a contract Hina Vinita-JRAN SISTORS Bi-Polan Junction Inansiston (BTT):-¥ • It is a three terminal device named as emitter; they are heavily deped. base, collector The conduction of current takes place due to majority as well as minority charge carriers, that's why it is called Bi-Polar Junction Inansiston Jypes of BJT :-\*> NPNCALIMO PNP ·(b) Construction of NPM N. B It is formed by sandwiching between a thin p-type semi-conductor between two trick n-type semi-conductor. Downloaded from : uptukhabar.net

It has three terminals, Emitter, Base and Collector, where Base terminal comes between emitter and collector, and also Base is thin and lightly doped a transport cardorent, antal - id. · Emitten and collecton are much wider than base and they are heavily doped, emitten is heavily doped than collecton was desperied in the the the the entry os well as employed the adverteens, that is Ques Define Inansiston. als ballos and geta Ans => It is a three terminal device (Emitter, base, Collector) => Depending upon the configuration it can be used as voltage as well as current amplification (1) => It can be used as voltage as well as currient amplikication. > The amplification in the transiston is achieved by passing input signal from low nesistance negion. to high nesistance negion (output). > The concept of transfer of resistance is Known by the name TRANSFER OF RESISTORS => JRANSISTORS In BJT, the output current is controlled by the input current. Hence, it is called CURRENT CONTROLLING DEVICE. Downloaded from : uptukhabar.net

Construction of PNP = Mainad avitable \* Han and the provide bias of the provide the Bas - mail inches of the base of t > Battery Vet 10 concepted acress Emitteen Rasa Jumit-Buins such a gay that Empiltan - base jusichten E de la symbol Partier de la construction de heermes novense biased \* Biasing of Inansistons: (BJT) ⇒ When an external DC voltage is applied across the different terminals of the transistons is called. Biasing.\_\_\_\_ > Depending upon the Dc applied voltage polarities, across the junction, the transistor work in about three modes of operation. all uppers the enditted areaerab Tet and the neisberry MODE Emitter-Base Junction Collector-Base Junction Forward Bias Revense Bias Active Saturation Forward Bias Jonward Bias <u>Revense</u> Bias Revense Bias cut-off Downloaded from : uptukhabar.net

· ACTIVE REGION :- - AMA JO MANDIELENCON ⇒ Emitten-Base junction is fompand biased and collector base junction is neverse biased, then it is Active Region. Region. Battery VBE is connected across Emitter - Base Junction on in such a way that Emitter - base junction becomes forwardbiased. => Batteny Ver is connected across collecton - Base Junction in such a way that bollecton -base junction becomes nevense biased. N P N P - > hoheon on external activities is applied actives the 2971 Mohig podday Bailgoo 22 ant regy BEARD Beag VCB > In this region, the collector averent Te depends upon the emitten current 'IE' and transiston work as an Amplifiere Harrit and - watting I Jaan Active transmet - - - - BCHVE Keyense Astres Satura Lina Antonia Star

· SATURATION REGION :- MANDARA AND MAN > Both the Emitter - Base Junction and Collector -Base Junction is forward biased, then it is Saturation Region. => Batteriy VBE is connected across Emitter - Base Junction in such a way that Emitter - base junction becomes forward bias. Battery VCB is connected across collector-base junction in such a way that collector-base junction becomes forward bias. the collecton current 'I' becomes independent of the base current 'IB' and transiston acts as an closed switchlie, shont cincuit). Downloaded from : uptukhabar.net

CUT-DEF REGION F > Both the Emitter-Base Junction and Collecton-base Junction is nevense biased, then it is cut-off Region. => Battery VBE is connected across Emitter - Base Junction in such a way that Emitter - base junction becomes revense biased. Battery Vee is connected across collector - Base Junction in such a way that collecton - base junction becomes reverse biased and becaused sauce N N P 14 N N E E B VCB => In this region, transiston is used as an open switch

Ques Jon a N-P-N transistor IE = 12 mA and B = 140 Determine the value of IB and Ic  $JI = I_{E} + I_{C}$ B = Ic Ans  $SI = 300 T_c = 12 - T_B$ 3.5.x 3 P. 0 = TB (= Tr BMG 34 - 140 = Ic IB  $140I_{B} = 12 - I_{B} + 12 - 12$  $AV = .141 T_B = 12 T_{-1} T_{-1}$  $E_{B} = D \cdot D 85 m A$  $T_c = .12 - 0.085 = 11.914 m A$ - Id = I Ic = 11.914 = 0.992 IE TR 12 Nr. Obenation of N-P-N Inansiston: ¥ x+ xIc ST = current flow B N Movement of electrons TE (E G Ic \_ + \_ \_ B CBJ EBJ IBT 8 = ~7 E Siz. (JI - JI)g-8-1- - - - = = BIB θŢ BTIC IF IE. Ic V = 3 1 Downloaded from : uptukhabar ne

The Emitten-Base Junction is forward biased by the DC source VEB, thus, the depletion negion\_ across it is reduced. The collecton - Base Junction is neverse biased and due to this the depletion negion will be increased across it as shown in the figure. The forward biased Emitten-Base Junction causes the electron in the N-type emitter to flow towards the base. And this generates the 35,66 emitter current IE. Due to light doping, veny jew no. of electrons injected into the base from the emitter recombine with holes to produce base current IB. And nemaining large no. of electrons crosses the bollector-Base Junction. This produces collector current Ic, thus, the e- flow produces the dominant current in a \_\_\_\_ N-P-N transister => Since, most of the electrons from emitter flow in the collector circuit and very few combine with the holes in the base. Thus, the collector current is larger than the base current and the relation between these currents is given by- $I_{E} = I_{C} + I_{B}$ Since, it is a bifolar device, the collector current Downloaded from : uptukhabar.net

includes two components - majority and minorit is called where minority current component Leakage current and is given by-Ic current with emitter terminal open) majority) 3 Ic = Ic (maj) + Ico orth Henation Inansiston 5 current flow And Hills > Flow of holes P N + ΙĘ Ic E é Ť, CBJ EBJ IB B Ic IB Ich= Ic+ Ig The Emitter - Base Junction cil. given by thrace nelphon 23 2 uptukhabar.net 6 Downloaded from

COMMON BASE CONFIGURATIONS & \* ANDRIC MANAGERISSER is 1170 FILME IE 340 5-Anare IR 1 induta is similar IE . Jose ning Ich percense RE 3 SRC 1 IB 140 13 A the bala enal pt and Усв VEB In bommon - Base configuration, the base is com mon between. both the input as well as output side as shown in the figure VCB = 20 V VCB = 10V VCB = 1V IE / It is max, when VCB = 20V BE Downloaded from : uptukhabar.net

Input Chanacteristics - 100 and manna) The snput characteristic is a graph between input current (IE) verses Input voltage (VBE). The input characteristics relate the input current IE to the input voltage VBE for the various levels of output voltage VCB It is similar to the VI-characteristics of pr-junc tion diode where IE will only flow when VBE is forward biased beyond the Knee voltage [Ge > 0.3  $Si \rightarrow 0.7$ ]. IE (Emitter current) increases rapidly with a small value of VBE. Hence, the dynamic input nesistance is low and is given by - $\frac{\delta}{2} = \Delta V_{BE}$ chie dynamic resistance • Output Characteristics -Downloaded from : uptukhabar.net

In Talma mailes, resider and rep heen destected summer is algoress angles ACTIVE -IVE I I I E = 5mA Income A. IE = 4mA  $\rightarrow I_E = 3mA$  $\rightarrow$   $I_E = 2mA$ IE = 1mA i him m -1 D CUTOFF SALAN VCB(V) in this region collectors commont To is indepe > The output characteristics is a graph between the output current (Ic) venses output voltage (Vcs). Ves is aregably (-ve) and -> The output characteristics shows the relation between putput current Ic verses the output voltage VEB for the various levels of input the - all Regiera current, IE. The dynamic output nesistance no is given by -+ maneic horn 200 no = AVCBiling rage no AIC IE = constant THE MARIN DEPENDING & DOWN A 18 KMDI • <u>Active Region - Par acession reasons</u> within a what are in a read of In this negion, Emitten-base junction is forward biased and collecton-base junction is neversed bias and transistor acts are amplifien.

In this negion collector current  $T_c \cong T_f$  and collector current is almost constant. Collector current 'I's almost independent of Ver [collector to base voltage) and provides very high dynamic resistance. • <u>Saturation Region</u> – In this region, emitter-base junction and collector base junction. both are in forward bias and transistor works as a closed switch-In this region, collector current Ic is independent of emitter current o TE. ingine and the -> In this negion Ver is negative (-ve) and Ic decreases napidly when Vos becomes more megative (-ve) and descent unit and applied but-off Region --> bollector - base junction and emitter - base junction both are in neverse bias and transistor works as a open switch. The region below IE = DMA, is Known as butoff negion where collector current is approximately 0. - Am this megissi Emilien - Loss Manchion 12 Lenie biased and contection - have firmerian is never each Downloaded from: uplukhabar.het

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	In common - emitte	n configu	vration	, the emitter				
	is common between both input as well as output							
	Side as shown in the Downloade	figure.	tukhabar	net				
A State State	Dowilloadd	Ju nom . up	uniaval.					

Input Characteristics APE garant insonmade IB(MA) VCE = 1V  $V_{CE} = 20 \gamma$ BE (V) The input characteristics is a graph between input current  $(I_B)$  verses Input voltage  $(V_{BE})$ . It shows the relation between the snput current IB to the input voltage VBE for the various levels of output voltage VCE. It is similar to the VI-characteristics of pnjunction diode where IB will only flow when VBE is forward biased beyond the Knee voltage With the higher value of VCE (output voltage), collector gathers slightly more electrons and therefore, base-current reduces. Normally, this effect is called Early effect which is generally neglected nie AVBE NCE = constant:

Output Characteristics of anon have all and Levices beer provident compend inch shoerpare. To i troating saturation Active Dipare side rate e  $I_{B} = 50 \mu A$ Attender funderen and for form > IB = 30MA at spath hope of anione IB = 20MA automotion with the nothing to good  $\rightarrow$   $I_B = IDMA$ VCE abai b cutoff  $I_{CED} = (1+\beta) I_{CBD}$ It is the graph between output current Ic V/s output sovoltageer Verse doming and theat real pare side with It shows the relation between Ic V/S VCE for the  $\rightarrow$ various levels of IB. and malade management Dynamic output resistance, ECENCES GENER HELEN TO  $AV_{CE}$  $\Delta I_C$   $I_B = constant$ • <u>Active Region</u> : In this region emitter base junction is forward bias and collector base junction is reversed biased. Downloaded from : uptukhabar.net

For the fixed value of IB, as we increase Vcs the collector base junction current increases rapidly. In this region, transistor current i.e. Ic responds most sensitively to IB. Saturation Region :-In this negion both the junction are in forward bias. Saturation region is very close to zero access where all the current napidly reduces to zero. In this negion, thansiston collector current is given by  $\binom{Nec}{R_c}$  and independent of base current <u>Cut off Region &</u> of is the couple be human of In this negion, both the junctions are neverse The negion below, IB = 0, is know as cut off region. When IB becomes zero then Ic is approximately equal to ICED and is given by IC60 = (1+B) ICBO is near somether have back Downloaded from : uptukhabar.net, ania

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	VCB - VCB - VCB - 212 - VCE SUCCOMPLE					

Input Characteristics (13) garage ) Manual -ALL. IB FMITTER PLIBURG 19 VCE=2V VCE = 4V 120 <u>100</u> 80 60 40 2D 13 456 7 9 12 8 YCB(V) Ο 1 ID The input characteristics is a graph between input current  $(I_B)$  V/s snput voltage  $(V_{CB})$ . It shows the relation between the Input current -> Is to the input voltage Ves for the various levels of output voltage VCE ッ It is similar to reverse bias V-I characteristics of a pn-junction diode When VCB increases, the IB > base voltage ~ decreases Dynamic A.C. nesistance is givenby--> A dares ALI = AVCBIN AIB VCE = constant Asiant Downloaded from : uptukhabar.net

Butput Characteristics: IE (mA) Ratur ation Active →← > IB = SOMA = IB = 4DMA > IB = BOMA > IB = 20MA -> IB = IDMA T IB = DMA VCE (V) D cut off region -> It is the graph between output current (IE) verses output voltage Ver It shows the relation between IE V/S VCE for ) the various levels of IB. Dynamic output nesistance, -> <u> A Vce</u> no = 4IE IB = constant <u>Active Region</u> • Downloaded from : uptukhabar.net

and the second se	Rues why CE is mostly used as an Amplifier? > most values are medium/ high/ Page No Very high Date								
*	Sure Prince the St lead lime also dehavious?								
314	city gathen for	and establi	Hing paint	19399					
S.NO	bhanacteristics_	CB	-therein a	chuic cc					
				9					
1.	Input Impedence/	Low (100-2)	Medium	V-High					
	Resistance		[800.r.)_	(750 K.n.)					
2.	Butput Ampedence	Very High	High	Law-					
	30 V	(500Kr)	(50 K.r.)	(50n)					
	4								
3.	Voltage Grain	High (< 150)	Very high	low					
	0	0 1	(< 500)	27					
			. ,						
4.	Current Grain	Nearly unity	1 Higto 1	High					
	0.7	(low)	(1.00)	(100)					
	3 = 17. 43 Wy OF 13	tit a th	<u>(</u>	( ( )					
5.	Phase Revensal	NØ	yes	Nø					
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=>	bommon emitter	Common emitter circuits and mostly							
	are quite high and output to input impedence natio is moderate								
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JFET [ Junction Field Effect Transiston]: \* working is same as tap and far. The current flow in JEET is controlled by an electr-ic field set up by an external voltage source is 7 called Field Effect. It is an uni-polar device because current flow-due to only one type of changes i.e. majority change carriers · Advantages of JFET over BJT: 1) JFET is an uni-folar device whereas BJT is a bi-Bolan device. 2) It requires less space as compared to BJT. 3) It has more thermal stability as compared to BJT 4) It is less affected by noise as companed to BIT 5) JFET is a voltage-control device whereas BJT is a current-control device. 6) At thas thigh imput impedence in the start of the ismension " Latter at

Construction of N- Channel JPET := Drain source semiconductor material of n-type is taken and of mic contacts are made at both the ends are called Drain (D) and source (S) terminals of JFET. Both sides of n-type material (left & night side) 12)8 are heavily doped p-type negions are formed by diffusing diffusion to create p=n junction N-type material is lightly doped and p-type 3) materials are heavily doped. The thin region between 2 p-type material 4) is called "channel". Since, this channel created in n-type material, hence, it called n-channel JFET. Both the p-negions are connected together to form a Grate terminal of JEET. Downloaded from : uptukhabar.net

\* Wonking of N-channel JFET ng No bias metterne prese tectoq i jo domini odt Marcon Me darcost produces nong issung s (a) Under no bias condition, that means no external De source is applied, only depletion regions are formed, no current flows under this condition A) Vou 15 Email magably Mag 10 prestave 5 The Vois = D, Vois is positive : ta) when we keep Vors = 0 and apply positive VIS then, the depletion region is Wider near the top of both p-type materials because, the upper negion of p-type material is neverse bias and lowen negion is less revense bias [approximately forward bias in lawcood baruhar at aut electrons can pass through the channel from 16) Since, the p-n junction is revense bias, across Gate tenminal, resulting gate current becomes zeno. [IG = 0] which is the most important charactenistics of JPET. when Vois=0, i.e., no bias but due to Vos, the electrons in the channel will flow from source to drain and current Is, will flow from drain to source. Id As we keep on increasing Vos, the defletion region keeps on increasing and the channel becomes nannow. At a centain voltage, the depletion regions almost touch each other and current becomes constant, is called PINCH OF VOLTAGE Downloaded from : uptukbabar not

and this condition is called PINCH OF CONDITION. (e) At the 'pinch of' point any furthur increase in Vos doesn't produce any increase in Io, that means, the value of drain current ID is maxim. orcha-1x um when Vois = 0 and is denoted as Ipss readiboran side ashan manage frameno are borreal 3) <u>Vois is small negative</u>, <u>Vos is positive</u> & (a) when a small negative voltage is applied between gate and source, due to the neverse bias the penetration of depletion negion into the n-type material increases and got - 10 rcg evense bias and (b) This will reduce the channel width further and due to reduced channel width, less number of electrons can pass through the channel from Source to drain and drain current To, reduces with the increase in negative Vois. sene. [Ta - e] which is the most important chana chaniching of IFERT electrons in the chamiel with flow thom source to vois =0 P/P P Strass at Vois =0 P/P P Strass at Nois = 0 P/P St Keeps on inmecsiong and the channel becomed manneur At a cesting y sudbage the depletion requens alonest south each althen and alment Downloaded from : uptukhabar.net

4) Vois is large negative, Vos is positive: a) As negative Vois is furthur increased, the depletion negion penetrates more inside the n-type material. At a centain value of negateve Vors the depletion region touch each The maximum value of random The channel width is therefore, becomes zero (6) and the drain current, Is is also zero. The gate to source voltage at which drain current reduces to zero, is called Vors (off) i.e. Vors (off) = - Vp (not including sign) I<sub>D</sub>(mA) Dnain Chanacteristics Iransfer (Gate) Characteristics SINHO TOSE - YONS A CHUNCH SKY > SATURATION d Vas I DSS E >VG1S = 0 V V615 = -1V V615 = -2V VG1S -5 -49-3 -2 -10 0 10  $\frac{\sqrt{61S}}{\sqrt{61S}} = -3 \vee$ VBS(V) VGIS = - 5 V → lows of pinch off voltage

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MDSFET (Metal Oxide Semiconducton field effect n Mit transiston) IGFET (Insulated Grate field effect transistan) r opn Depletion MOSFET -12A D-MOSFET (n-channel and p-channel) Darrie Z(i) E- MOSPET [n-channel and p-channel] (11) Enhancement MOSFET AICAN (n-channel) - MDSFET > ii Si02 P N D SS n-channel N 1984 Jaimon

Construction of n-channel Depletion MOSFET (D-MOSE 1) In n-channel MOSFET, a f-type of semiconductor material is used as a substrate. Usually substri ate is connected to a source but sometimes it is taken as a seperate terminal 2) Drain and source are connected to n-type region through metallic contact and they are linked with each other by n-channel. Gate is insulated from channel by SiDz layer. That's why it is called Insulated Gate Field Effect Inansiston. • Wonking : when Vois=0, Vos is positive then the source (.a) terminal will repel the e- towards drain terminal because of forward bias condition. So the charge carries will move / flow from Source to drain through n-chammel and curnent will flow from drain to source terminal  $V_{G1S} = D \Rightarrow I_{D} = I_{DSS}$  $\rightarrow$ 

manusten tehandetenic Mala Blick Her. Phoing 1 SiD2 P Briain Ν 2 2 3 4 5 6 6 7 2 CH and Cenic 2 350 ID chanacticistic 55 60 n-channel VGIS=D + Vas (b) When Vois is negative then es from n-channel will repelled towards p-type substrate and. necombination will take place inside the channel. and charge canniers will be reduced. If Vois is negative and Vos is positive the Is current will be neduced and it is Known as Depletion mode. when Vois is positive then the minority carri-(2) ers in p-substrate (e-s) will be attracted towards n-channel and the no. of es will be increased for the conduction of current. So, Is current increases with the increase of positive Vois and is known as Enhancement mode.

Drain Characteristics and Inansfer Characteris • tics : Drain Inansfer ID(mA) IQ(mA) Characteristics <u>Chanacteristics</u> Depletion mhar mode cement møde 1 VG15 = IV ID ØSS  $VG_{1}S = -1V$ VG15 = -20 VGIS. =-31 -4 3 D 2 0 Ves VGIS 1.1 115 1(11)== nanne D - MOSFET N ID P D G  $V_{G1S} = D$ Vas P P + 2 1 6 6-5 m p made VI - chanacteristics ٥ 3 Downloaded from : uptukhabar.net

J ID(mA) Drain ID(MA) Inansfer characteristics <u>Chanacteristics</u> Enhan-cement Depletion Mode mode -> R VOIS= Iøss Iøss 4 = OV Yors ١ YOIS VGS = 2V C 0 V615=3VE Q -1V D VGIS=4V 4 1 2 3 Väs(V) VDS 1 Downloaded from : uptukhabar.net in." . 1  $\{ g_i \}_{i \in I}^{i}$