F.Y. Diploma : Sem. II
[DE/EJ/IE/IS/EE/MU/ET/EN/EX]

Basic Electronics

Time: 3 Hrs.] Prelim Question Paper Solution [Marks : 70

Q.1 Attempt any FIVE of the following : [10]

Q.1(a) State materials used for LED's to emit different colour light. [2]

Ans.:

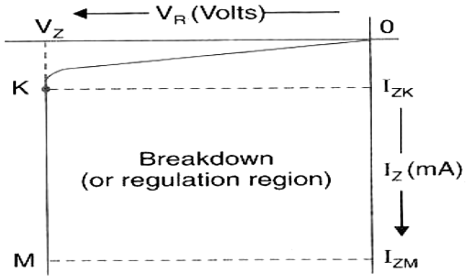
Sr. No.	Material used	Colour of the emitted light
(i)	Gallium arsenide (GaAs)	Infrared (IR)
(ii)	Gallium arsenide phosphide GaAsP	Red or Yellow
(iii)	Gallium phospide (GaP)	Red or Green
(iv)	Gallium nitrite Ga(NO2)3	

Q.1(b) List any two BJT biasing circuits with respect to operating point. [2]

Ans.: (i) Fixed bias
(ii) Base biased with emitter feedback
(iii) Collector to base bias
(iv) Voltage divider bias

Q.1(c) Sketch reverse characteristics of zener diode with proper labelling. [2]

Ans.:



Reverse characteristic of a zener diode.

Q.1(d) State cut in voltage value of diode for silicon and germanium. [2]

Ans.: The cut in voltage value of diode for silicon is 0.7 Volt and for Germanium is 0.3 Volt

Q.1(e) Define Transistor. State its type. [2]

Ans.: Transistors are active electronic components made of semiconducting materials, which can amplify the electric signals by the application of a small input signal.
Types of transistors:
- Unipolar Junction Transistors
- Bipolar Junction Transistors

Q.1(f) State application of FET. [2]

Ans.: **Applications of FET:**
(i) As input amplifiers in oscilloscopes, electronic voltmeters and other measuring and testing equipment because high input impedance reduces loading effect to the minimum.
(ii) Constant current source.
They are used to build RF amplifiers in FM tuners and other communication circuits. Because of low noise.
(iv) FETs are used in mixer circuits of FM and TV receivers as it reduces inter modulation distortion.
(v) Used as Analogue switch.
(vi) As a Voltage Variable Resistor (VVR) in operational amplifiers.

Q.1(g) State the need of DC regulated power supply. **[2]**

Ans.: Need of DC regulated power supply:

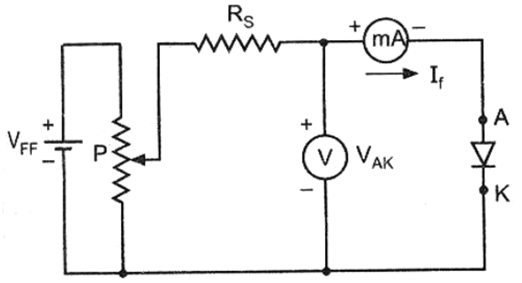
(i) To convert unregulated AC into constant DC.

(ii) To convert fluctuating main supply into regulated constant DC.

Q.2 Attempt any THREE of the following : **[12]**

Q.2(a) Describe experimental set–up for operation of P–N junction diode in forward bias. Draw its characteristics. **[4]**

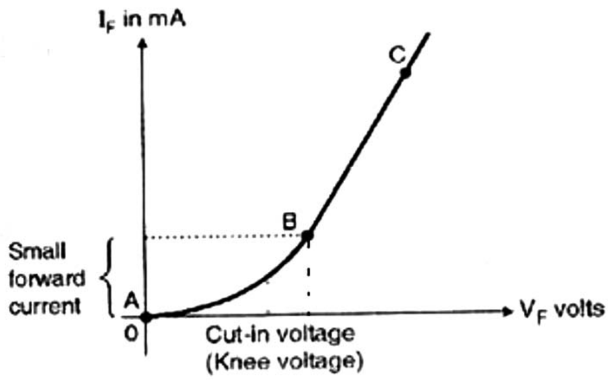
Ans.: Experimental set up Forward characteristics:



Explanation:

- PN junction diode is forward biased when positive terminal of the power supply is connected to the P-type side, and the negative terminal of the power supply is connected to the N-type side.
- When a PN junction is forward biased, the holes are repelled from the positive terminal of the battery and are moved towards the junction.
- Similarly the free electrons are repelled from the negative terminal of the battery and move towards the PN junction.
- Because of their acquired energy (from the battery V_{FF}), some of the holes and the free electrons enter into the depletion region and recombine themselves.
- This reduces the potential barrier and the width of the depleting region.
- The width of depletion region and the barrier potential reduces with the increase in forward bias.
- As a result of this, more majority carriers diffuse across the junction. Therefore, it causes a large current to flow through the PN junction. This is called forward current.
- The point at which this sudden increase in current takes place is represented as the "knee" point
- The PN junction does not permit the current to flow until the external bias voltage overcomes the barrier potential V_B. The external bias voltage should be greater than the barrier potential for the current to flow.

Forward characteristics:



Q.2(b) Explain the need of stabilization of Q point. **[4]**

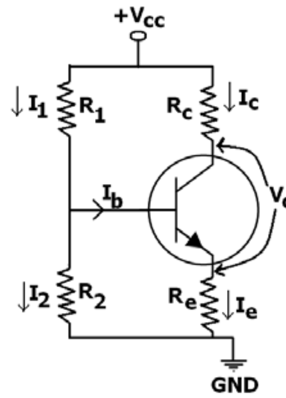
Ans.:

- Bias stabilization is a process of stabilizing the position of operating point "Q"
- The stabilization of Q-point is necessary to maintain the Q-point at the centre of load line because the bias point (Q-point) changes its position on the load line due to the factors such as temperature or device to device variations.

- If the Q-point gets shifted towards saturation or cut off regions, then amplified output waveform is distorted. In order to avoid such distortion it is necessary to stabilize the Q-point at the centre of the load line.
- So we need to design a biasing circuit which will keep the position of Q-point stable on the load line.

Q.2(c) Explain with a neat circuit diagram of voltage divider bias method for biasing a transistor. **[4]**

Ans.: The voltage divider is formed using external resistors R_1 and R_2. The voltage across R_2 forward biases the emitter junction. By proper selection of resistors R_1 and R_2, the operating point of the transistor can be made independent of β. In this circuit, the voltage divider holds the base voltage fixed independent of base current provided the divider current is large compared to the base current.



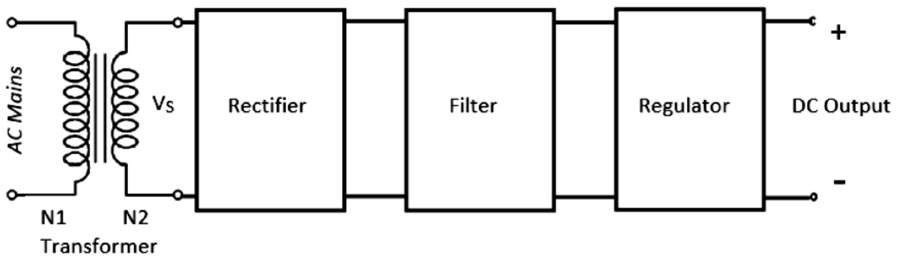
The voltage at transistor base, $V_B = V_{CC} \times \dfrac{R_2}{R_1 + R_2}$

Neglecting V_B, The emitter current = $I_E = \dfrac{V_E}{R_E}$

$V_{CE} = V_{CC} - I_C \cdot R_C - I_E \cdot R_E$

Q.2(d) Draw the block diagram of DC power supply. Explain the function of each block. **[4]**

Ans.:



Transformer: It reduces the amplitude of ac voltage to the desired level and applies it to a rectifier circuit.

Rectifier: This circuit converts the voltage at the secondary of the transformer into a pulsating dc voltage.

Filter: This circuit reduces the ripple content in the pulsating dc, producing unregulated dc voltage.

Regulator: This circuit converts the unregulated dc voltage into regulated constant dc voltage.

Q.3 Attempt any THREE of the following : **[12]**

Q.3(a) Explain the working of positive clamper with proper circuit diagram and draw the waveforms at input & output of clamper. **[4]**

Ans.: **Positive clamper circuit:**

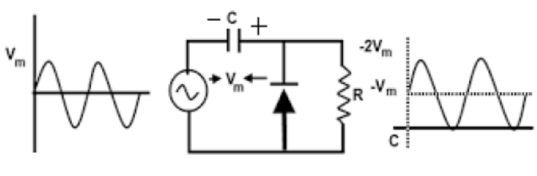


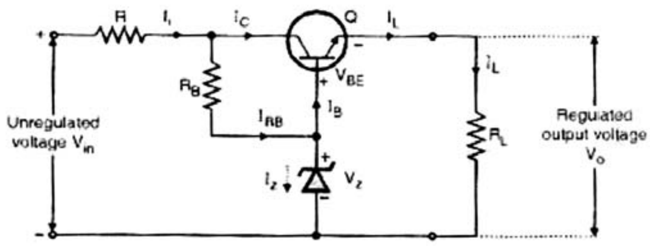
Fig. Positive Clamper

- The circuit will be called a positive clamper, when the signal is pushed upward by the circuit.
- During the positive half cycle, the diode is reverse biased.
- During the negative half cycle, it is forward biased and current flows through it. It charges the capacitor to the negative peak voltage $-V_m$

- Once the capacitor is fully charged to $-V_m$, cannot discharge because the diode cannot conduct in the reverse direction.
- Therefore the capacitor acts as a battery with e.m.f equal to $-V_m$.
- This voltage gets added to the input signal, $V_m \cdot \sin\omega t$.
- Therefore the output voltage is equal to, $v_0 = V_m \cdot \sin\omega t + V_m$
- Thus a d.c voltage equal to V_m is added to input signal. It causes the waveform to clamp positively at 0 V.

Q.3(b) Draw the circuit diagram for transistor series regulator and explain functions of each component. **[4]**

Ans.:



Transistor (Q)- It acts as a control element and it is connected in series with the load resistor R_L. It also acts as a variable resistor to control the output voltage.
Zener Diode - It provides reference voltage.
Resistor (R) - It acts as a current limiting resistor.
Base Resistor (R_B) -It provides biasing for transistor Q to keep the transistor in active region.

Q.3(c) An AC supply of 230 V is applied to HWR through a transformer with turns ratio 10 : 1. Find Average DC output, Voltage current and P/V of diode. RMS value of voltage and current. **[4]**

Ans.: Vrms = 230V, np/ns = 10/1
Max primary voltage is

$Vp = \sqrt{2} * Vrms$
$= \sqrt{2} * 230$
$= 325.22$Volt

The max secondary voltage is Vm = ns/np*Vp =
= 1/10*325.22
= 32.52V

V average = Vdc = Vm/π
= 32.5/ 3.14
= 10.35V

PIV = Vm = 32.52V
Vrms = Vm/2
= 32.52/2
= 16.25V

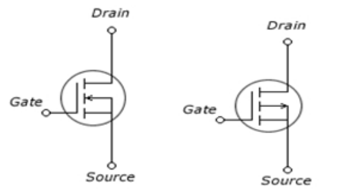
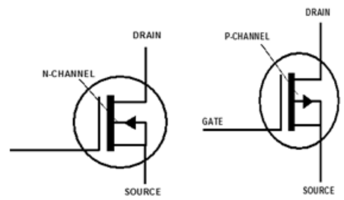
Idc = Im/π
Irms = Im/2

Assume $R_L = 10K\Omega$
Im = Vm/R_L
= 32.52/10*1000
= 3.25mA

Idc = Im/π
$= 3.25*10^{-3}/\pi$
= 1.03 mA

Q.3(d) Compare EMOSFET & DMOSFET. **[4]**

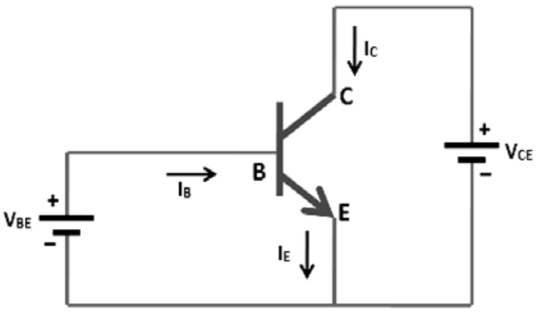
Ans.:

Sr. No.	E MOSFET	DMOSFET
(i)	Insulating oxide layer is present between gate and substrate channel is absent. At the operation induced channel get created.	An insulating oxide layer is present between G & channel n or p-type channel is present.
(ii)	For n- channel EMOSFET V_{GS} will be only positive.	For an n-channel DMOSFET, the V_{GS} can be negative for depletion mode & positive for Enhancement mode
(iii)	For an n-channel EMOSFET I_D increases as V_{GS} becomes more and more positive	For an n-channel DMOSFET I_D decreased as V_{GS} becomes more and more negative.
(iv)	For an n-channel EMOSFET I_D = 0 for $V_{GS} \leq V_T$ (V_{GSTh})	For an n-channel DMOSFET I_D = 0 for $\lvert V_{GS}\rvert \geq V_P$
(v)	 N- Channel EMOSFET P- Channel EMOSFET	 N- Channel DMOSFET P- Channel DMOSFET

Q.4 Attempt any THREE of the following : **[12]**

Q.4(a) Explain the operation of npn transistor in the active region. **[4]**

Ans.:



Operation of NPN transistor in active region:

Active region is one in which base emitter junction is forward biased and base collector junction will be reverse biased in a transistor.

Due to forward bias at base emitter junction, the barrier potential is reduced and results in electron flow from emitter to base or current I_E.

Some of the electrons entering base region will combine with holes in the base region and result in base current I_B.

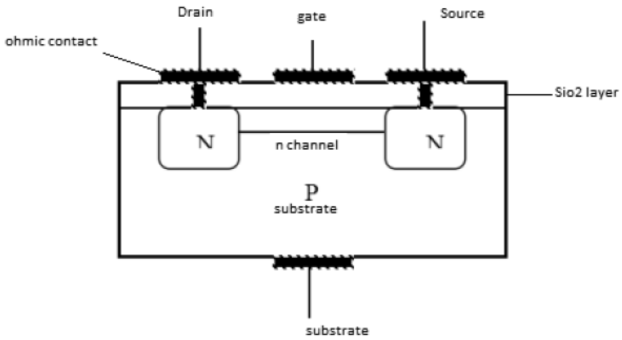
Remaining large number of electrons will pass to the collector circuit and represent the collector current I_c .

In the active region, the collector current increases slightly (nearly constant) as collector-emitter voltage V_{CE} increases. The value of the collector current I_C increases with the increase in I_B.

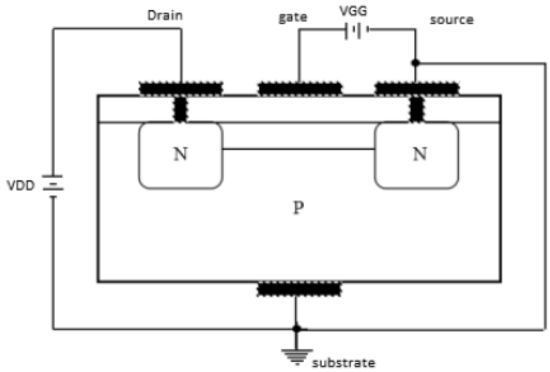
In the active region $I_C = \beta I_B$.

Q.4(b) Draw the constructional details of n–channel MOSFET. State its working principle. [4]

Ans.: Depletion type MOSFET:



Circuit Operation:



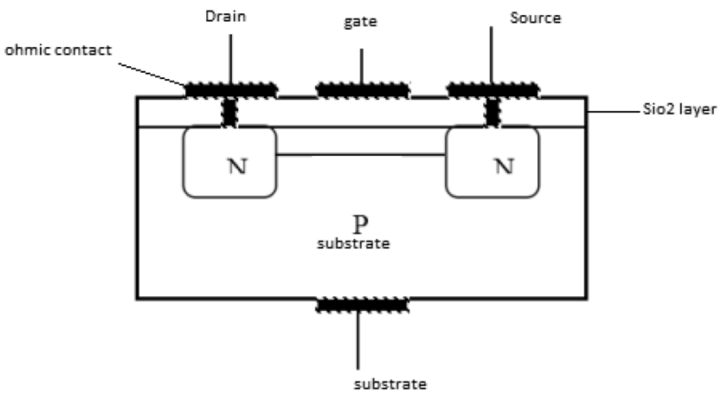
The gate to source voltage is set to zero volts by the direct connection from one terminal to the other & voltage V_{DS} is applied across the drain to source terminals. This results the attraction by the free electrons of the n channel due to positive drain & I_{DSS} establish in the circuit.

For negative voltage at gate, electrons are repelled towards P type substrate and holes are attracted towards insulated layer. Recombination occurs between electron & holes that will reduce the number of free electrons in the channel for conduction. So drain current reduces. The value of V_{GS} at which drain current is nearly equal to zero is called cut off voltage.

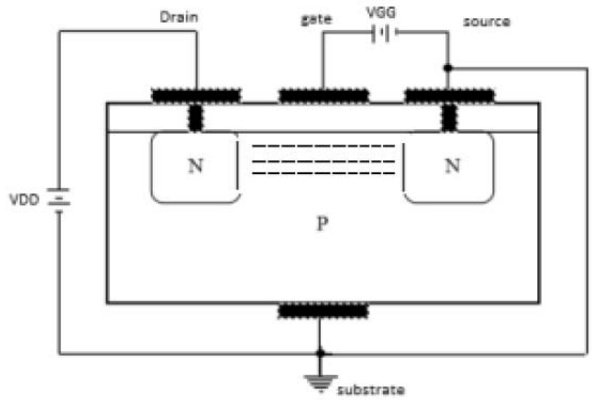
When gate is positive with respect to source, then positive V_{GS} draws additional electrons from the P type substrate. Thus drain current (I_D) increases as increase in positive VGS.

OR

Enhancement – Type MOSFET:



Circuit Operation:



In fig. both V_{GS} & V_{DS} have been set at positive with respect to the source. The positive potential at the gate will attract the electrons from the P substrate & accumulate in the region near to the surface of SiO_2 layer. The SiO_2 layer & its insulating qualities will prevent the negative carriers (i.e. electrons) from being absorbed at the gate.

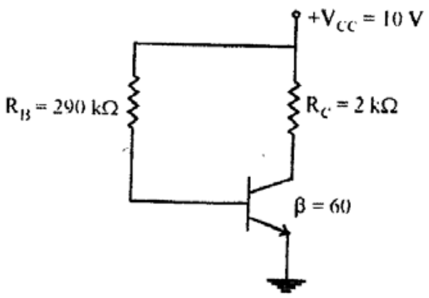
As V_{GS} increases, the concentration of electrons near the SiO_2 surface increases & there is formation of channel & the current starts following through the circuit for further applied voltage.

Q.4(c) Compare L, C, LC and π filter on the basis of usefulness in reducing ripple or suitability for heavy/light load. **[4]**

Ans.:

Parameters	L filter	C filter	LC filter	π filter
Ripple	MORE	LESS	LOW	LOWEST
Suitability for heavy / light load.	HEAVY LOAD	LIGHT LOAD	HEAVY LOAD CURRENT	LOW LOAD CURRENT

Q.4(d) Find the Q point values for the following circuit. **[4]**
Assume V_{BE} = 0.7 V & β = 60



Ans.: By KVL

V_{CE} = Vcc - Ic.Rc

For point on X axis—Ic = 0

V_{CE} = Vcc = 10V

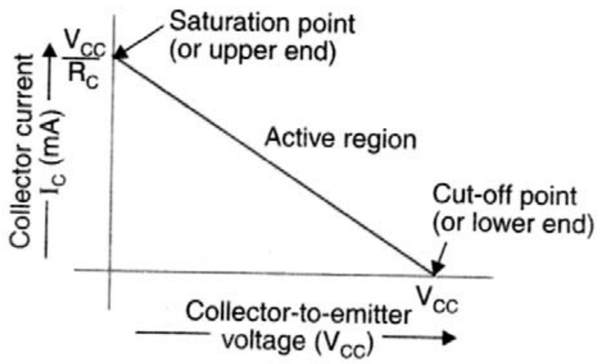
For point on Y AXIS -- VCE=0

$I_C = V_{CC}/R_C$

= 10/2000

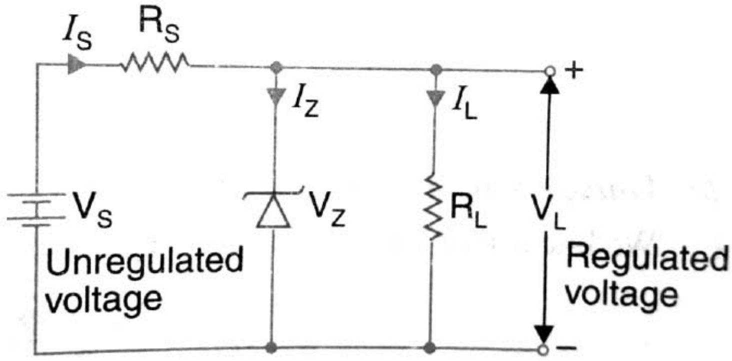
= 0.005

= 5mA



Q.4(e) Describe the working of zener diode as a voltage regulator with reverse characteristics of zener diode. **[4]**

Ans.:



Circuit Description

As the zener diode is connected in parallel or shunt with the load hence it is also known as shunt regulator.

A resistance (Rs) is connected in series with the zener diode to limit current in the circuit.

For proper operation, the input voltage(Vs) must be greater than the zener voltage(Vz).

$$Is = \frac{Vs - Vz}{Rs}$$

$V_L = V_Z + I_Z \cdot R_Z$

Where,

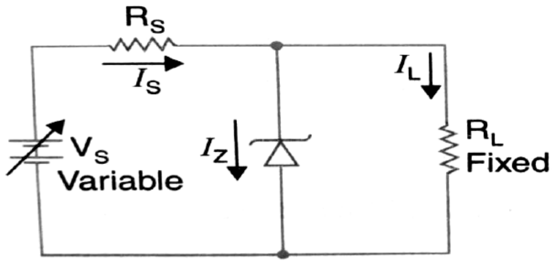
Rz = zener resistance

$$I_L = \frac{V_L}{R_L}$$

$Is = Iz + I_L$

Working of zener diode shunt regulator

(a) Regulation by Varying Input Voltage



Here the load Resistance is kept fixed and input voltage is varied within the limits

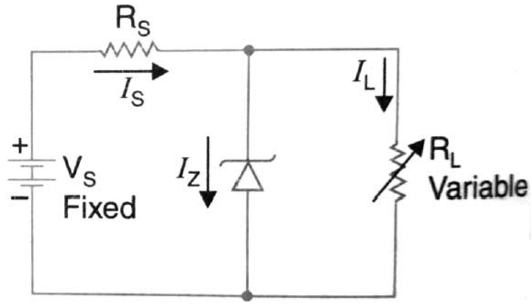
Condition 1. When Input Voltage is Increased

When input voltage is increased the input current (Is) also increases. Thus current through zener diode gets increased without affecting the load current(IL).The increase in input voltage also increases the voltage drop across the resistance Rs thereby keeping the VL constant.

Condition 2. When Input Voltage Is Decreased

When input voltage is decreased, the input current gets reduced, as a result of this Iz also decreases. The voltage drop across Rs will be reduced and thus the load voltage (V_L) and load current (I_L) remains constant.

(b) Regulation by Varying Load Resistance



In this method the input voltage is kept constant whereas load resistance R_L is varied.

Condition 1. When Load Resistance is Increased

When load resistance is increased, the load current reduces, due to which the zener current I_Z increases. Thus the value of input current and voltage drop across series resistance is kept constant. Hence the load voltage remains constant.

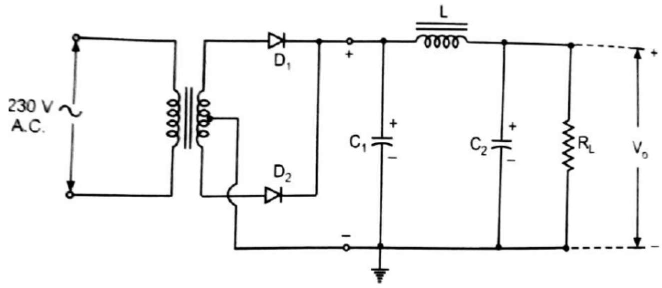
Condition 2. When Load Resistance is Reduced

When load resistance is decreased, the load current increases. This leads to decrease in I_Z. Because of this the input current and the voltage drop across series resistance remains constant. Hence the load voltage is also kept constant.

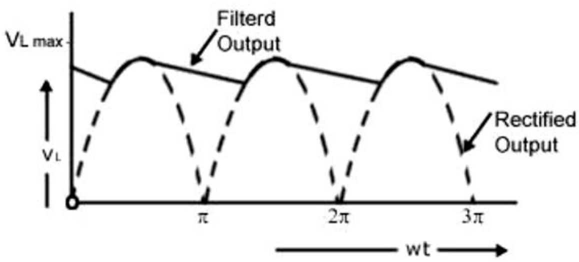
Q.5 Attempt any TWO of the following : [12]

Q.5(a) Draw circuit diagram and input and output waveforms of full wave rectifier connected with π filter. [6]

Ans.: Circuit diagram of full wave rectifier connected with π filter:



Input and Output waveforms of full wave rectifier connected with π filter

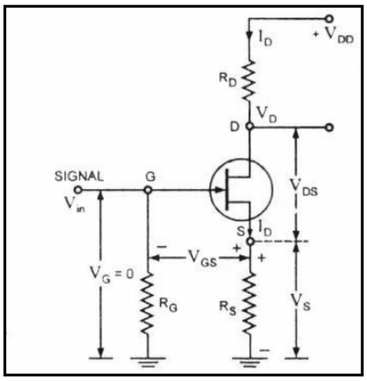


Q.5(b) With neat circuit diagram and mathematical expressions, explain the self biasing used in FET. [6]

Ans.: **1. Self Biasing**

- In this circuit there is only one drain supply and no gate supply.
- The gate terminal is connected through resistor R_G to the ground.
- The source terminal is connected through resistor R_S to the ground.

  {NOTE: In JFET input PN junction between gate & source is always reverse bias, due to this input resistance of JFET is very high. Due to this input gate current I_G = zero. Hence if resistor R_G is connected in series with gate terminal, voltage drop across R_G is zero as $V_{RG} = I_G R_G = 0$}

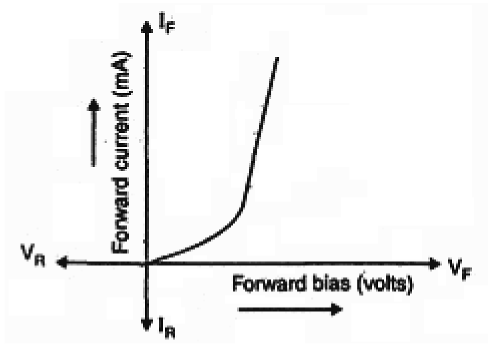


- $V_G = I_G R_G = 0$
- $V_{GS} = V_G - V_S$
  $= -V_S$

Apply KVL to input loop
$V_{GS} + I_D R_S = 0$
$\therefore V_{GS} = -I_D R_S$

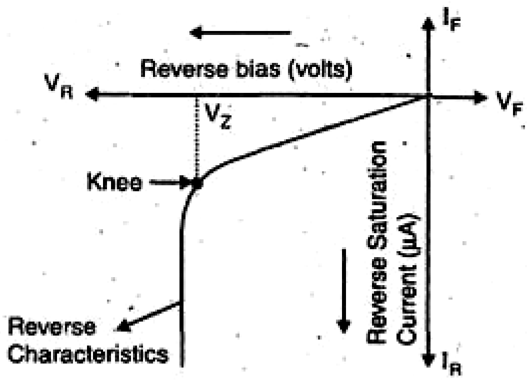
- $I_D = I_{DSS}\left\{1 - \dfrac{V_{GS}}{V_P}\right\}^2$ Shockley's equation
- Apply KVL to output loop
  $V_{DD} - I_D R_D - V_{DSQ} - I_D R_S = 0$
  $V_{DSQ} = V_{DD} - I_D R_D - I_D R_S$

Q.5(c) Explain V-I characteristics of zener diode. **[6]**
Ans.: Forward characteristics of Zener diode:



This characteristic is similar to that of an ordinary silicon P-N junction diode.
This indicates forward current is very small for voltages below knee voltage (VK = 0.7V) and large for voltages above knee voltage.

Reverse characteristics of Zener diode:



- Fig above shows the reverse portion of V-I characteristics of the zener diode.
- As the reverse voltage (V_R) is increased the reverse current (I_Z) remains negligibly small up to the 'Knee' of the curve.
- At this point the effect of breakdown process begins.

- From the bottom of the knee, the breakdown voltage or Zener voltage (V_Z) remains essentially constant.
- This ability of a diode is called regulating ability and is an important feature of Zener diode.
- Following two points are important from the characteristics of a Zener diode.
- There is a minimum value of Zener current called "break over current" designated as I_{ZK} or I_Z(min) which much be maintained in order to keep the diode in regulation region.

There is a maximum value of Zener current designated as I_{ZM} or I_Z(max) above which the diode may be damaged.

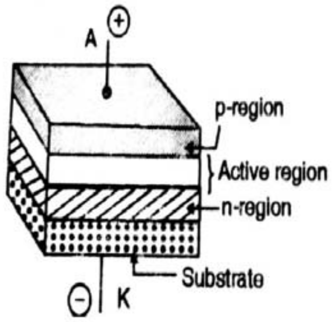
Q.6 Attempt any TWO of the following : [12]

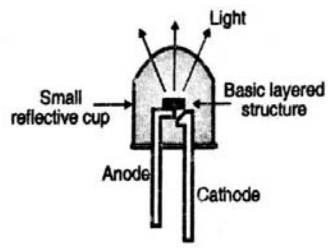
Q.6(a) Show constructional details of LED. Give any two application of LED. [6]

Ans.: Constructional details of LED:

A pn junction diode, which emits light when forward biased, is known as a light emitting diode (LED). This 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.

Here, an N-type layer is grown on P-type substrate by a diffusion process. Then a thin Ptype layer is grown on N-type layer. It has two electrodes namely Anode and Cathode. The light energy is released at the junction, when the recombination of electrons with the holes takes place. After passing through the P-region, the light is emitted through the window provided at the top of the surface.





Applications of LED:

1. It is used in opto couplers.
2. It is used in optical communication systems.
3. It is used in infrared remote control.
4. It is used in 7- segment, 16- segment, alphanumeric displays.
5. It is used as indicators in various electronic circuits.
6. It is used in optical switching applications.
7. It is used in burglar alarm systems.
8. It is used to indicate digital logic state.
9. Used for traffic signal management
10. Used in aviation lighting, automotive lighting, advertising and general lighting

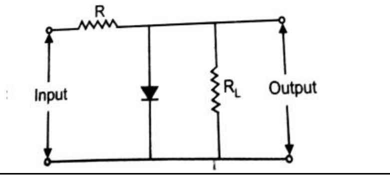
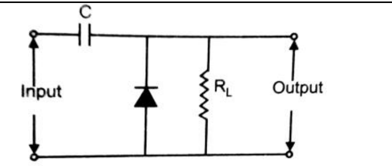
Q.6(b) Differentiate clipper and clamper with following points : [6]

(i) Components used in circuit **(ii) Function**

(iii) Application **(iv) Configuration**

Ans.:

Sr. No.	Parameter	Clipper	Clamper
(i)	Components used in circuit	Diode, resistor	Diode, resistor, capacitor
(ii)	Function	To remove a part of input signal voltage above or below a certain level.	To add a DC shift to the input signal

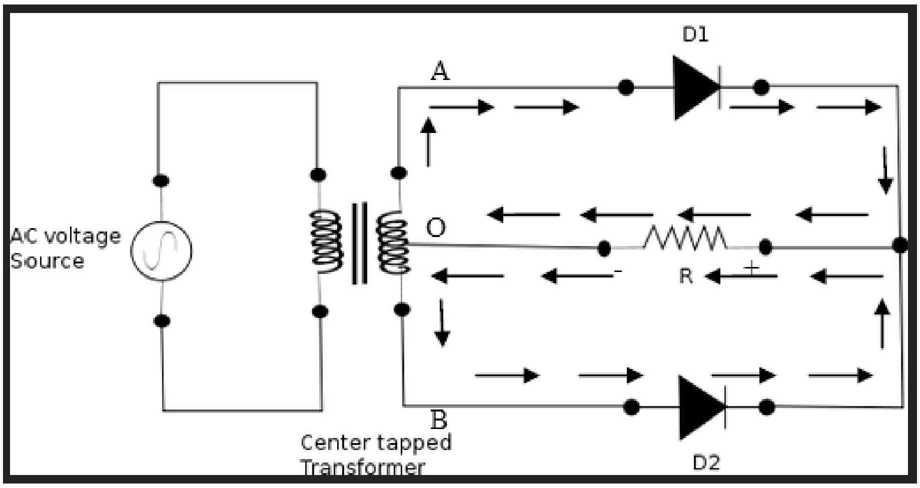
(iii)	Application	• Digital computers, • radars, • radio and television receivers, • to limit the amplitude of the input signal voltages required in several applications.	• Used in Television receivers to restore the original dc reference signal to the video signal, • voltage multipliers.
(iv)	Configuration		

Q.6(c) Draw circuit and describe working of full wave rectifier using center tapped transformer with waveforms. **[6]**

Ans.: **Full wave Rectifier with Center tapped transformer(FWR):**

- In full wave rectification, the rectifier conducts in both the cycles as two diodes are connected.

  Circuit diagram:



- The circuit employs two diodes D1 and D2 as shown. A center tapped secondary winding AB is used with two diodes connected. So that each uses one half – cycles of input AC voltage.
- Diode D1 utilized the AC voltage appearing across the upper half (OA), while diode D2 uses the lower half winding (OB).
- The voltage V_s between the center-tap and either ends of secondary winding is half of the secondary voltage V_2i.e$V_s = \frac{V_2}{2}$
- If the output voltage should be equal to the input voltage, a step up transformer with turns ratio $\frac{N_2}{N_1} = 2$ must be used. Thus the total secondary voltage V_2 is twice the primary voltage.

  i.e, $V_s = V_1 = \frac{V_2}{2}$

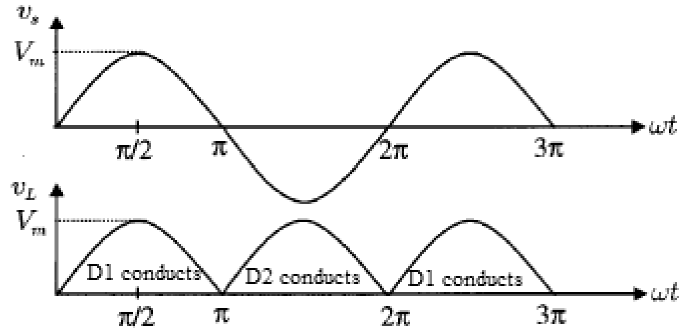
Operation:

1. **In positive half cycle (0-π).**
   - The end A of the secondary winding becomes positive and end B negative.
   - This makes diode D1 forward biased and diode D2 reverse biased. Therefore D1 conducts while D2 does not.

- The conventional current flow direction in the upper half winding as shown in the figure above.

  A – D1 – RL – O

2. **In negative half cycle (π - 2π):**
   - End A of secondary winding becomes negative and end B positive. Therefore diode D2 conducts while diode D1 does not.
   - The conventional current flow is from as shown by the arrows in the above figure B – D2 – RL – O
   - From fig. current in the load RL is in the same direction for both half-cycles of input AC voltage. Therefore DC is obtained across the load RL.



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