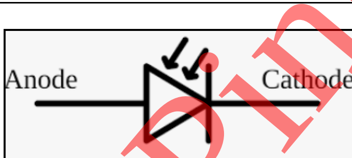
MODEL ANSWER

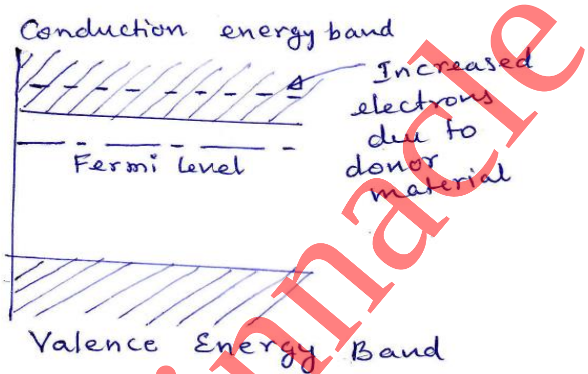
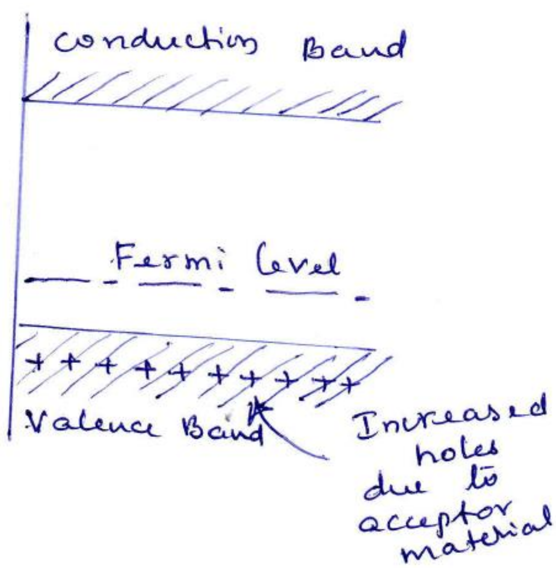
WINTER– 18 EXAMINATION

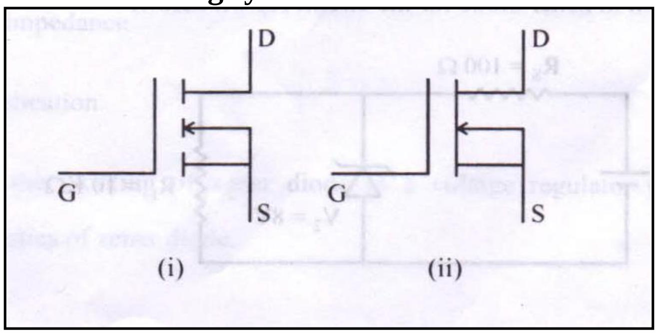
Subject Title: Basic Electronics (BEL) Subject Code: 22216

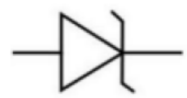
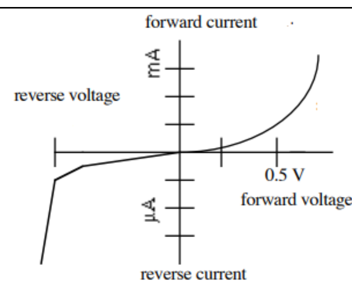
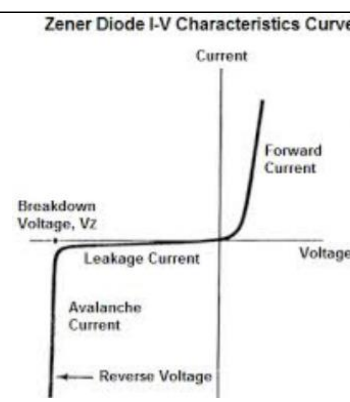
Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for anyequivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q. No.	Sub Q.N.	Answer	Marking Scheme
Q.1		**Attempt any FIVE :**	**10-Total Marks**
	a)	**Draw the symbol of photodiode.**	**2M**
	Ans:		Correct symbol -2M
	b)	**Define Transistor. State its type.**	**2M**
	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: 1. Unipolar Junction Transistors 2. Bipolar Junction Transistors	Definition - 1M; Types - 1M
	c)	**Define load and line regulation.**	**2M**
	Ans:	**Load regulation** is the ability of the power supply to maintain its specified output voltage given changes in the load. **Line regulation** is the ability of the power supply to maintain its specified output voltage over changes in the input line voltage.	Each definition - 1M

	d)	**State application of FET.**	**2M**
	Ans:	***(NOTE : Any other relevant Application mark shall be given)*** **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.	**Any two applications** (1M each)
	e)	**Sketch energy band diagram of semiconductor.**	**2M**
	Ans:	**Energy band diagram for N type semiconductor:**  **Energy band diagram for P type semiconductor:**  	Any one correct diagram - 2M

	f)	**State the need of DC regulated power supply.**	**2M**
	Ans:	**Need of DC regulated power supply :** **1.** To convert unregulated AC into constant DC. 2. To convert fluctuating main supply into regulated constant DC.	Any one relevant need - 2M
	g)	**Name the components of following symbol:** 	**2M**
	Ans:	(i) N-channel Enhancement type MOSFET (ii) N-channel Depletion type MOSFET	Each correct answer -1M
Q. 2		**Attempt any THREE of the following :**	**12-Total Marks**
	a)	**Compare PN junction diode & Zener diode. (four points).**	**4M**
	Ans:	(see table below)	Each point - 1M

Parameter	**PN junction diode**	**Zener diode**
Symbol		
Direction of Conduction	Conducts only in one direction	Conducts in both directions
Reverse breakdown	It has no sharp reverse breakdown	It has quite sharp reverse breakdown
Application	Used in rectification	Used in regulation
Resistance in reverse biased condition	Very high	Very small
Characteristics		

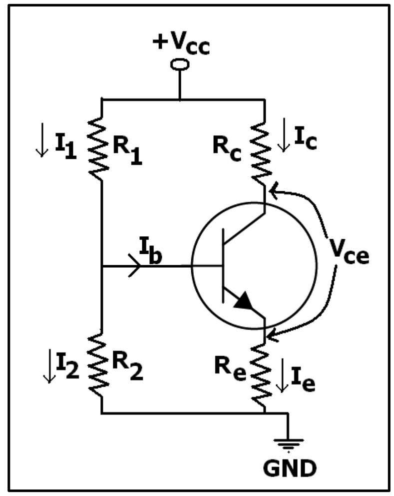
b) **Explain with a neat circuit diagram of voltage divider bias method for biasing a transistor.** **4M**

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, $V_B = V_{CC} \times \frac{R_2}{R_1 + R_2}$

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

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



Explanation - 2M
Diagram - 2M

c) **Draw the block diagram of DC power supply. Explain the function of each block.** **4M**

Ans:

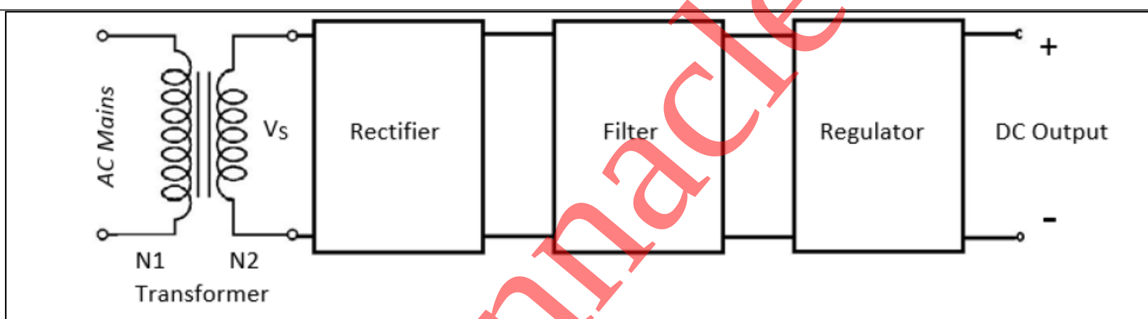


Diagram - 2M

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.

Functions - 2M

d) **Explain the concept of DC load line and oprating point.** **4M**

Ans: **DC load line**: The straight line drawn on the characteristics of a BJT amplifier which give the DC values of collector current I_C and collector to emitter voltage V_{CE} corresponding to zero signal i.e. DC conditions is called DC load line. 1M

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

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

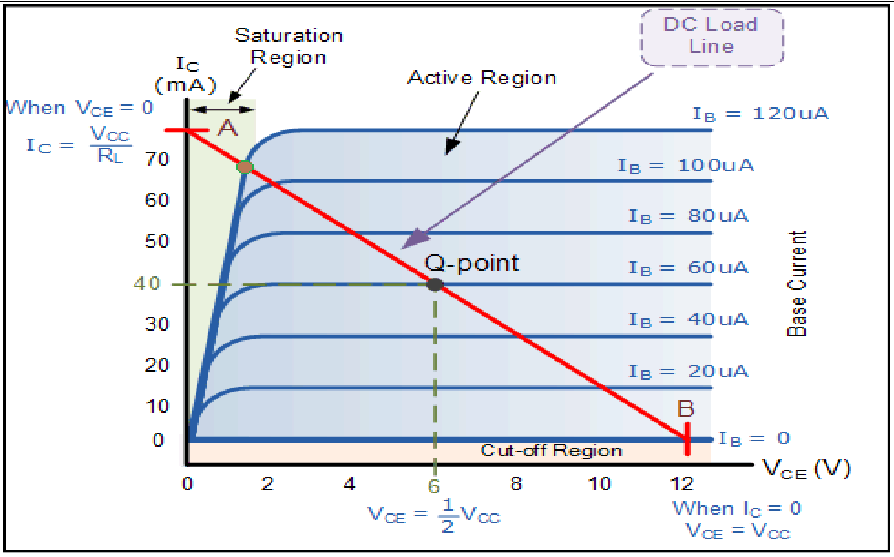
$V_{CE} = V_{CC} - I_c \; R_c$

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

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

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

2M



1M

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.

Q. 3 **Attempt any THREE of the following:** **12-Total Marks**

a) **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 PIV of diode, RMS value of voltage and current.** **4M**

Ans: Vrms=230V, np/ns=10/1

Max primary voltage is

Vp=√2* Vrms

=√2* 230

=325.22Volt

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

Vdc = 1 Mark

PIV=Vm= 32.52V

Vrms=Vm/2

=32.52/2

=16.25V

PIV = 1 Mark

Idc=Im/π

Irms= Im/2

Assume R_L=10KΩ - *(Note - Students may assume any value and attempt to solve, can be considered)*

$Im = Vm/R_L$
$= 32.52/10*1000$
$= 3.25mA$

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

$Irms = Im/2$
$= 3.25*10^{-3}/2$
$= 1.62$ mA

Idc = 1 Mark
Irms = 1mark

b) State the values of following parameters with reference to full wave rectifier: **4M**

(i) Ripple factore **(ii) Efficiency**
(iii) TUF **(iv) P/V**

Ans:

(i) Ripple factor -48%
(ii) Efficiency - 81.2%
(iii) TUF -69.3 or 81.2
(iv) PIV- Vm

1 mark each parameter

c) Compare EMOSFET & DMOSFET.

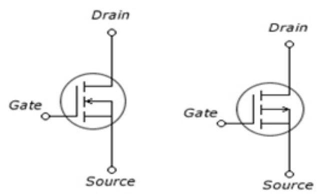
Ans:

Sr. No.	E MOSFET	DMOSFET
1	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.
2.	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
3	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.
4	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 $\lvert V_{GS}\rvert \geq V_P$

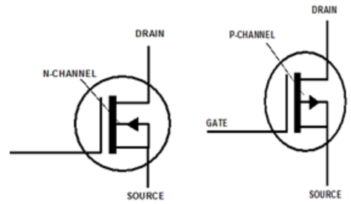
4M

Any 4 points – 1mark each

5

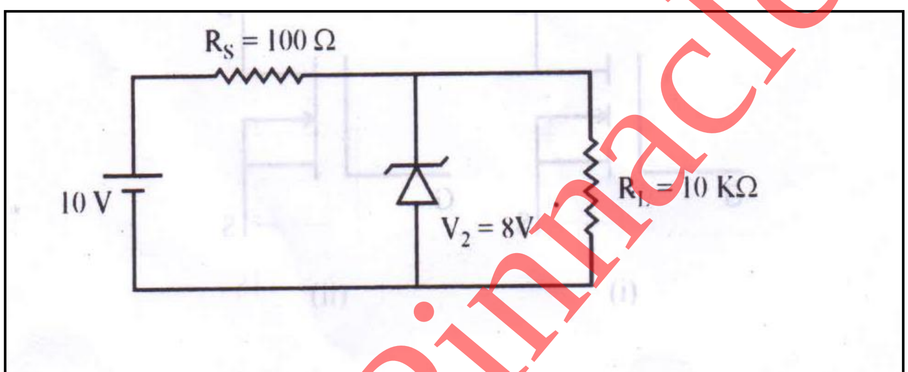


N- Channel EMOSFET P- Channel EMOSFET



N- Channel DMOSFET P- Channel DMOSFET

d) **Determine output voltage V_0, load current I_L, zener current I_z & power dissipation in zener diode for the circuit shown below.** **4M**



Ans:

i)Vo=Vz

=8V

V_0 = 1mark

ii) load current I_L

$I_L = V_o/R_L$

= 8/(10*1000)

=0.0008

=0.8 mA

I_L = 1mark

iii)zener current I_z

I_z = 1mark

Vo=Vin-Is.Rs

Is=(Vin- Vo)/Rs

= (10-8)/100

=2/100

Is =0.02A

$I_s = I_z + I_L$
$I_z = I_s - I_L$
$= 0.02 - 0.0008$
= 0.0192A

iv)Power dissipation
$= V_L * I_L$
= 8* 0.0008
= 0.0064
=6.4mW

Power dissipation = 1mark

Q. 4		**Attempt any THREE of the following:**	**12-Total Marks**
	a)	**Compare L, C, LC and π filter on the basis of usefulness in reducing ripple or suitability for heavy / light load.**	**4M**

Ans:

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

ripple or suitability for heavy / light load = 1 mark each point

b) Explain the operating principle of PNP transistor. **4M**

Ans:

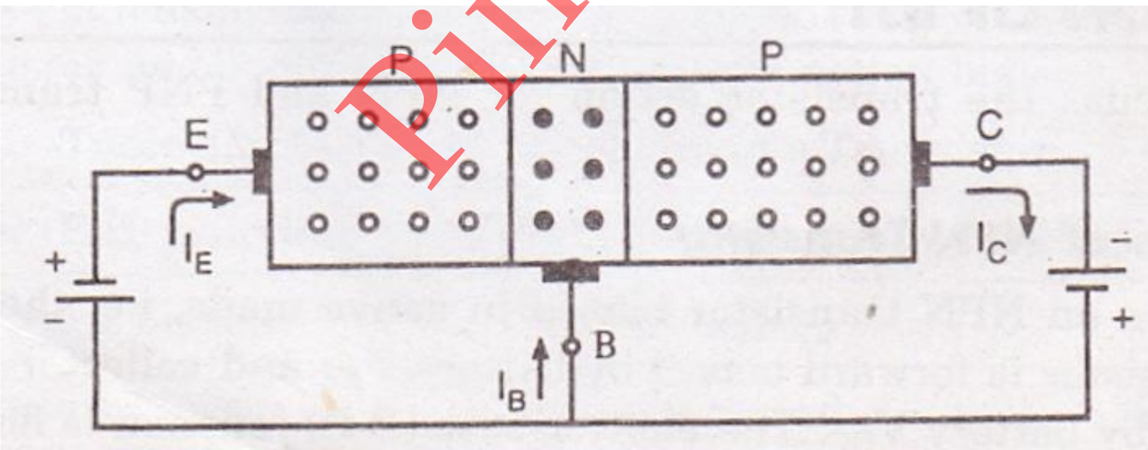


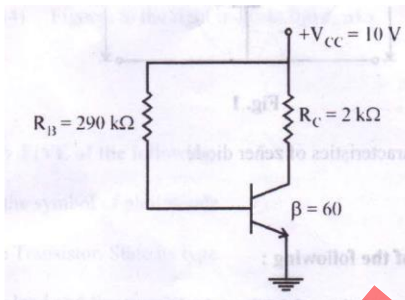
Diagram – 1 mark
Explanation = 3marks

A PNP transistor biased in active mode, i.e. the emitter –base (E-B) junction as forward biased battery V_E and the collector – base (C-B) junction as reverse biased, the emitter – base (E-B), junction is forward biased only if the emitter to base (E-B) voltage (VEB) exceed the barrier potential which is 0.7 volts for silicon and 0.3 volts for germanium transistors.

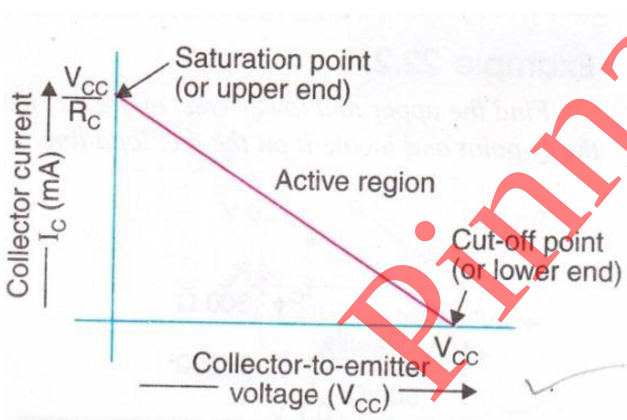
The forward biased on the emitter base (E-B) junction causes majority carriers i.e. holes in the P type emitter region to flow towards the N type base region. This E-B junction, they tend to combine with the majority carriers i.e. holes in the base region.

Most collector current is also injected current because this current is produced due to the holes injected from the emitter region. There is another small component of collector current due to thermally generated carriers. This current component is called reverse saturation current (I_{CO}) and is quite small. In this way, almost entire emitter current flows in the collector circuit, it is clear that the emitter current is the sum of the base current and collector current i.e. $I_E = I_B + I_C$

c) **Find the Q point values for the following circuit, Assume V_{BE} = 0.7 V & β = 60.** **4M**



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

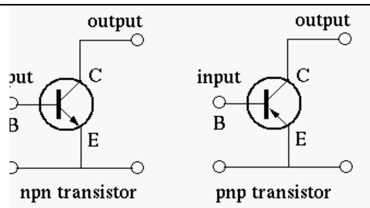
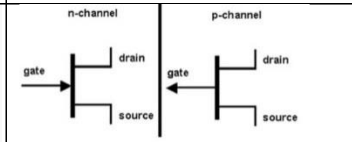
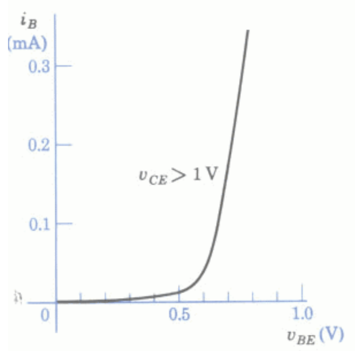
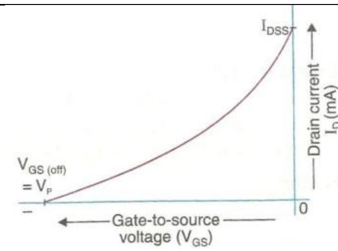
Ic = 2marks

V_{CE} = 2marks

d) **Compare BJT & JFET with reference to following point:** **4M**

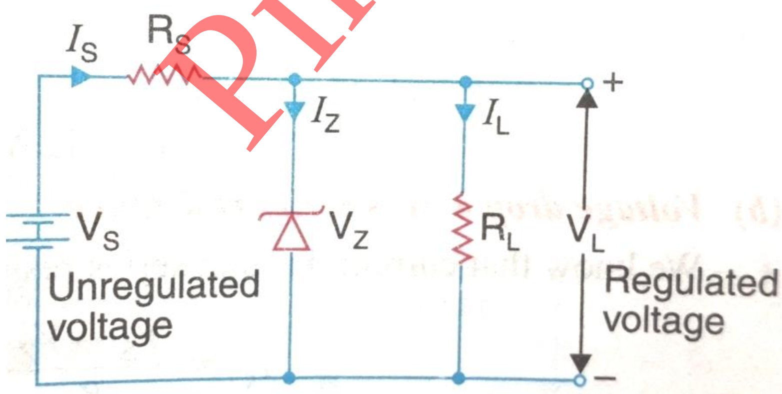
- **i) Symbol**
- **ii) Transfer characteristics**
- **iii) I/P impendence**
- **iv) Application**

	Ans:	(table below)	1 mark each

Parameters	**BJT**	**FET**
Symbol		
Transfer characteristics	 **OR** Linear in BJT	 **OR** Non-linear in FET
I/P impedance	Low	High
Application	Amplifier and Switch	Amplifier and Switch

	e)	**Describe the working of Zener diode as a voltage regulator with reverse characteristics of zener diode**	**4M**

Ans: (2 marks diagram 2 marks explanation)



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).

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

$$V_L = V_Z + I_Z . R_Z$$

Where,

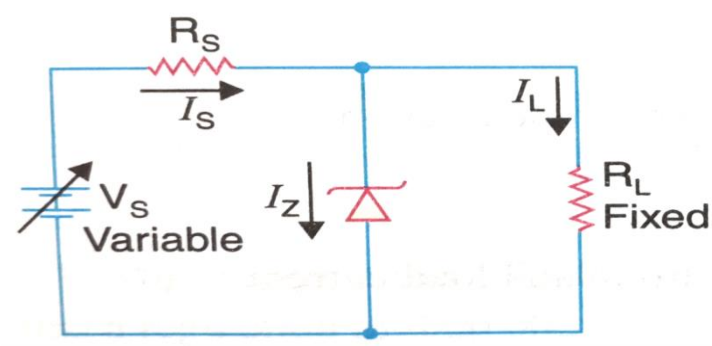
Rz= zener resistance

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

Is=Iz + I_L

WORKING OF ZENER DIODE SHUNT REGULATOR

A] <u>REGULATION BY VARYING INPUT VOLTAGE</u>



This diagram is optional

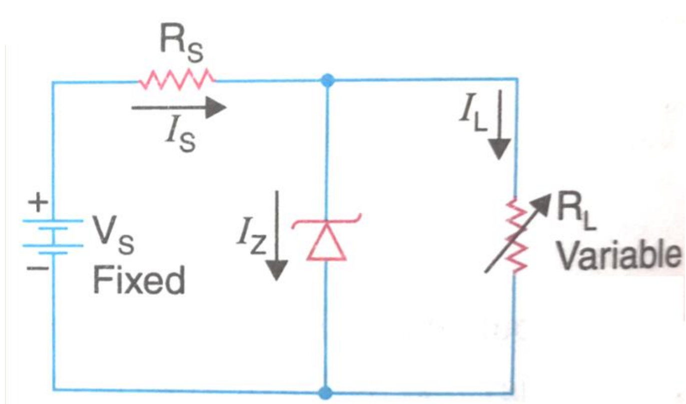
Here the load Resistance is kept fixed and input voltage is varied within the limits

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] <u>REGULATION BY VARYING LOAD RESISTANCE</u>



This diagram is optional

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.

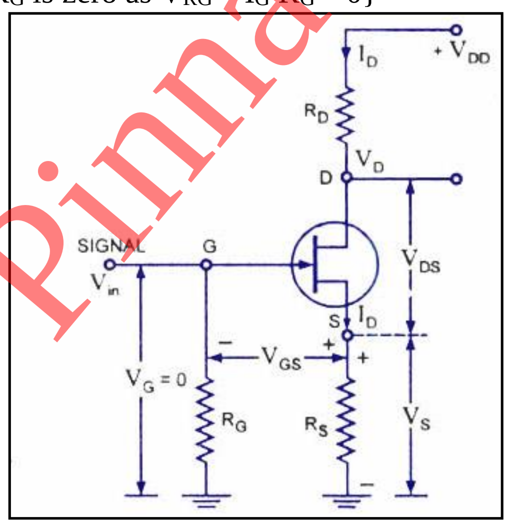
CONDITION 2. WHEN LOAD RESISTANCE IS REDUCED

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.

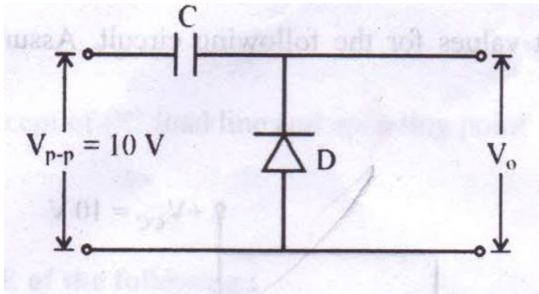
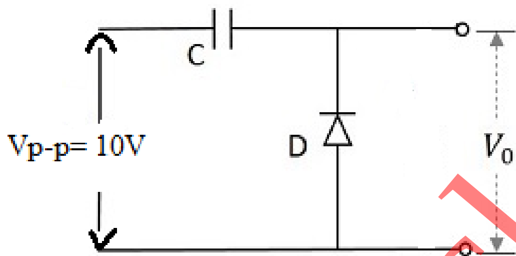
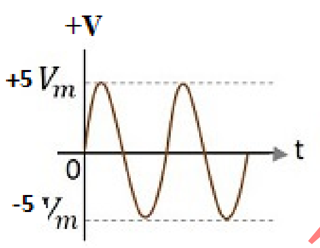
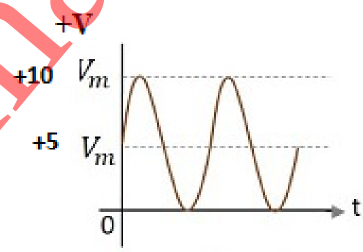
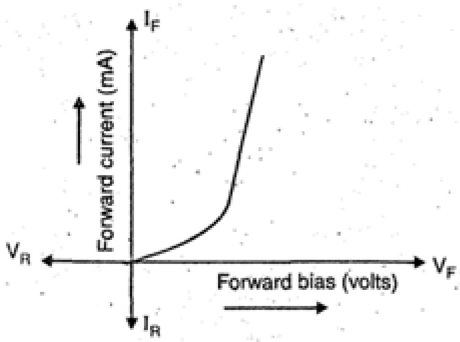
Q.5		**Attempt any TWO of the following :**	**12-Total Marks**
	a)	**With neat circuit diagram and mathematical expressions, explain the self-biasing used in F.E.T.**	**6M**
	Ans:	(see below)	Circuit Digram:3M Explanation: 1M Mathematical expression:2 M

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 $V_{RG} = I_G R_G = 0$}

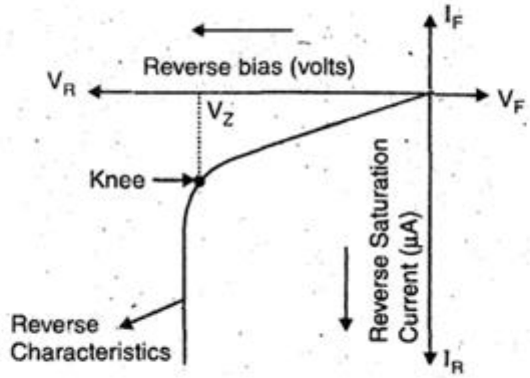


- $V_G = I_G R_G = 0$
- $V_{GS} = V_G - V_S$
  $= -V_S$
  APPLY KVL TO INPUT LOOP
  $V_{GS} + I_D R_S = 0$
  $\therefore V_{GS} = -I_D R_S$
- $I_D = I_{DSS}\{1-\frac{V_{GS}}{V_P}\}^2$ Shockley's equation
- APPLY KVL TO OUTPUT LOOP
  $V_{DD} - I_D R_D - V_{DSQ} - I_D R_S = 0$
  $V_{DSQ} = V_{DD} - I_D R_D - I_D R_S$

		$= V_{DD} - I_D [R_D + R_S]$	
	b)	**Identify the following circuit shown in Fig. No. 1 and draw input and output waveforms.**  **Fig. 1**	**6M**
	Ans	 **Assume Ideal Diode** Ckt is Positive Diode Clamper  Input Waveform  Output Waveform	Circuit Identification :2M Input, output waveform:4 M
	c)	**Explain V-I characteristics of zener diode.**	**6M**
	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 =	Forward characteristics of Zener diode: 2M Reverse characteristics of Zener diode: (2M Draw and 2M Description)

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.

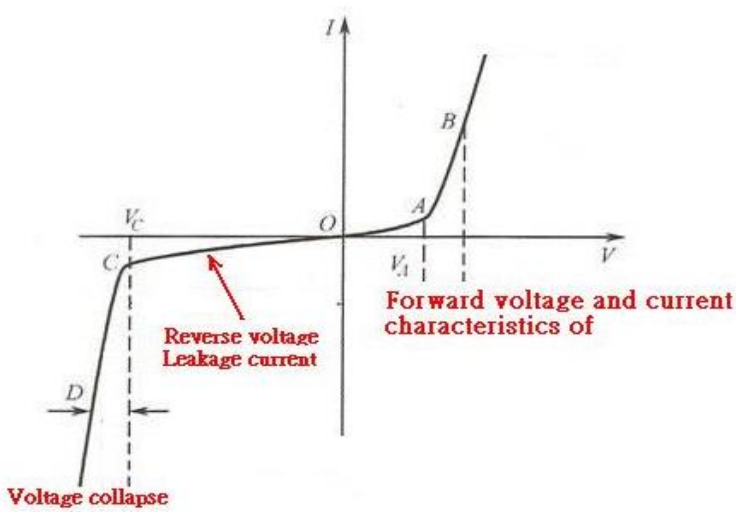
There is a maximum value of Zener current designated as I_{ZM} or I_Z(max) above which the diode may be damaged.

Q.6 **Attempt any TWO:** **12-Total Marks**

a) **Draw the characteristics of LED and write advantages, disadvantages and application of it. (each two points)** **6M**

Ans: **V-I characteristics of LED:**

V-I characteristics of LED:3M



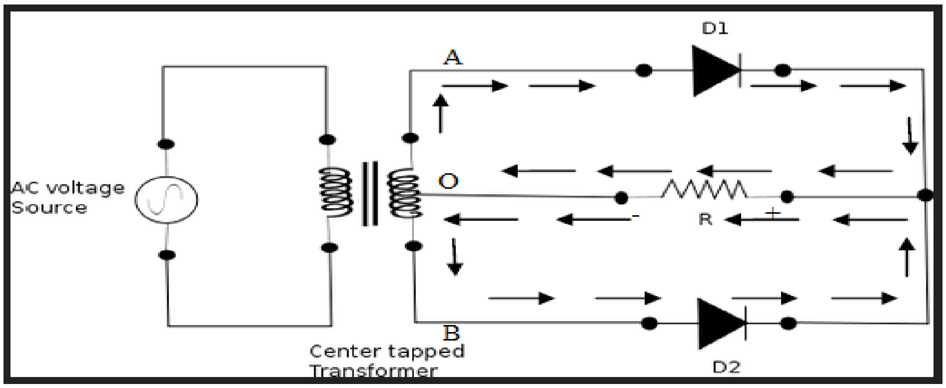
		ADVANTAGES: (Any Two Points) • **Efficiency:** LEDs emit more lumens per watt than incandescent light bulbs. • **Color:** LEDs can emit light of an intended color. This is more efficient and can lower initial costs. • **Size:** LEDs can be very small (smaller than 2 mm^2) and are easily attached to printed circuit boards. • **On/Off time:** LEDs light up very quickly. LEDs used in communications devices can have even faster response times. • **Dimming:** LEDs can very easily be dimmed either by pulse-width modulation or lowering the forward current. • **Cool light:** In contrast to most light sources, LEDs radiate very little heat. • **Slow failure:** LEDs mostly fail by dimming over time, rather than the abrupt failure of incandescent bulbs. • **Lifetime:** LEDs can have a relatively long useful life. product. • **Shock resistance:** LEDs, being solid-state components, are difficult to damage with external shock, unlike fluorescent and incandescent bulbs, which are fragile. • **Focus:** The solid package of the LED can be designed to focus its light. **Disadvantages** (Any Two Points)**:** • **High initial price:** LEDs are currently more expensive (price per lumen) on an initial capital cost basis, than most conventional lighting technologies. • **Temperature dependence:** LED performance largely depends on the ambient temperature of the operating environment – or "thermal management" properties. • **Voltage sensitivity:** LEDs must be supplied with the voltage above the threshold and a current below the rating. Current and lifetime change greatly with a small change in applied voltage. • **Light quality:** Most cool-white LEDs have spectra that differ significantly from a black body radiator like the sun or an incandescent light. • **Area light source:** Single LEDs do not approximate a point source of light giving a spherical light distribution. • **Efficiency droop:** The efficiency of LEDs decreases as the electric current increases. Heating also increases with higher currents which compromise the lifetime of the LED. • **Impact on insects:** LEDs are much more attractive to insects. • **Use in winter conditions:** Since they do not give off much heat in comparison to traditional electrical lights, LED lights used for traffic control can have snow obscuring them, leading to accidents. **Applications of LED (Any Two Points)::** • As a power indicator. • In seven segment display. • In the opto-couplers. • In the infrared remote controls.	Advantages: 1M (2Points) Disadvantages: 1M (2Points) Application: 1M (2Points)

b) **Draw circuit and describe working of full wave rectifier using center tapped transformer with waveforms.** **6M**

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: *(Circuit Diagram:2 M)*



(Description: 2M)

- 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_2 i.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 fig above.

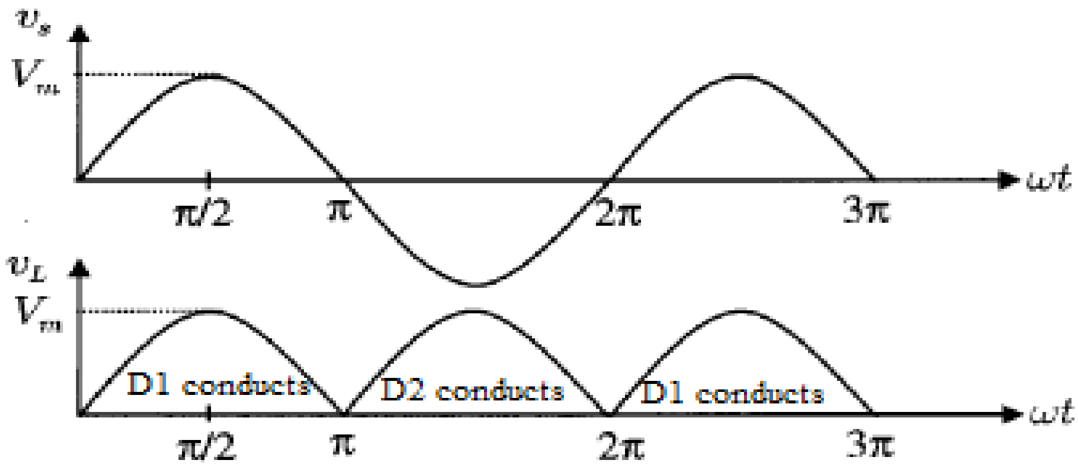
A – D1 – RL – O

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 fig.

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.

			Waveforms: 2M
	c)	**i) In CE configuration if β = 99 leakage current I_{CEO} = 50 µA. If base current is 0.5 mA. Determine I_C and I_E.** **ii) Derive relation between α & β.**	**6M**
	Ans:	**i)** Given: $\beta = 99$ $I_{CEO} = 50\ \mu A$, $I_B = 0.5\ mA, = 500\ \mu A$ To Find: I_C & I_E Solution: $I_C = \beta * I_B + I_{CEO}$ Therefore, $I_C = 99 \times 500\ \mu A + 50\ \mu A$ $I_C = 49550 \mu A$ Therefore, IC = 49.55 mA $I_E = I_C + I_B$ $I_E = 49.55\ mA + 0.5\ mA$ $I_E = 50.05 mA$ $I_E = 50.05\ mA$ **ii) Relation between α & β:** We know that; $I_E = I_B + I_C$……………..(i) Dividing equation (i) by I_C. $I_E / I_C = I_B / I_C + I_C / I_C$ Therefore $1/\alpha = 1/\beta + 1$ (Since $\alpha = I_C / I_E$, $\beta = I_C / I_B$	**To find I_C and I_E = 1/5marks each** **Derive relation between α & β = 3marks**

		Therefore $1/\alpha = \frac{1+\beta}{\beta}$ Therefore $\alpha = \frac{\beta}{1+\beta}$ $\alpha(1+\beta) = \beta$ $\alpha + \alpha\beta = \beta$ Therefore $\alpha = \beta - \alpha\beta$ Therefore $\alpha = \beta (1 - \alpha)$ Therefore $\beta = \frac{\alpha}{1-\alpha}$	