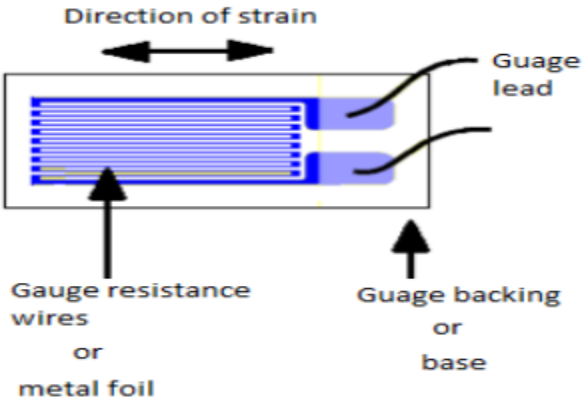
For VGS = OV & negative value of VGS, the absence of n channel will result zero current. As positive value of VGS, less than VGSth drain current is zero. If VGS > VGSth current starts increasing.

39)Describe strain gauge with labelled diagram.

Ans : A Strain gauge is a sensor whose resistance varies with applied force. It converts force, pressure, tension, weight, etc., into a change in electrical resistance which can then be measured. When external forces are applied to a stationary object, stress and strain are the result.



- The foil type strain gauges are very common in which a resistive foil is mounted on a backing material. Metal foil gauges use similar materials to wire strain gauges.
- The sensing elements of foil gauges are formed from sheets less than 0.005 mm thick by photo etching processes, which allows greater flexibility with regards to shape.
- The resistance of the foil changes as the material to which the gauge is attached undergoes tension or compression due to change in its length and diameter. This change in resistance is proportional to the applied strain. As this change in resistance is very small in magnitude so its effect can be only sensed by a Wheatstone bridge.
- When strain is applied to the strain gauge, the resistance of the strain gauge sensor changes, the Wheatstone bridge becomes unbalanced, a current flows through the voltmeter. Since the net change in the resistance is proportional to the applied strain, therefore, resultant

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current flow through the voltmeter is proportional to the applied strain. So, the voltmeter can be calibrated in terms of strain or force.

40)With the help of circuit diagram describe conversion of VG. Source to current source.

Ans : Any practical voltage source or simply a voltage source consists of an ideal voltage source in series with an internal resistance or impedance.

The voltage and current source are mutually transferable i.e. voltage to current source and current to voltage source.

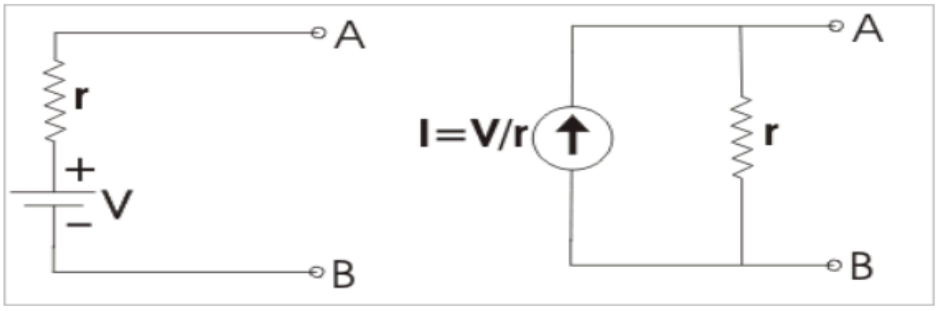

Figure A represents a practical voltage source in series with the internal resistance r while figure B represents a practical current source with parallel internal resistance r

Therefore, for any practical voltage source, if the ideal voltage be V and internal resistance be r, the voltage source can be replaced by a current source I (i.e. $\frac{V}{r}$) with the internal resistance(r) in parallel with the current source as shown.

41)Describe LVDT with labelled diagram.

Ans:-

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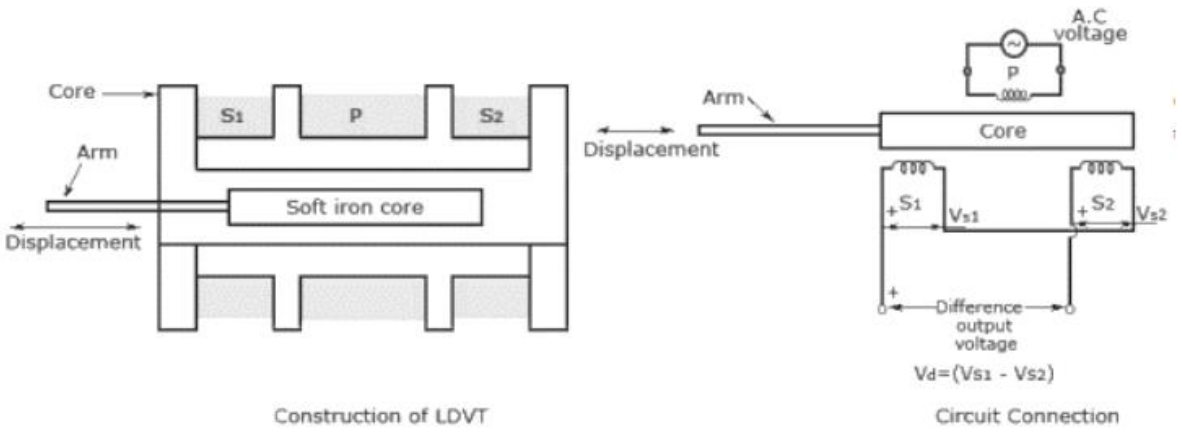
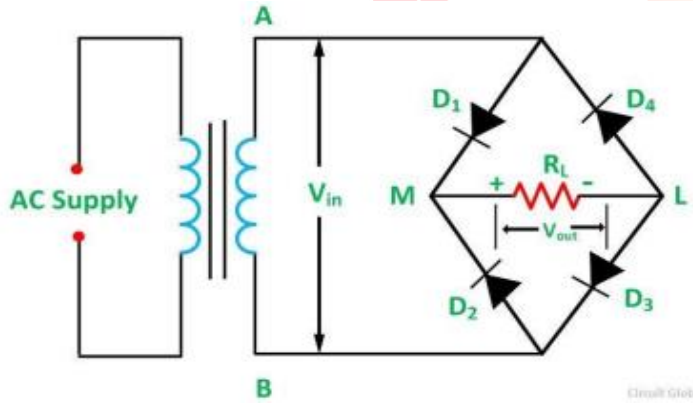


Working: LVDT is the example of inductive transducer, in LVDT any physical displacement of the core cause the voltage of any secondary winding to increase while simultaneously reducing the voltage in the other secondary winding. The difference of the two voltages appears across the output terminal of the transducer and gives a measurement of the physical position of the core.

42)Draw circuit diagram of bridge rectifier. Draw its input output waveforms and describe its operation.

Ans:-



Working: - The four diodes labelled D1 to D4 are arranged in “series pairs” with only two diodes conducting current during each half cycle.

During the positive half cycle of the supply: - diodes D1 and D3 conduct in series while diodes D2 and D4 are reverse biased and the current flows through the load for the period o to π.

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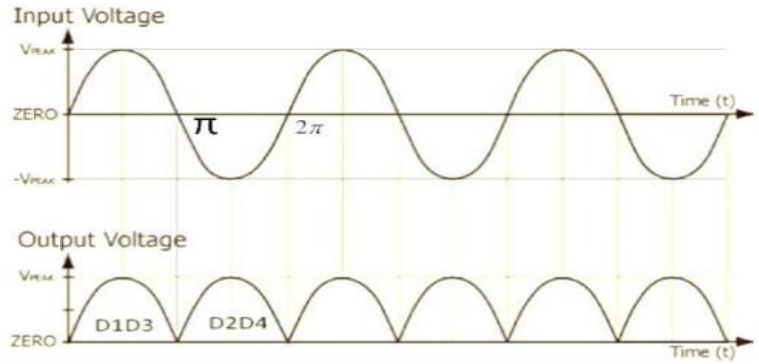
During the negative half cycle of the supply:- diodes D2 and D4 conduct in series, but diodes D1 and D3 switch “OFF” as they are now reverse biased.

The current flowing through the load is the same direction as before for the period π to 2π.

Waveform:



43)Give the relations between AC drain resistance (rd), transconduction (gm) and amplification factor.

Ans:-

Since

AC drain resistance is given as, $r_d = \frac{\Delta V_{DS}}{\Delta I_D}$ at V_{GS} constant

Transconductance gm is given as , $g_m = \frac{\Delta I_D}{\Delta V_{GS}}$, V_{DS} at constant

Amplification factor μ

$$\mu = r_d \times g_m$$

$$\mu = \frac{\Delta V_{DS}}{\Delta I_D} X \frac{\Delta I_D}{\Delta V_{GS}}$$

$$\mu = \frac{\Delta V_{DS}}{\Delta V_{GS}}$$

44)Sketch the constructional diagram of LED and describe its working.

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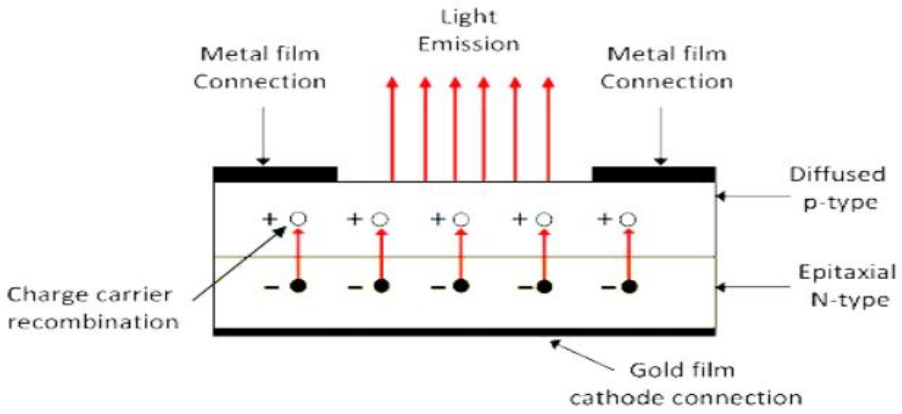
Ans : Constructional Diagram:



- Light Emitting Diode (LED) works only in forward bias condition. When Light Emitting Diode (LED) is forward biased, the free electrons from n-side and the holes from p-side are pushed towards the junction.
- When free electrons reach the junction, some of the free electrons recombine with the holes in the positive ions. In the similar way, holes from p-side recombine with electrons in the depletion region. Some free electrons from n-type semiconductor cross the p-n junction and recombines with holes in p-type semiconductor. In the similar way, holes from ptype semiconductor cross the p-n junction and recombines with free electrons in the n-type semiconductor.
- Thus, recombination takes place in depletion region as well as in p-type and n-type semiconductor.
- The free electrons in the conduction band releases energy in the form of light before they recombine with holes in the valence band.
- In silicon and germanium diodes, most of the energy is released in the form of heat and emitted light is too small.
- However, in materials like gallium arsenide and gallium phosphide the emitted photons have sufficient energy to produce intense visible light.

45)Draw DC load line of transistor. Explain working of transistor as a switch.

Ans:

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1. Q-point is the operating point of the transistor (ICQ, VCEQ) at which it is biased. 2. The concept of Q-point is used when transistor act as an amplifying device and hence is operated in active region of input output characteristics. 3.To operate the BJT at a point it is necessary to provide voltages and currents through external sources. 4.To draw DC load line of a transistor we need to find the saturation current and cutoff voltage. The saturation current is the maximum possible current through the transistor and occurs at the point where the voltage across the collector is minimum. 5. The cutoff voltage is the maximum possible voltage across the collector and occurs at zero collector current. A common emitter amplifier is shown the figure below:

Applying KVL to the collector circuit,

VCC-VCE - IC.RC=0

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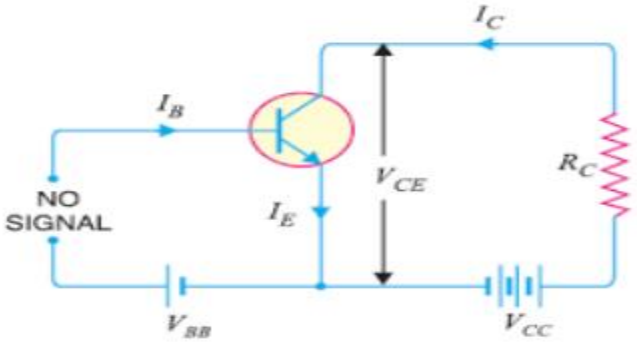
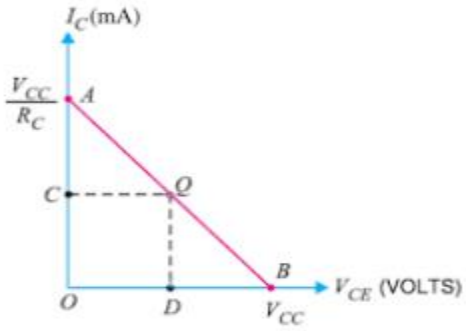
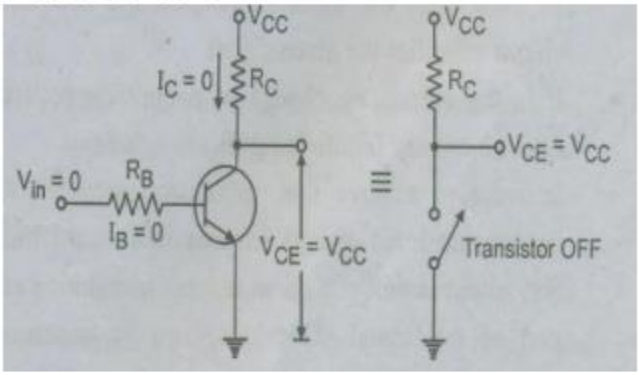
Rearranging this equation we get,
$I_C = (-1/RC).V_{CE} + (V_{CC}/R_C)$
Compare the above equation with equation of a straight line ie.y=mx+c
Substituting $V_{CE}=0$, we get $I_C=V_{CC}/R_C$
Substituting $I_C=0$, we get $V_{CE}=V_{CC}$
This straight line is called as DC load line





Transistor as a switch:



1. Transistor in cut- off region is an open switch. Here Vin is 0 V.

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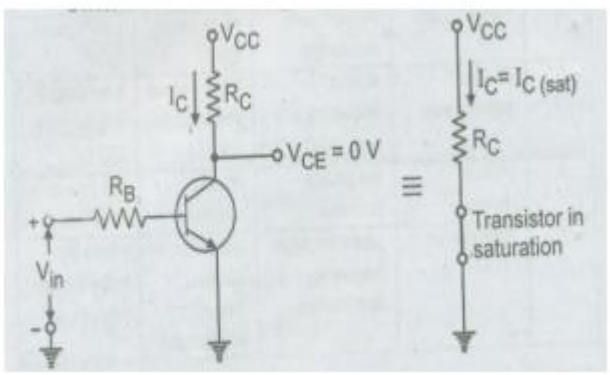
2. In the cut –off region both the junction of a transistor are reverse biased and very small reverse current flows through the transistors.

3. The voltage drop across the transistor (VCE) is high. Thus, in the cut off region the transistor is equivalent to an open switch as shown in figure.



In saturation the transistor is equivalent to a closed switch. When Vin is positive a large base current flows and transistor saturates.

In the saturation region both the junctions of a transistor are forward biased.

The voltage drop across the transistor (VCE) is very small, of the order of 0.2 V to 1V depending on the type of transistor and collector current is very large.

46)Differentiate between P-N junction diode and zener diode.

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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.

47)Explain any four selection criteria of transducers for temperature measurement.

Ans:-

1. Ambient temperature range: It will impact on sensor accuracy as we can easily predict the ambient temperature effect on measurement taken from the sensor.

2. Stability & control precision requirement: If accuracy requirement is far better than 20F, use an RTD and if long term stability is required an RTD is better choice than Thermocouple.

3. Speed of response to temperature change requirement. Spring loaded temperature sensor and stepped thermo wells provide good speed of response.

4. Cost: Measurement failure most often results in production down time costs.

48)Explain the working of two stages RC coupled amplifier with neat circuit diagram.

Ans:-

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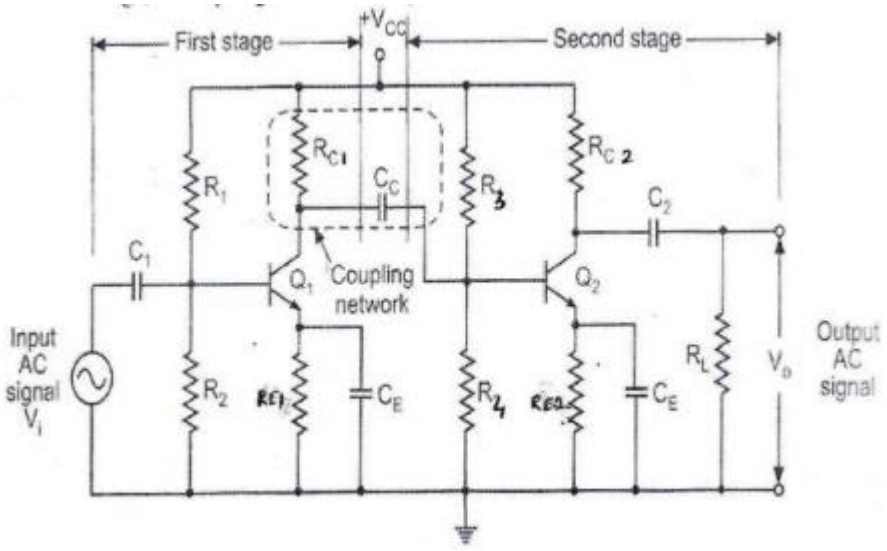

Two stages are connected with R & C components so it is called as RC Coupled amplifier.

a) Resistor RC1, R3 & Capacitor CC form the coupling network.

b) R1, R2 , R3, R4 provide voltage divider bias to Q1 & Q2.

c) RC1& RC2 provide VCE to Q1 & Q2.

d) RE1 & RE2 provide bias stabilization.

Applications of RC Coupled Amplifier:

Excellent frequency response from 50 Hz to 20 KHz so it is very useful in the initial stage of all public address systems.

49)State the different types of resistors. State any four specifications of resistors.

Ans:

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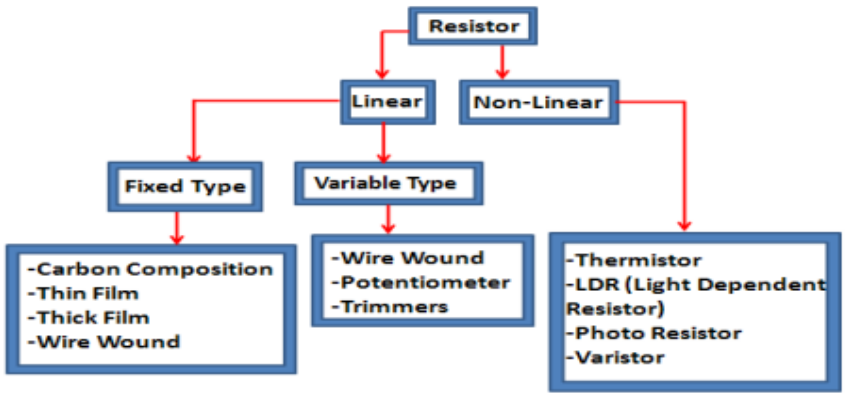
Different types of Resistors:-



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.

50) Attempt any THREE: Determine the value of capacitance with the following colour code.

(i) Orange, Orange, Blue

(ii) Yellow, Violet, Yellow

Ans:(i) Orange, Orange, Blue Colour coding:

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Orange	Orange	Blue
↓	↓	↓
3	3	6

Value of capacitor: 33×10^6 pF
$= 33 \times 10^6 \times 10^{-12}$F
$= 33 \times 10^{-6}$ F
= 33µF

ii) Yellow, Violet, Yellow

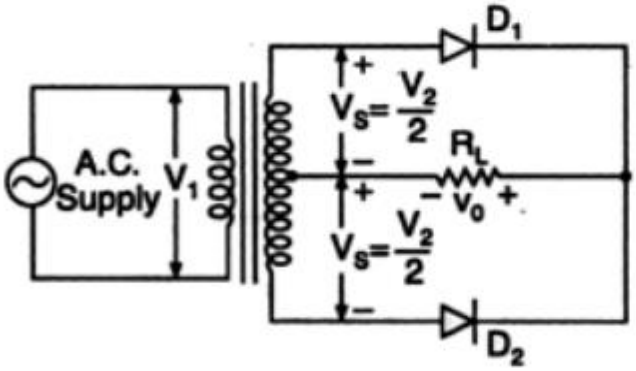
Yellow	Violet	Yellow
↓	↓	↓
4	7	4

Value of capacitor : 47×10^4 pF
$= 470$KpF
OR
$= 47 \times 10^4 \times 10^{-12}$F
$= 47 \times 10^{-8}$ F
= 0.47uF

51) Draw the neat sketch of center tap full wave rectifier. Draw i/p and o/p waveforms. Circuit Diagram.

Ans:

Circuit Diagram



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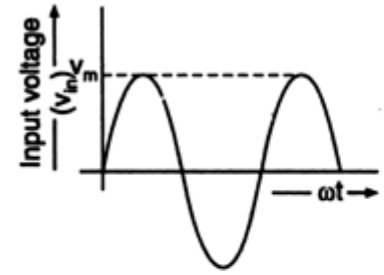
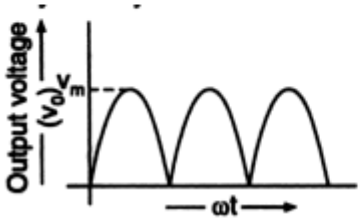
Input and Output Waveforms

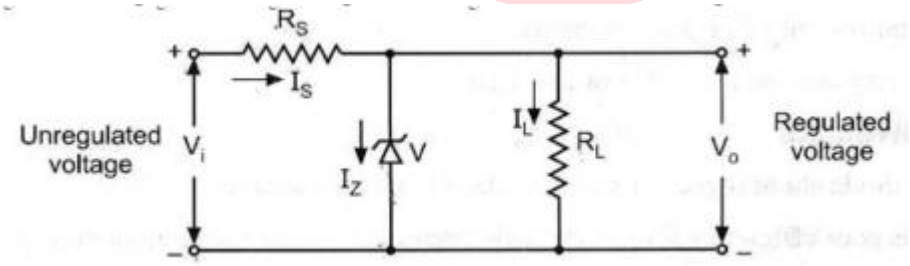




52) Draw and explain zener diode as a voltage regulator. Zener diode as voltage regulator.

Ans:

A reverse biased Zener diode is used to provide a constant voltage across the load resister RL. The voltage regulator circuit diagram showing the Zener diode is as given below.



For proper operation, the input voltage Vi must be greater than the Zener voltage Vz. This ensures that the Zener diode operates in the reverse breakdown condition. The unregulated input voltage Vi is applied to the Zener diode.

Regulation with varying input voltage:(Line Regulation)

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As the input voltage increases, the input current (IS) increases. This increases the current through Zener Diode, without affecting the load current (IL). The increase in input current will also increase the voltage drop across RS and keeps VL as constant. If the input voltage is deceased, the input current also decreases. As a result, the current through zener will also decrease. Hence voltage drop across series resistance will be reduced. Thus VL and IL remains constant.

Regulation with varying load resistance: (Load Regulation)

The variation in the load resistance RL changes IL, thereby changing VL. When load resistance decreases, the load current increases. This causes zener current to decrease. As a result, the input current and voltage drop across RS remains constant. Thus, the load voltage VL is also kept constant. On the other hand, When load resistance increases, the load current decreases. This causes zener current to increase. This again keeps the input current and voltage drop across RS constant. Thus, the load voltage VL is also kept constant. Thus, a Zener diode acts as a voltage regulator and the fixed voltage is maintained across the load resistor RL.

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Basic Electronics

- **6 Marks**

1) From the sinusoidal wave given below, in fig. (i) & fig. (ii) calculate

Amplitude, Frequency.

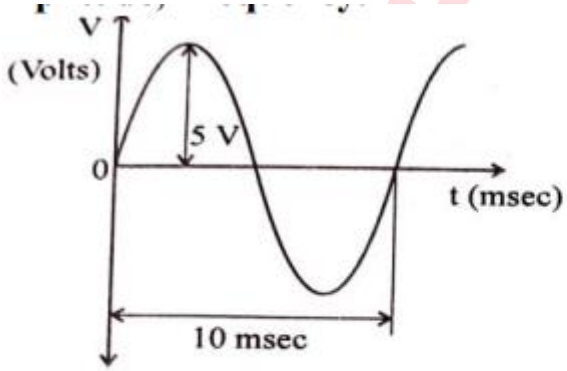

Fig. (i)

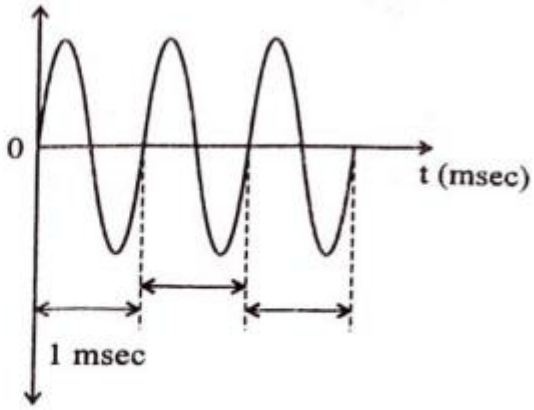

Fig. (ii)

(ii) Give the value of resistance for the following colour codes -

Red Blue Green Gold.

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i)

Fig.I -Solution:

- Amplitude =5 V
- Frequency=1/T =1/ (10ms) = 100 Hz

Fig.II-Solution:

- Assume(any value) Amplitude =10 V
- Frequency=1/T =1/ (1ms) = 1000 Hz=1KHz

(ii)

Red= 2, Blue=6, Green=*10^5 and Gold=+-5%

$26*10^5 = 2600000\Omega = 2.6M\Omega$

2)

(i) In NPN transistor,
I_{CEO} = 1000 µA, β= 50, I_B = 10 µA
Find Ic & I_E
(ii) Define operating point of a transistor.

Ans:

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i)I_{CEO}= 1000 μA= 1000 × 10^{-6} =10^{-3}A

β = 50

I_B= 10 μA = 10 ×10^{-6} = 10^{-5}A

Ic=?

Ic= β I_B + I_{CEO}

= 50 × 10^{-5} +(10^{-3})

=0.0015

=1.5mA

IE= IC+IB

= 0.0015 + 10^{-5}

=0.00151

=1.51 mA

ii) Definition: The point which is obtained from the values of the I_C (collector current) or V_{CE} (collector-emitter voltage) when no signal is given to the input is known as the operating point or Q-point in a Transistor. It is called operating point because variations of I_C (collector current) and V_{CE} (collector-emitter voltage) takes place around this point when no signal is applied to the input.

3) (i) Identify the given circuit in fig. (iii) and explain its working.

(ii) Draw the input and output for the same circuit.

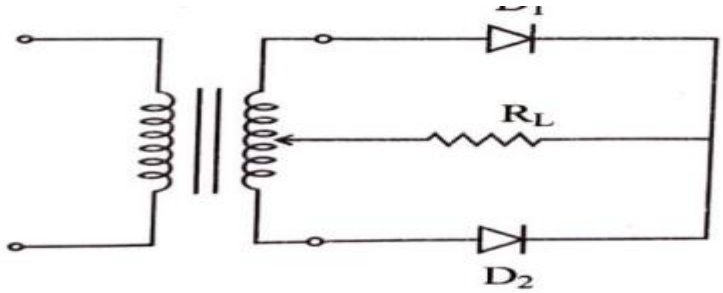

Fig. (iii)

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(iii) State application for the given circuit.

Ans:

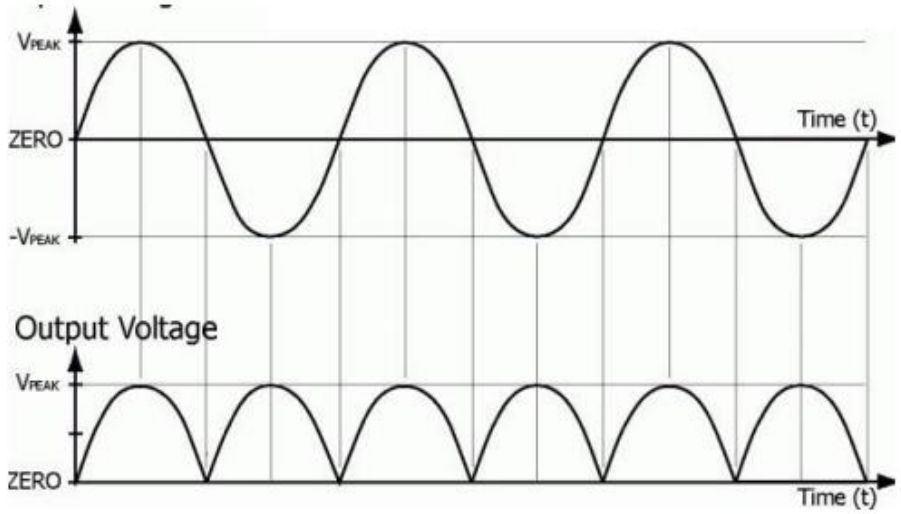
i) Center tapped full wave rectifier :

ii**) Working:**

During the positive half cycle of the input voltage, the point A at the transformer secondary becomes positive. This makes the diode D1 forward biased. Hence current I1 **flows through the load resistor.**

When the negative half cycle of the input voltage is applied, the point A at the transformer secondary becomes negative. This makes the diode D2 forward biased. Hence current I2 **flows through the load resistor.**

ii) Input- Output Waveform:



iii) State application for the given circuit:

- The conversion between high AC to low DC can be done by using this type of rectifiers.
- The efficiency is high in these circuits make it capable of using it as a basic component in the power supply units.
- In the criteria of powering on the devices like LED's or it may be motors this type of rectifiers are preferred.

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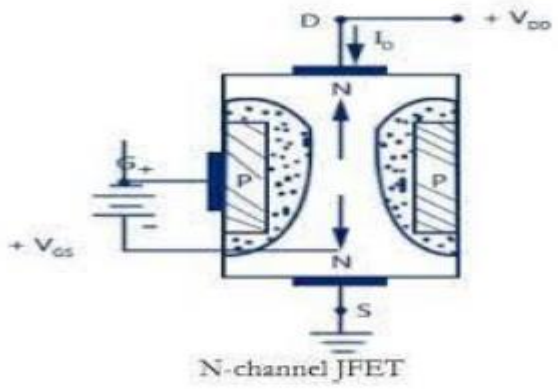
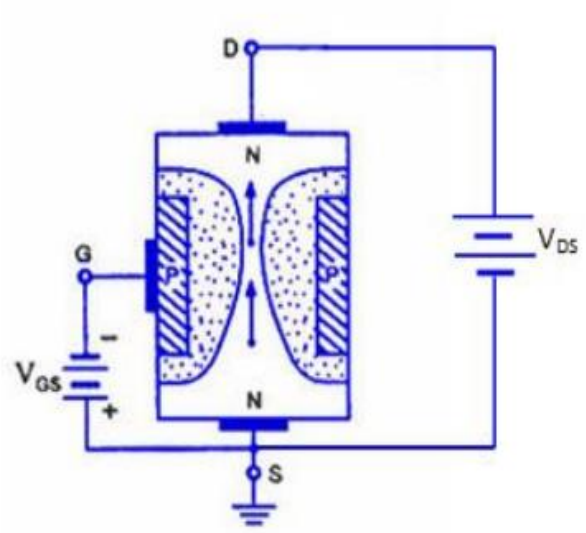
4)Draw suitable diagrams showing depletion regions before & after pinch-off for N channel JFET.

Ans:

Depletion regions before pinch-off for N channel JFET



Depletion regions after pinch-off for N channel JFET.



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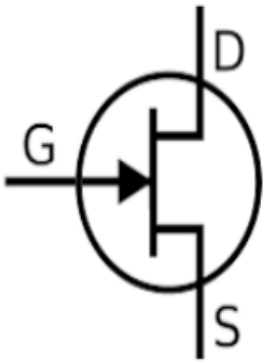
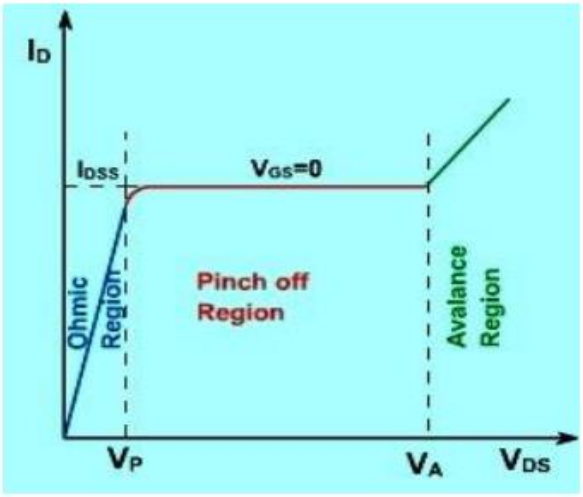


N Channel
JFET

Pinch off voltage: Pinch off voltage is the drain to source voltage after which the drain current becomes almost constant and JFET enters into saturation region and is defined only when gate to source voltage is zero.



5)Distinguish between CB, CC, CE (four points). Explain why CE configuration is the most preferred combination.

Ans:

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Parameter	Common Base	Common Emitter	Common Collector
Voltage Gain	High, Same as CE	High	Less than Unity
Current Gain	Less than Unity	High	High
Power Gain	Moderate	High	Moderate
Phase inversion	No	Yes	No
Input Impedance	Low (50 Ohm)	Moderate (1KOhm)	High (300 KOhm)
Output Impedance	High (1 M Ohm)	Moderate (50 K)	Low (300 Ohm)

•CE is most widely used because it provides the voltage gain required for most of the day to day applications of preamp and power amps. This is not possible in CB mode.

• Common emitter is the most basic configuration for amplifier circuits. It also provides the maximum transconductance or voltage gain for a given load.

• The common emitter configuration has the highest power gain combined with medium voltage and current gain.

6)With suitable diagram, explain how photodiode & phototransistor can be used as control device for the given application.

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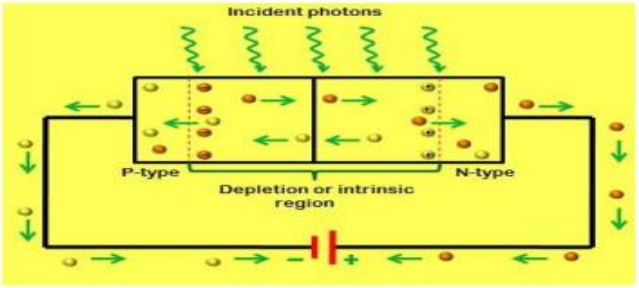
Ans :

Note: Any other diagram with similar concept shall be considered

Photodiode:

It is a form of light sensor that converts light energy into electrical energy (voltage or current). Photodiode is a type of semi conducting device with PN junction. Between the p (positive) and n (negative) layers, an intrinsic layer is present. The photo diode accepts light energy as input to generate electric current . It is also called as Photodetector, Photo Sensor or Light Detector. Photodiode operates in reverse bias condition i.e., the p – side of the photodiode is connected with negative terminal of battery (or the power supply) and n – side to the positive terminal of battery.Typical photodiode materials are Silicon, Germanium, Indium Gallium Arsenide Phosphide and Indium gallium arsenide .Internally, a photodiode has optical filters, built in lens and a surface area. When surface area of photodiode increases, it results in less response time. Few photo diodes will look like Light Emitting Diode (LED). It has two terminals as shown below. The smaller terminal acts as cathode and longer terminal acts as anode.



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Symbol:

Applications of Photodiode

- Photodiodes are used in many simple day to day applications. The reason for their use is the linear response of photodiode to a light illumination. When more amount of light falls on the sensor, it produces high amount of current. The increase in current will be displayed on a galvanometer connected to the circuit.
- Photodiodes help to provide an electric isolation with help of optocouplers. When two isolated circuits are illuminated by light, optocouplers is used to couple the circuit optically. But the circuits will be isolated electrically. Compared to conventional devices, optocouplers are fast Photodiodes are also used in safety electronics like fire and smoke detectors. It is also used in TV units.

Phototransistor:

A phototransistor is similar to a regular BJT except that the base current is produced and controlled by light instead of a voltage source. The phototransistor effectively converts light energy to an electrical signal. In a phototransistor the base current is produced when light strikes the photosensitive semiconductor base region. The collector-base pn junction is exposed to incident light through a lens opening in the transistor package. When there is no incident light, there is only a small thermally generated collector-toemitter leakage current, ICEO; this dark current is typically in the nA range. When light strikes the collector-base pn junction, a base current is

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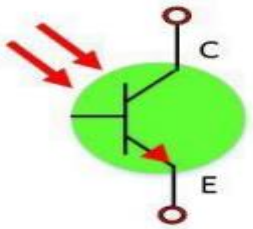
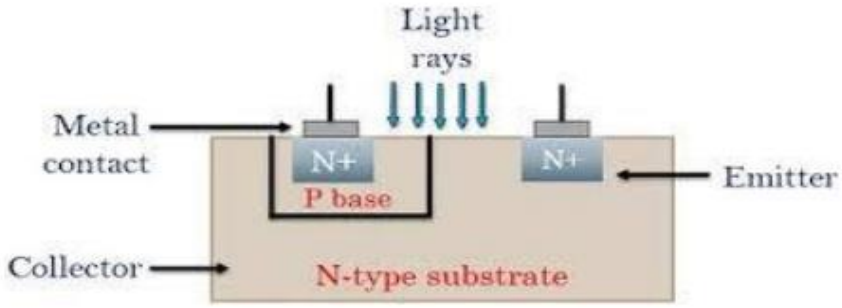
produced that is directly proportional to the light intensity. This action produces a collector current. Except for the way base current is generated, the phototransistor behaves as a conventional BJT. In many cases, there is no electrical connection to the base.

Symbol:



Construction:



A phototransistor can be either a two-lead or a three-lead device. In the three-lead configuration, the base lead is brought out so that the device can be used as a conventional BJT with or without the additional light-sensitivity feature. In the two-lead configuration, the base is not electrically available, and the device can be used only with light as the input. In many applications, the phototransistor is used in the two-lead version. Phototransistors are not sensitive to all light but only to light within a certain range of wavelengths. They are most sensitive to particular wavelengths in the red and infrared part of the spectrum.

Applications of Phototransistors:

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The Areas of application for the Phototransistor include:

- Punch-card readers.
- Security systems
- IR detectors photo
- electric controls
- Computer logic circuitry.
- Relays
- Lighting control (highways etc.)

7)Calculate peak to peak amplitude, Frequency and wavelength of waveforms shown in figure-1

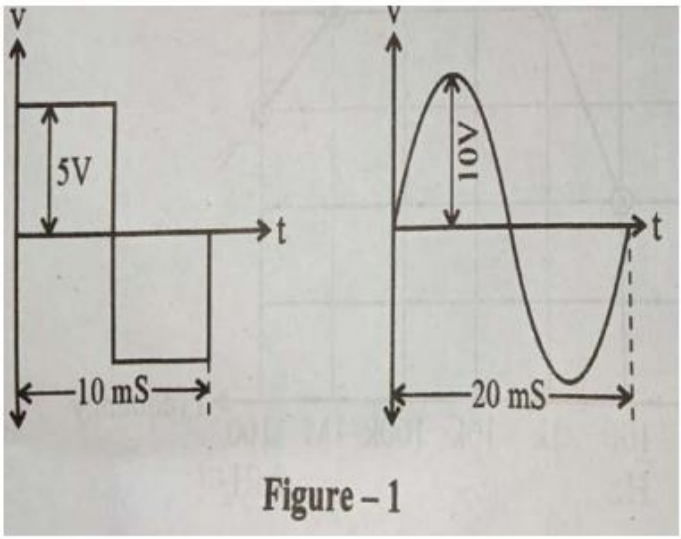

Figure – 1

Ans:-

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For square waveform:

1. Peak to peak amplitude =10 V
2. Frequency=1/T =1/(10 ms) = 100 Hz
3. wavelength $\lambda = V_c/f = (3x10^8)/100 = 3000000$ m

For sine waveform:

1. Peak to peak amplitude =20 V
2. Frequency=1/T =1/(20ms) = 50 Hz
3. wavelength $\lambda = V_c/f = (3x10^8)/50 = 6000000$ m

8)In CE configuration of transistor, if B = 50, leakage current ICEO=100µa. If the Base current is 0.2 mA. Calculate the value of IC,IE and α

Ans:-

Given data:-β =50, I_{CEO} = 100 µA. I_B is 0.2mA ,
To find I_C, I_E and α.
Solution.
$\alpha = \beta / (\beta + 1)$
$= 50/(50+1) = 0.98$
I_C is given as, $I_C = \beta * I_B + I_{CEO}$
$= (50*0.2*10^{-3}) + 100*10^{-6} = 10.1$ mA.

I_E is given as,
$I_E = I_C + I_B$
$= (10.1 + 0.2)$ mA $= 10.3$ mA

9) (i) Sketch the Full Wave Bridge Rectifier and draw the waveforms of Load voltage and Load Current. (ii) State any two advantages of FWR over HWR.

Ans:-

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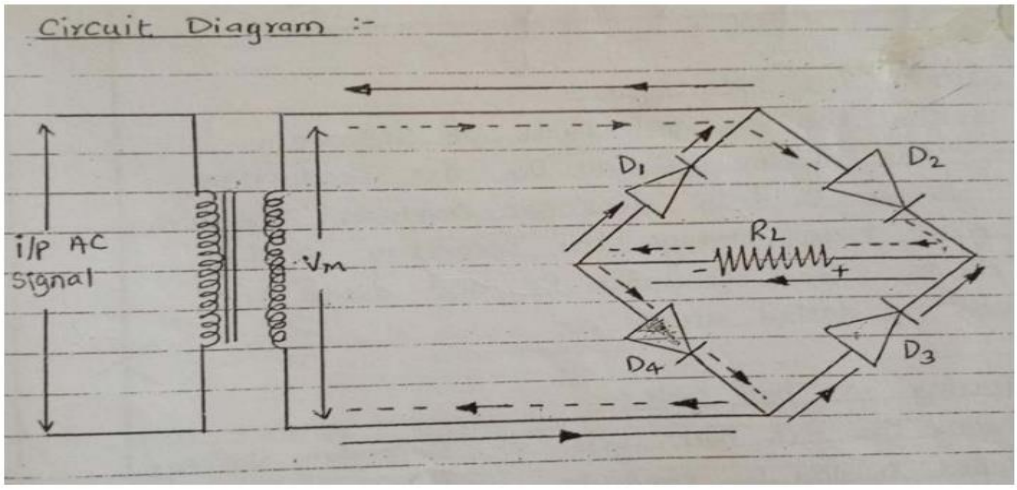

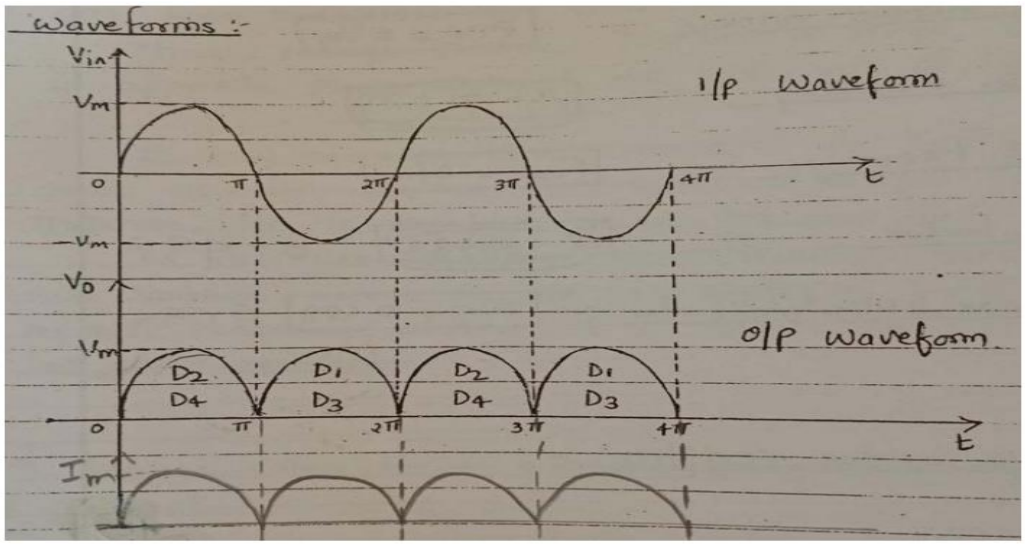

Advantages of full-wave rectifier:

1. The ripple frequency is two times the input frequency.
2. Efficiency is higher.
3. The large DC power output.
4. Ripple factor is less.
5. The ripple voltage is low and the higher frequency in case full-wave rectifier so simple filtering circuit is required.
6. Higher output voltage.

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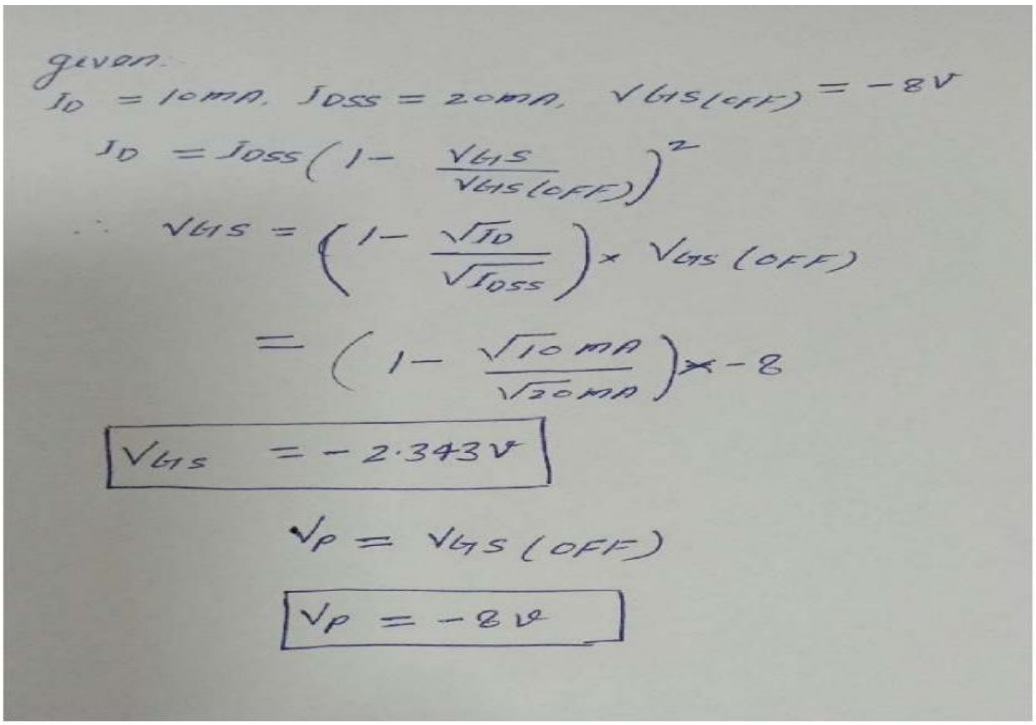
7. Higher transformer utilization factor.

8. Utilizes both halves of the AC waveform.

9. Easier to provide smoothing as a result of using the ripple frequency.

10) i) A JFET has a drain current of 10 m A .if IDSS= 20 m A and VGS(off) = -8V. Find the value of : (i) VGS (ii) VP ii) Draw the symbol of N- channel and P-channel MOSFET.

Ans:-



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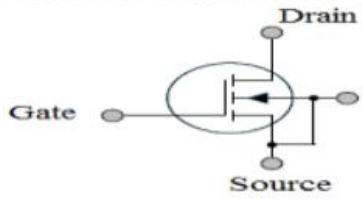
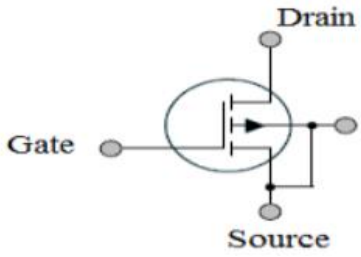
Symbol of N- Channel Enhancement MOSFET:



Symbol of P- Channel Enhancement MOSFET:



11)Observe the given frequency response of RC coupled amplifier, shown in figure-2 Calculate:

i) Lower cutoff frequency (fL)

ii) Higher cutoff frequency (fH) and

iii) Bandwidth(BW)

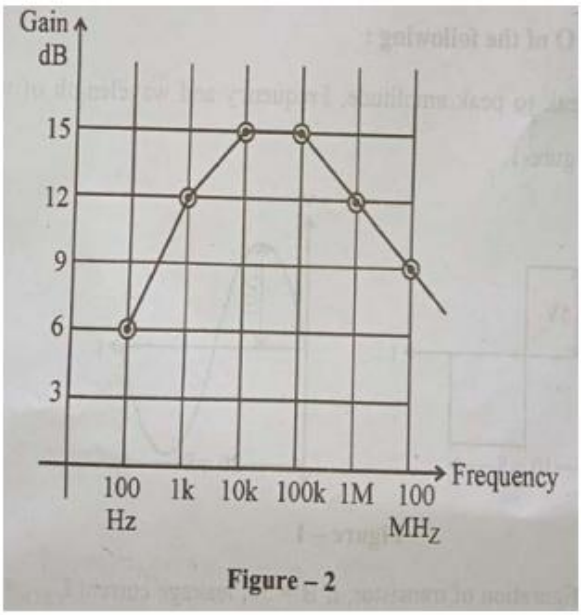


Figure – 2

Ans:-

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As maximum gain is 15 dB, 3 dB down gain is 12 dB. So,

(i) The lower cut-off frequency F_L= 1KHz

(ii) Higher cut-off frequency F_H =1 MHz

(iii) Bandwidth (BW) = F_H - F_L =(1000 -1)KHz =999 KHz

12)List four types of electrical pressure transducers and state one application of each type.

Ans:-

Types of electrical pressure transducers:

1.Strain gauge pressure transducers

2.Potentiometer pressure transducers

3.Piezoelectric pressure transducers

4. Reluctance pressure transducers

5. Capacitive pressure transducers

1. Applications of Strain gauge pressure transducers

a) In biomedical, structural, mechanical and industrial filed.

b) Used for measurement of force, displacement and acceleration.

2. Applications of Potentiometer pressure transducers

a) It is used in many applications such as

b) Linear displacement measurement

c) Liquid level measurements using floats

d) Rotary displacement measurement

d) Brightness control

e) Volume control

3. Applications of Piezoelectric pressure transducers

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a) Piezoelectric transducer is used in high frequency accelerometer.

b) It is used in under water detection system ie. SONAR.

c) These are used in measurement of surface roughness in accelerometer and vibration pickups.

4. Reluctance pressure transducers

a) Useful for measurement and control of thickness of metal.

b) Useful for measurement of tension in cord.

c) Useful in force, pressure and weight measurement as a secondary transducer.

d) Useful for measurement weight or pressure exerted by liquid in tank.

5. Applications of Capacitive pressure transducers

a) The capacitive transducers are used to measure humidity in gases.

b) It is used to measure volume, liquid level, density etc.

c) It is used for measurement of linear and angular displacement.

13)Calculate peak-to-peak amplitude, frequency and wavelength of waveforms shown in Fig.1.

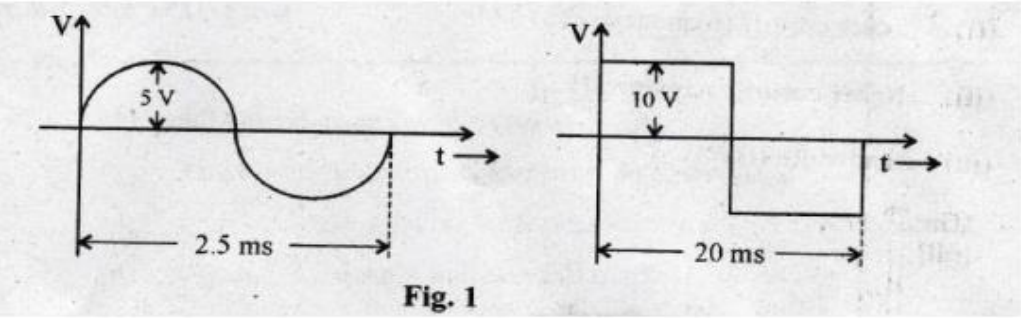

Fig. 1

Ans:-

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For sine waveform:

1. Peak to peak amplitude =10 V
2. Frequency=1/T =1/(2.5ms) = 400 Hz
3. wavelength $\lambda = Vc/f = (3*10^8)/400 = 750000$ m

For square waveform:

1. Peak to peak amplitude =20 V
2. Frequency=1/T =1/(20 ms) = 50 Hz
3. wavelength $\lambda = Vc/f = (3*10^8)/50 = 6000000$ m

14)In CE configuration, if β = 100, leakage current ICEO = 150 μA. If the base current is 0.2 mA, calculate the value of IC, IE and α.

(Note: Marks should be given for correct formula)

Ans:-

Given data:-$\beta = 100$, $I_{CEO} = 150\ \mu A$. I_B is 0.2mA ,
To find I_C, I_E and α.

Solution :-

We know

1) $\alpha = \beta / (\beta + 1)$
$= 100/(100+1) = 0.99$

2) I_C is given as,
$I_C = \beta * I_B + I_{CEO}$
$= (100*0.2*10^{-3}) + 150*10^{-6} = 20.150$ mA.

3) I_E is given as,
$I_E = I_C + I_B = (20.150 + 0.2)$ mA $= 20.35$ mA

15)Identify the circuit shown in Fig. 2 and explain working with input-output waveforms for a sinusoidal input.

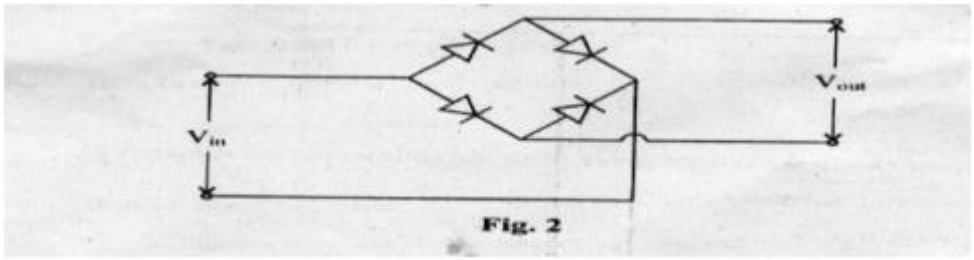

Fig. 2

Ans:-

The given circuit is Bridge rectifier– (with diodes numbered)

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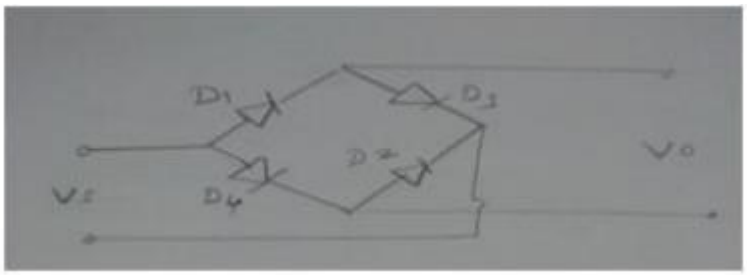
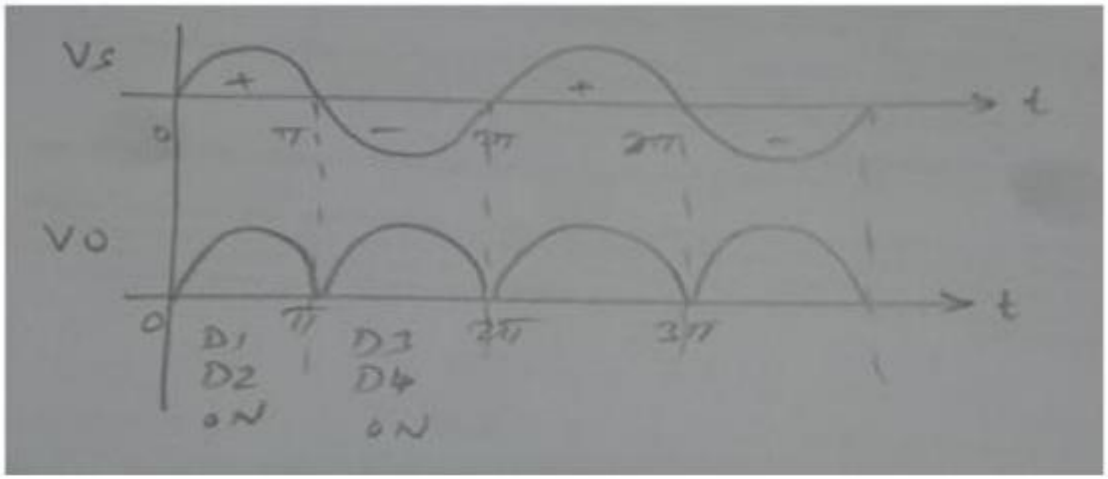


Working :- The four diodes labelled D1 to D4 are arranged in "series pairs" with only two diodes conducting current during each half cycle.

During the positive half cycle of the supply:- diodes D1 and D2 conduct in series while diodes D3 and D4 are reverse biased and the current flows through the load for the period o to π

During the negative half cycle of the supply:- diodes D3 and D4 conduct in series, but diodes D1 and D2 switch "OFF" as they are now reverse biased. The current flowing through the load is the same direction as before for the period π to 2π.

Waveforms:-



16)State the applications and specification of

(i) Resistor

(ii) Capacitor

(iii)Inductor

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Ans:-

Application of resistor:

1.Resistors are used in high frequency instrument.

2.Resistor is used in power control circuit.

3.It is used in DC power supplies.

4.Resistors are used in filter circuit networks.

5.It is used in amplifiers, oscillators, telecommunication and digital multimeter.

6.It is used in wave generators.

Applications of capacitor:

1.Use for capacitors is energy storage.

2.Additional uses include power conditioning, signal coupling or decoupling, electronic noise filtering, and remote sensing.

Applications of Inductors:

1.Filters

2.Sensors

Specifications of Resistor:

1.Temperature Coefficient.

2.Size or value of a resistor

3.Power Dissipation / wattage

4.Tolerance

5.Thermal Stability

6.Frequency Response.

7.Power De-rating.

8.Maximum Temperature.

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9.Maximum Voltage.

Capacitor specifications:

1.Capacitance value

2.Tolerance

3.Working voltage

4.Dielectric

5.Working temperature

6.Temperature coefficient

Inductor Specification:

1.DC Resistance (DCR)

2.Maximum DC Current

3.Electromagnetic Interference (EMI)

4.Magnetic Saturation Flux Density

5.Curie Temperature

17)Describe how transistor can be used as a switch and draw waveforms.

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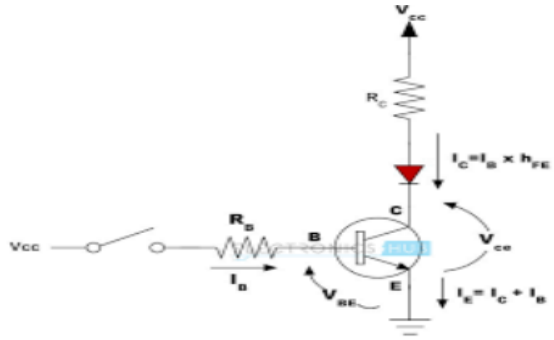
Ans:-



a)when both junctions are forward bias ,it works in saturation region & act as closed switch.

b)when both junctions are reverse biased ,it works in cutoff region & act as open switch.

c)If input is not given to base ,transistor remains off.diode will be off.IC=0,Acts as open switch.

d)when input is applied to base above 0.7V ,transistor becomes ON,Diode is ON. IC starts flowing ,Transistor acts as close switch.

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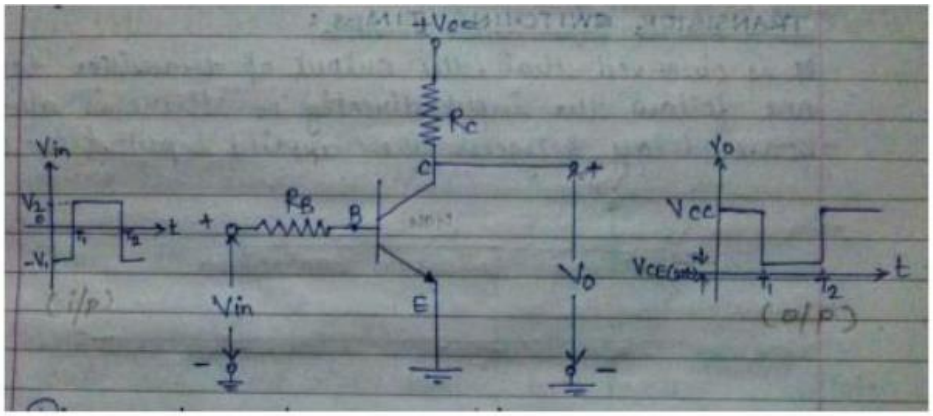
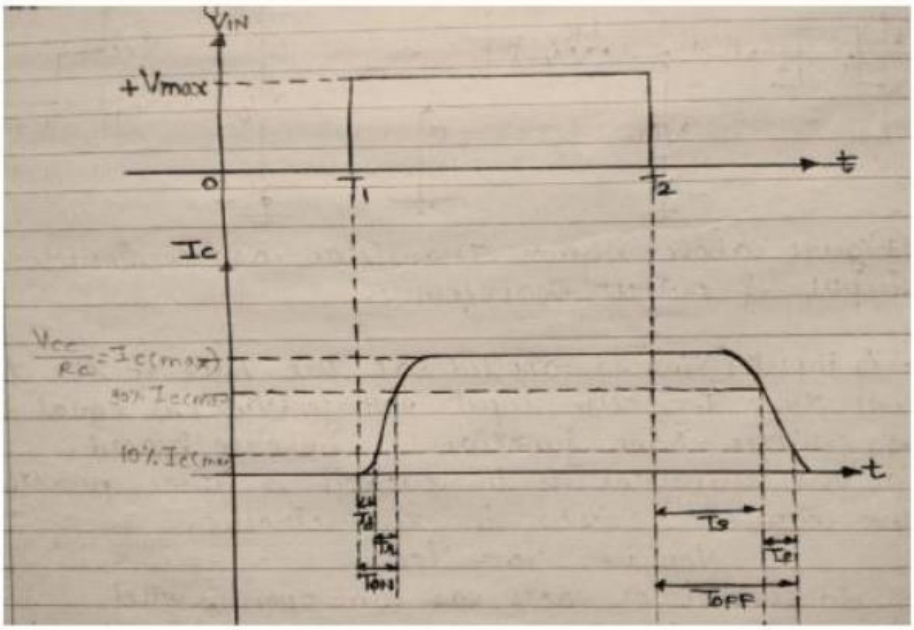


Waveform:



18)Draw the block diagram of regulated power supply, explain function of each block and draw waveforms of each stage.

Ans:-

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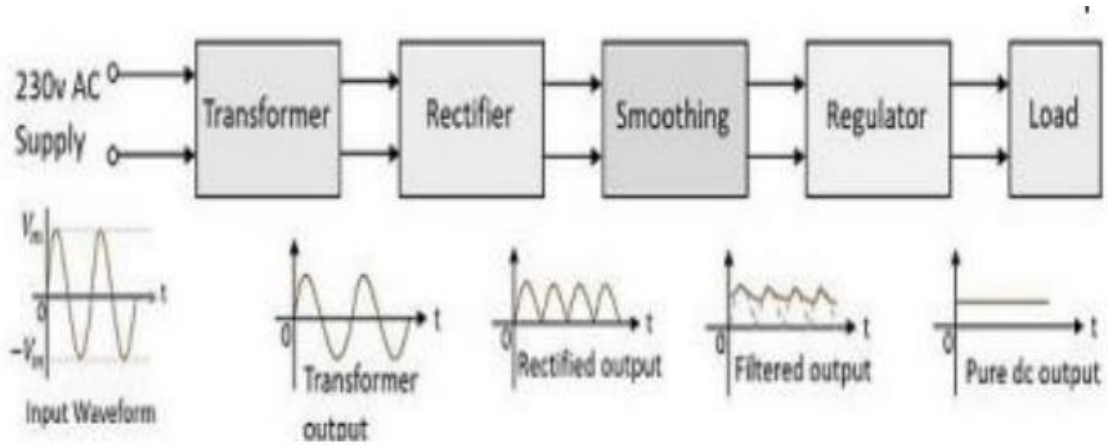

A typical Regulated Power supply unit consists of the following.

Transformer – Stp Up or Step Down input transformer for the stepping up or down AC power supply.

Rectifier – A Rectifier circuit to convert the AC signal into pulsating DC components.

Smoothing – A filtering circuit to smoothen the variations present in the rectified output.

Regulator – A voltage regulator circuit is used to control the voltage to a desired output level against line and load variations.

Load – The load which uses the pure dc output from the regulated output.

19)With the help of N-channel JFET describe the effect of input voltage VGS on output current ID.

Ans :

Working of N channel FET:

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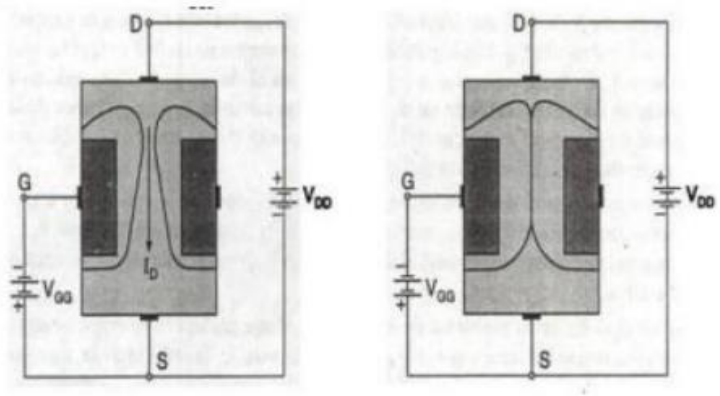


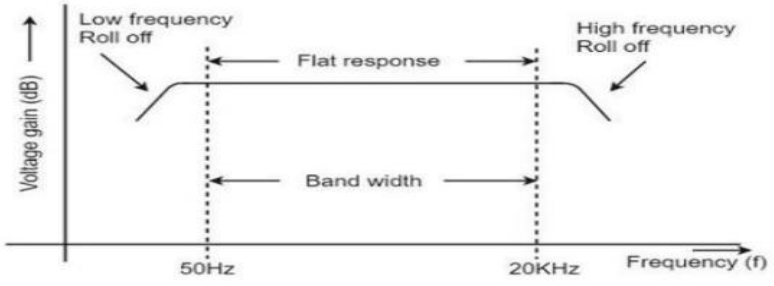
- When a voltage is applied between the drain and source with a DC supply (VDD), the electrons flows from source to drain through narrow channel existing between the depletion regions.
- This constitutes drain current, ID.
- The value of drain current is maximum when the external voltage applied between gate and source 0V.
- When the gate to source voltage (applied by VGG) becomes negative,, the reverse bias voltage across gate source junction is increased.
- The depletion region is widened. This reduces the width of the channel and thus controls the flow of current.
- The gate source voltage reaches a point where the channel gets completely blocked and the drain current becomes zero is called pinch- off voltage.

20)Draw frequency response of RC coupled two stage amplifier. Write formula to calculate bandwidth and state any two methods to improve bandwidth.

Ans :

Frequency response of RC coupled two stage amplifier:

Frequency response:-



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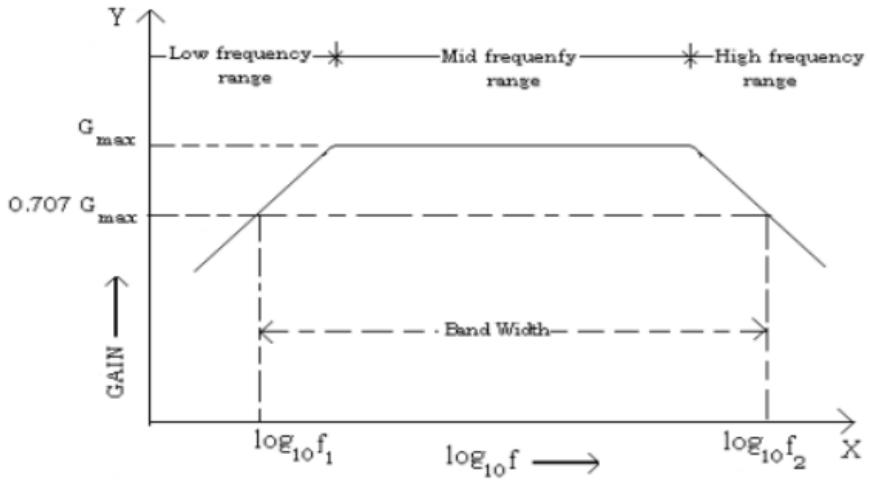

Bandwidth of the amplifier = Higher frequency – Lower frequency

$=f_H - f_L$ OR f2 - f1

Two methods to improve bandwidth:

1.Direct coupled Amplifier

2.The basic bootstrapping principle is to use an additional buffer amplifier to actively charge and discharge to input capacitance as required. By doing so the effective source capacitance is reduced, enabling the overall bandwidth of the circuit to be increased.

20) i) Compare

1) Active and Passive transducer

2) Analog and digital transducer.

ii) Differentiate following transducer in active and passive.

1) Strain gauge

2) Photovoltaic cell

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3) Thermocouple

4) Thermistor.

Ans:-

Sr. No.	Parameters	Active Transducer	Passive Transducer
1	Working Principle	Operate under energy conversion principle.	Operate under energy controlling principle.
2	Example	Thermocouple, Piezoelectric Transducer etc.	Thermistors, Strain Gauges etc.
3	Advantage	Do not require external power supply for its operation.	Require external power supply for its operation.
4	Application	Used for measurement of Surface roughness in accelerometers and vibration pick ups.	Used for measurement of Power at high frequency.

Analog Transducers	Digital Transducers
1.Output of these transducers are analog in nature	1.Output of these transducers are in the form of pulses
2.Convert the input quantity in analog Output	2.Convert the input quantity in digital output

1) Strain gauge:-Passive Transducer.

2) Photovoltaic cell:-Active Transducer.

3) Thermocouple :-Active Transducer.

4) Thermistor:-Passive Transducer.

21)Explain working principle of N-channel depletion type MOSFET with construction diagram. Compare depletion type MOSFET & enhancement type MOSFET.

Ans:-

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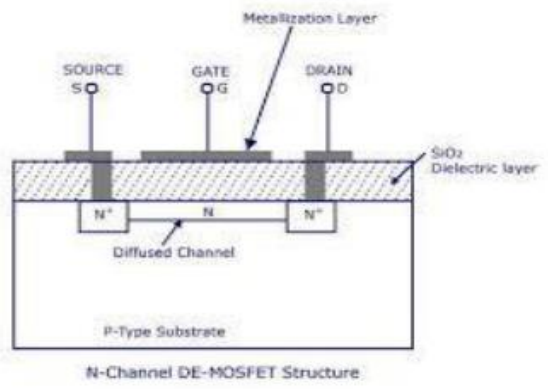
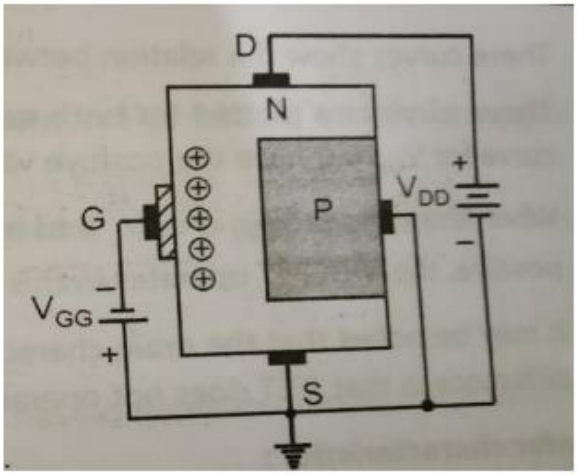


N-Channel DE-MOSFET Structure

Working principle:

The depletion type MOSFET can be operated in the following two ways:

1. **Depletion mode:**



A depletion type N channel MOSFET with negative gate to source voltage is shown in figure. The negative gate voltage induces positive charges in N type channel through the insulating layer SiO2. Since, conduction of current through the N type channel is by means of majority carriers (i.e. electrons), the free electrons in the vicinity of positive charges are repelled away in the N type channel. This reduces the number of free electrons passing through the N type channel. As a result of this, the N type channel is depleted of free electrons(i.e. majority carriers). Thus, it reduces the drain current flowing through the N type channel as the gate to source voltage is made more negative. As large negative gate to source voltage, the N type channel region

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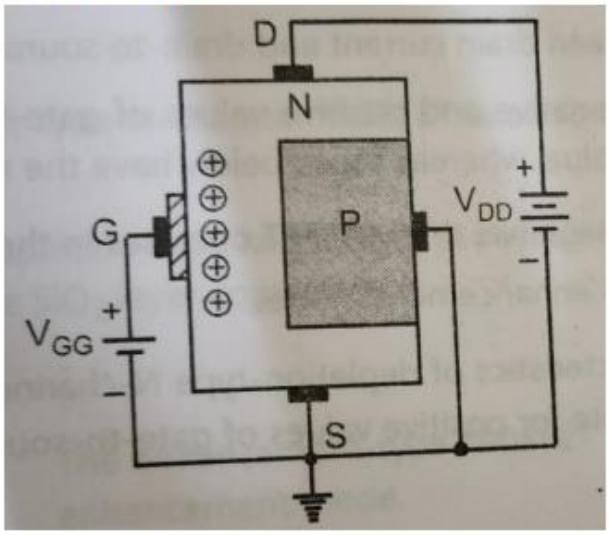
near the drain end is totally depleted of free electrons and therefore the drain current reduces to zero.

2. Enhancement mode:



An enhancement type N channel MOSFET with positive gate to source voltage is shown in figure. The positive gate voltage induces negative charges in N type channel through the insulating layer SiO2. Since, conduction of current through the N type channel is by means of majority carriers(i.e. electrons), the free electrons in the vicinity of positive charges are added together in the N type channel. Thus, the positive gate voltage increases the number of free electrons passing through the N type channel. This increases the drain current flowing through the N type channel as a result, it enhances the conductivity of the N channel. Thus, it increases the drain current flowing through the N type channel as the gate to source voltage become more positive. Because of the fact, the positive gate operation is called an enhancement mode.

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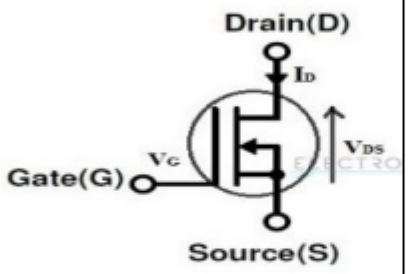
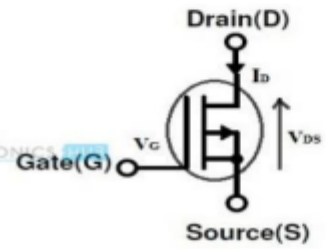
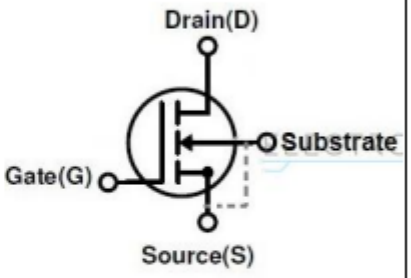
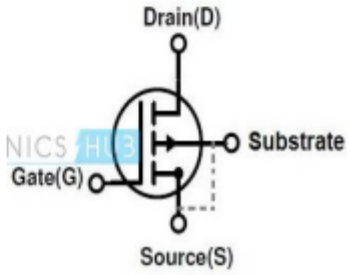
Comparison of Depletion type MOSFET & Enhancement type MOSFET

Sr. No.	Depletion type MOSFET	Enhancement type MOSFET
1	 N-Channel P-  Channel	 N- Channel  P- Channel
2	An insulating oxide layer is present between gate and channel.	An insulating oxide layer is present between gate and substrate.
3	N or P type channel is present.	N or P type channel is not present. At a time of operation, induced channel is created.
4	For N channel V_{GS} = negative (for depletion mode) V_{GS} = positive (for enhancement mode)	For N channel V_{GS} = only positive
5	For N-channel, If V_{GS} is more negative, drain current decreases more.	For N-channel, If V_{GS} is more positive, drain current increases more.

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Sy-D
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22)Differentiate CE, CB, CC, w.r.t. to

(i) Input resistance

(ii) Output resistance

(iii) Current gain

(iv) Voltage gain

(v) Phase shift between input and output

(vi) Applications

Ans:-

Sr. No	Parameter	CB	CE	CC
1	Input resistance	Very low (20Ω)	Low(1K Ω)	High (500K Ω)
2	Output resistance	Very high (1M Ω)	High(40K Ω)	Low(50 Ω)
3	Current gain	Less than unity	High (20 to few hundred)	High (20 to few hundred)
4	Voltage gain	Medium	Medium	Less than unity
5	Phase shift between input and output	0	180°	0
6	Applications	As pre-amplifier	As Audio amplifier	For impedance matching

23)List four types of electrical pressure transducers and describe one application of each one.

Ans:-

Types of electrical pressure transducers:

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2. Strain gauge pressure transducers
3. Potentiometer pressure transducers
4. Piezoelectric pressure transducers
5. Reluctance pressure transducers
6. Capacitive pressure transducers

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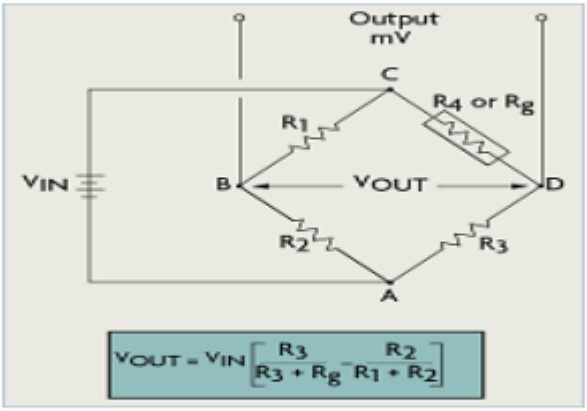
Applications:

1.Strain gauge pressure transducers

In measurement of strain



In order to measure strain with a bonded resistance strain gauge, it must be connected to an electric circuit that is capable of measuring the minute changes in resistance corresponding to strain. Strain gauge transducers usually employ four strain gauge elements that are electrically connected to form a Wheatstone bridge circuit. The Figure shows a typical strain gauge diagram. A Wheatstone bridge is a divided bridge circuit used for the measurement of static or dynamic electrical resistance. The output voltage of the Wheatstone bridge is expressed in millivolts output per volt input. The Wheatstone circuit is also well suited for temperature compensation. The number of active strain gauges that should be connected to the bridge depends on the application. For example, it may be useful to connect gauges that are on opposite sides of a beam, one in compression and the other in tension. In this arrangement, one can effectively double the bridge output for the same strain. In installations where all of the arms are connected to strain gauges, temperature compensation is automatic as resistance change (due to temperature variations) will be the same for all arms of the bridge.

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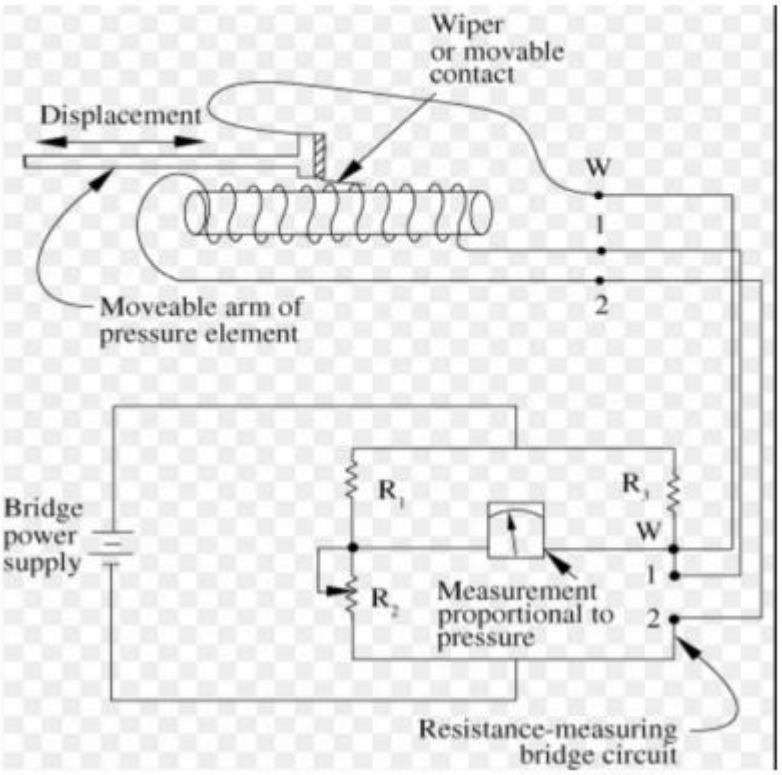
2.Potentiometer pressure transducers

In pressure measurement:



A potentiometric consists of a wire wound resistor with removable slide attached to it. Moving the slide will change the amount of resistance of the potentiometer. When the potentiometer is connected in an electronic circuit any movement of the slide on the potentiometer will change the resistance in the circuit. The circuit configuration most often used to make accurate measurement is the Wheatstone bridge.

In a Wheatstone bridge, the bridge has two parallel legs. Each leg has two resistors in series. A voltage source has connected to the bridge so that current will follow through each leg. In a typical bridge, there is another circuit installed here. When the resistance of all four resistor is exactly equal the current flow through each leg is equal. In this condition, the bridge is balanced. However, if one of

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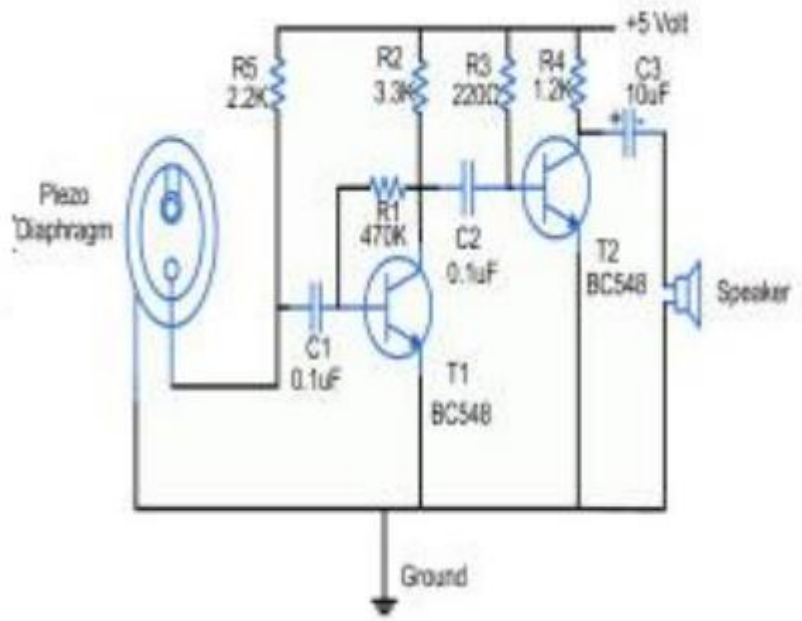
these resistors is changed, current flow through each leg is no longer equal.

3. Piezoelectric pressure transducers

In detection of audio signal

The following circuit shows the piezoelectric sensor circuit diagram. The components required for this circuit are four resistors, speaker, two NPN transistor, capacitor, and piezo diaphragm. The generation of the electrical signal in the piezo diaphragm is when it is subjected to the pressure variation due to the sound in the vicinity. The output of the piezo-diaphragm is supplied to the two transistors of T1 & T2 (BC548) and the two transistors are known as a Darlington pair, it has a very high current



Circuit Diagram of Piezoelectric Sensor

If piezo diaphragm receives any audio signals, in the opposite faces it produces the voltage difference. By using the capacitors C1 of 0.1µF the signal is filtered or a DC component. The first transistor T1 of the Darlington pair amplifiers of the input signal and the output appears at the resistor R2. For the transistor T1, base-collector bias is given by the resistor R1 of 470k. The output of the first transistor T1 is given to the base of the T2 transistor after it is filtered by another capacitor C2. In further the output of the transistor T1 is amplified by

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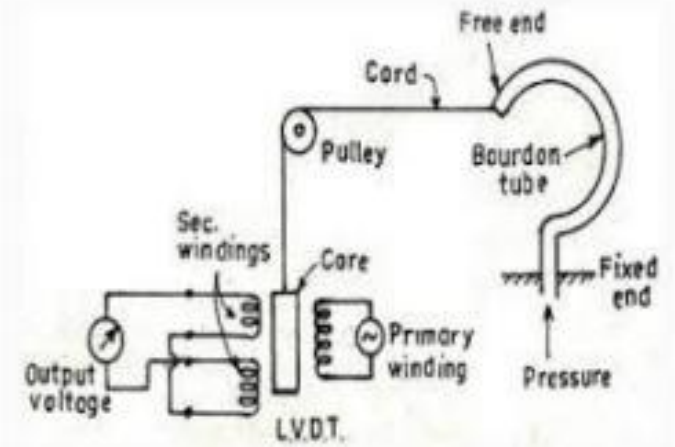
the transistor T2 and at the resistor R4, the amplified signal is produced. The R3 resistor is used for the necessary bias for the transistor T2. The output of the second transistor T2 is filtered with the capacitor C3 and it is connected to the speakers.

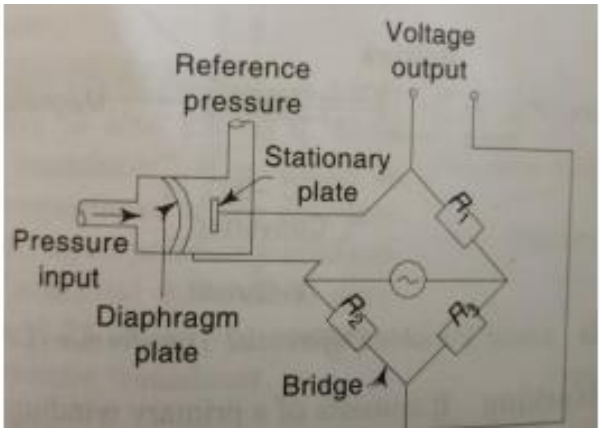
4. Reluctance pressure transducers :Measurement of fluid pressure in bourdon tube



In this the, the bourdon tube act as primary transducer and LVDT which follows the output of bourdon tube act as a secondary transducer. The bourdon tube senses the pressure when liquid enters into it, it will bend depending upon the pressure of the fluid and converts it into a displacement. This set up is used for measurement of pressure which is converted into electrical signal by LVDT.

5. Capacitive pressure transducers:

Measurement of pressure in pipe



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In this arrangement, in place of movable plate, diaphragm is used, which expands and contracts due to change in pressure. The diaphragm plate acts as a movable plate of a capacitor. A fixed plate is placed near the diaphragm. These plates form a parallel plate capacitor which is connected as one of the arms of a bridge. Any change in pressure causes a change in distance between the diaphragm and fixed plate, which is unbalances the bridge. The voltage output of the bridge corresponds to the pressure applied to the diaphragm plate.

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