Department of Electrical Engineering
Midterm Exam
Date: 29/09/2020

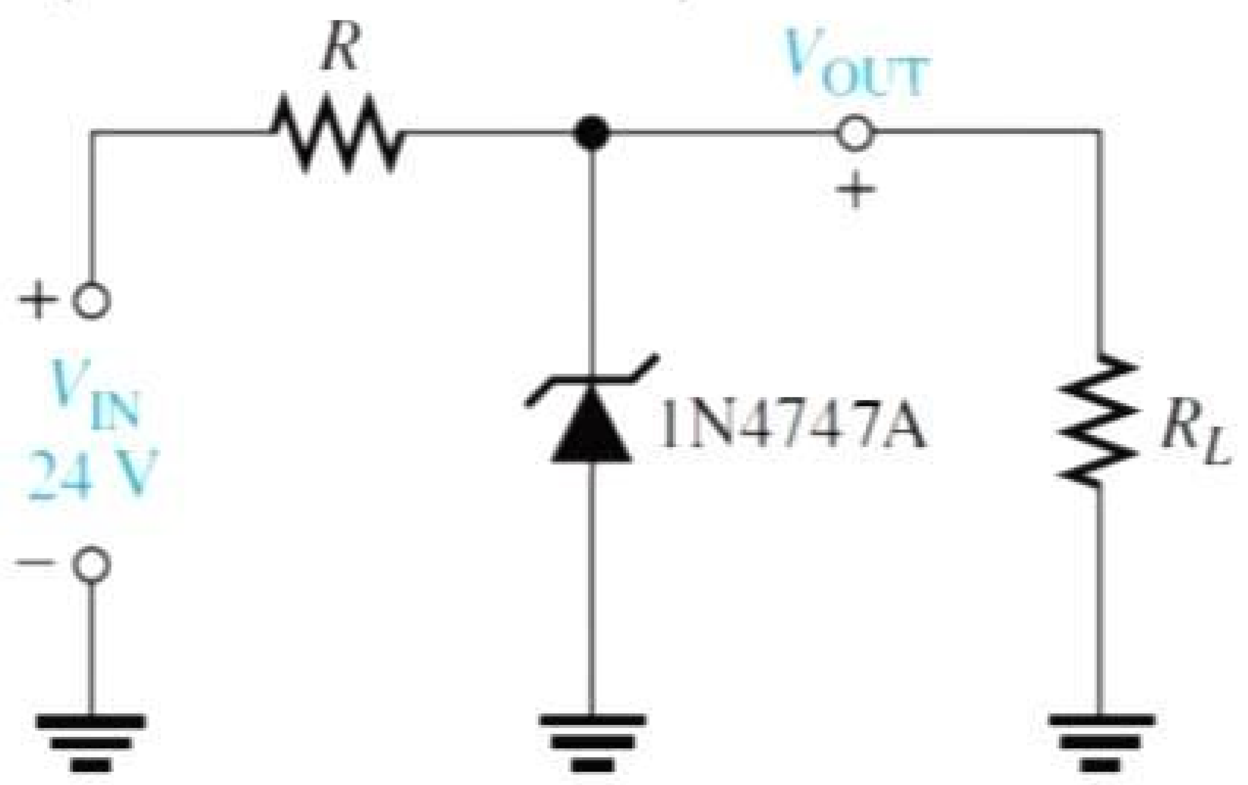
Course Details

Course Title: Electronic Devices and Circuits **Module:**
Instructor: **Total Marks:** 50

Student Details

Name: shehriyar khan **Student ID:** 13738

Student Signature:

Q1.	The 1N4747A zener used in the regulator circuit of Figure 1 is a 15 V diode, determine the following: (a) Determine V_{OUT} at I_{ZK} and at I_{ZM}. (b) Calculate the value of R that should be used. (c) Determine the minimum value of R_L that can be used. The electrical characteristics and values of V_Z, I_Z, IZ_K, Z_Z can be found in diode datasheet Fig 3-7 (in course reference book) and online.  **Figure 1**		Marks 10 CLO 02
Q2.	Determine I_B, I_C, I_E, V_{BE}, V_{CE} and V_{CB} in the circuit shown in Figure 2.		Marks 05 CLO 02

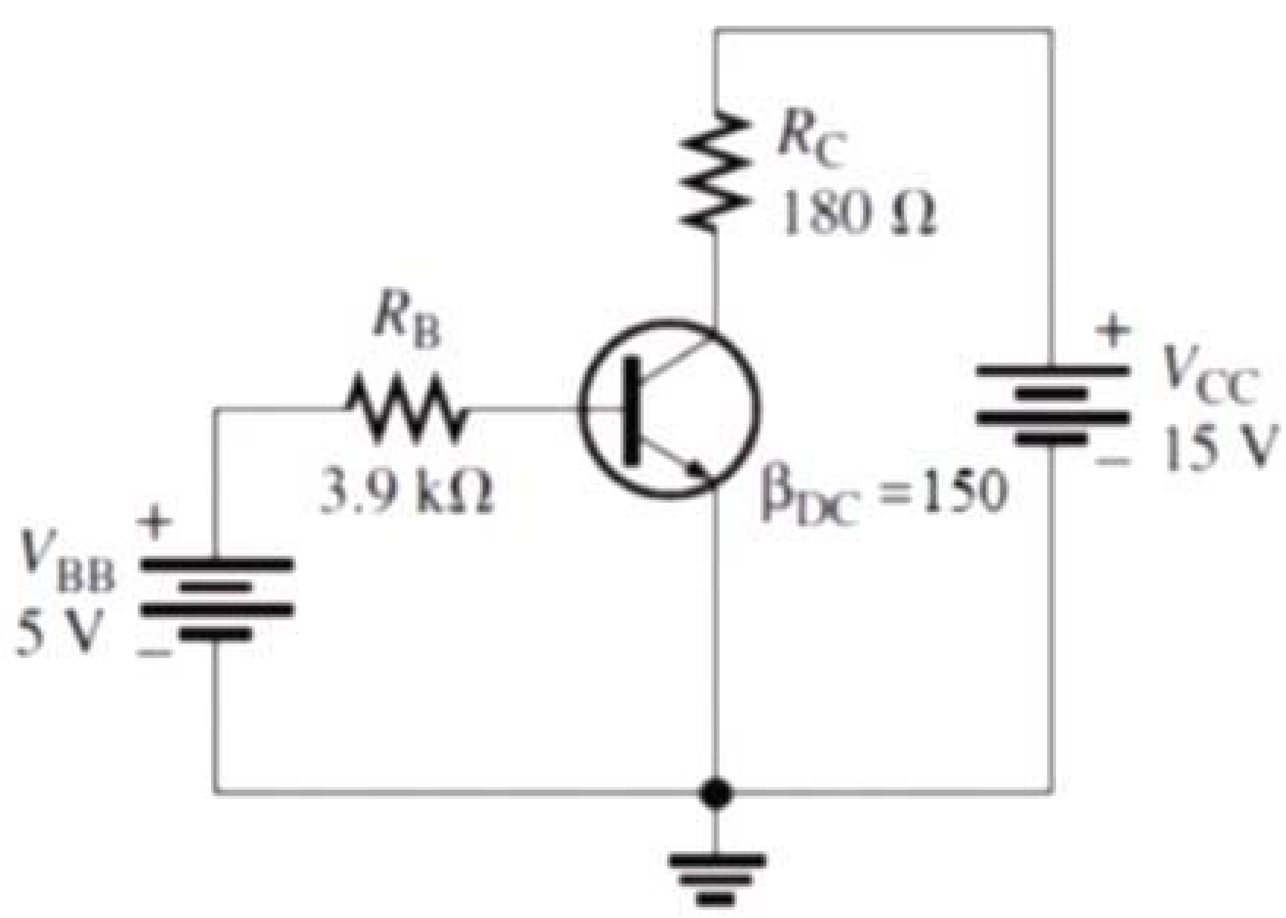


Figure 2

Q3.		Discuss how is BJT used as an amplifier with the help of schematic diagram for a basic BJT amplifier? Which basic configurations are required for it? Consider input AC and DC values as 5μA and 15μA respectively, assume $\beta = 200$.	Marks 10 CLO 03
Q4.		**For a transistor to act as a "switch", you need to join each of the following conditions on the left to "ON" or "OFF" state.** Transistor fully ON Transistor fully OFF Input and base are at 0V Collector current $I_c = 0$ OFF $V_{CE} = V_{CC}$ BE junction is reverse bias BC junction is forward bias Maximum of saturation current I_c flows BE junction is forward bias ON BC junction is forward bas $V_{CE} = 0V$ BE junction is less than 0.7V	Marks 05 CLO 02
Q5.		Discuss that how JFET (n-channel) can be used as voltage control device when the value of $V_{GS} < 0V$ and $V_{DS} > 0V$. Draw schematics with polarity conventions and explain the operation in detail.	Marks 10 CLO 03
Q6.		For the transistor circuit given in Fig. 3, calculate the following: a) What is V_{CE} when $V_{IN} = 0V$? b) Determine the minimum value of I_B is required to saturate this transistor if β_{DC} is 125 and $V_{CE(sat)}$ is 0.4V.	Marks 10 CLO 03

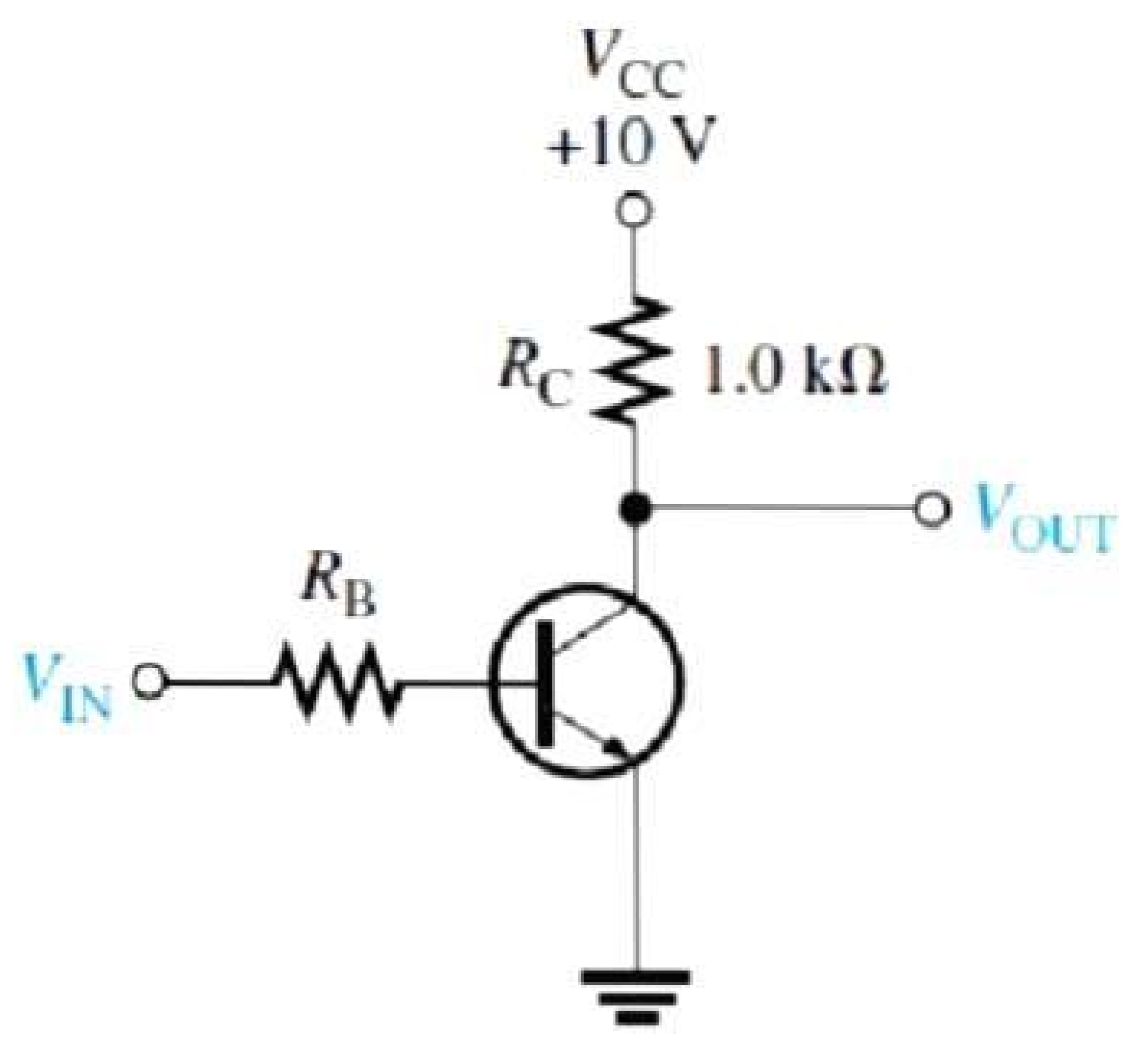


Figure 3

Figure 2

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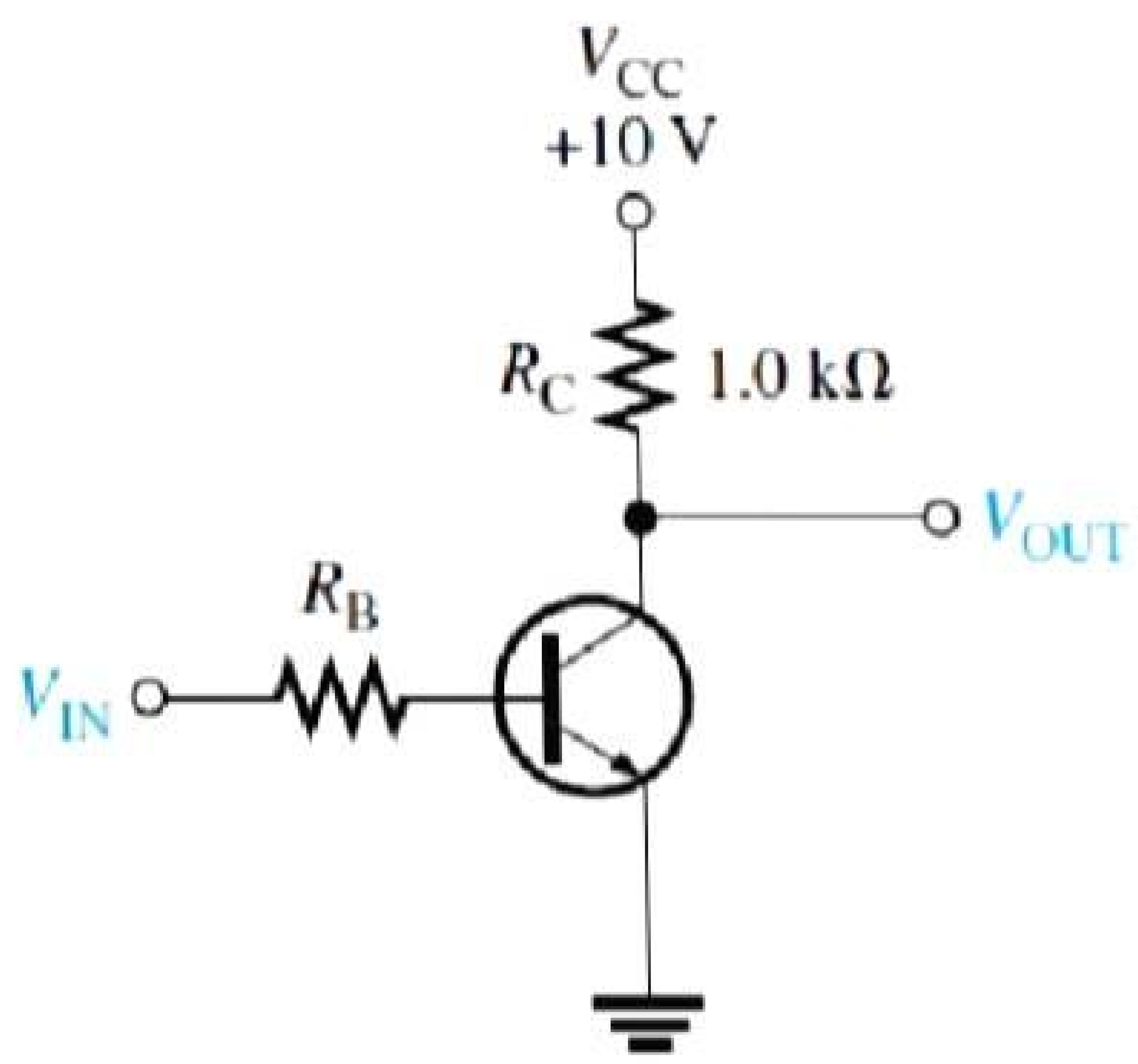

Figure 3

FAIRCHILD
SEMICONDUCTOR®

1N4728A - 1N4764A

Zeners

DO-41 Glass case
COLOR BAND DENOTES CATHODE

Absolute Maximum Ratings * T_A = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
P_D	Power Dissipation @ TL ≤ 50°C, Lead Length = 3/8"	1.0	W
	Derate above 50°C	6.67	mW/°C
T_J, T_{STG}	Operating and Storage Temperature Range	-65 to +200	°C

* These ratings are limiting values above which the serviceability of the diode may be impaired.

Electrical Characteristics T_A = 25°C unless otherwise noted

Device	V_Z (V) @ I_Z (Note 1)			Test Current I_Z (mA)	Max. Zener Impedance			Leakage Current	
	Min.	Typ.	Max.		Z_Z @ I_Z (Ω)	Z_{ZK} @ I_{ZK} (Ω)	I_{ZK} (mA)	I_R (μA)	V_R (V)
1N4728A	3.315	3.3	3.465	76	10	400	1	100	1
1N4729A	3.42	3.6	3.78	69	10	400	1	100	1
1N4730A	3.705	3.9	4.095	64	9	400	1	50	1
1N4731A	4.085	4.3	4.515	58	9	400	1	10	1
1N4732A	4.465	4.7	4.935	53	8	500	1	10	1
1N4733A	4.845	5.1	5.355	49	7	550	1	10	1
1N4734A	5.32	5.6	5.88	45	5	600	1	10	2
1N4735A	5.89	6.2	6.51	41	2	700	1	10	3
1N4736A	6.46	6.8	7.14	37	3.5	700	1	10	4
1N4737A	7.125	7.5	7.875	34	4	700	0.5	10	5
1N4738A	7.79	8.2	8.61	31	4.5	700	0.5	10	6
1N4739A	8.645	9.1	9.555	28	5	700	0.5	10	7
1N4740A	9.5	10	10.5	25	7	700	0.25	10	7.6
1N4741A	10.45	11	11.55	23	8	700	0.25	5	8.4
1N4742A	11.4	12	12.6	21	9	700	0.25	5	9.1
1N4743A	12.35	13	13.65	19	10	700	0.25	5	9.9
1N4744A	14.25	15	15.75	17	14	700	0.25	5	11.4
1N4745A	15.2	16	16.8	15.5	16	700	0.25	5	12.2
1N4746A	17.1	18	18.9	14	20	750	0.25	5	13.7
1N4747A	19	20	21	12.5	22	750	0.25	5	15.2
1N4748A	20.9	22	23.1	11.5	23	750	0.25	5	16.7
1N4749A	22.8	24	25.2	10.5	25	750	0.25	5	18.2
1N4750A	25.65	27	28.35	9.5	35	750	0.25	5	20.6
1N4751A	28.5	30	31.5	8.5	40	1000	0.25	5	22.8
1N4752A	31.35	33	34.65	7.5	45	1000	0.25	5	25.1
1N4753A	34.2	36	37.8	7	50	1000	0.25	5	27.4
1N4754A	37.05	39	40.95	6.5	60	1000	0.25	5	29.7
1N4755A	40.85	43	45.15	6	70	1500	0.25	5	32.7
1N4756A	44.65	47	49.35	5.5	80	1500	0.25	5	35.8
1N4757A	48.45	51	53.55	5	95	1500	0.25	5	38.8
1N4758A	53.2	56	58.8	4.5	110	2000	0.25	5	42.6
1N4759A	58.9	62	65.1	4	125	2000	0.25	5	47.1
1N4760A	64.6	68	71.4	3.7	150	2000	0.25	5	51.7
1N4761A	71.25	75	78.75	3.3	175	2000	0.25	5	56
1N4762A	77.9	82	86.1	3	200	3000	0.25	5	62.2
1N4763A	86.45	91	95.55	2.8	250	3000	0.25	5	69.2
1N4764A	95	100	105	2.5	350	3000	0.25	5	76

Notes:

1. Zener Voltage (V_Z)
The zener voltage is measured with the device junction in the thermal equilibrium at the lead temperature (T_L) at 30°C ± 1°C and 3/8" lead length.

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QNo (1)

sol:- The 1N4747 Zener diode used The regulator circuit in figure is 20 V

$V_Z = 20\,V$ $I_Z = 12.5\,mA$

$I_{ZK} = 0.25\,mA$ $Z_Z = 22\,\Omega$.

a) for I_{ZK}

$V_{out} = V_Z - \Delta I_Z \cdot I_Z$

$= 20V - (I_Z - I_{ZK}) Z_Z$

$= 20V - (12.5mA - 0.25mA)\,22\,\Omega$

$= 20\,V - (12.25\,mA)\,22\,\Omega$

$= 20\,V - 0.267\,V$

$V_{out} = 19.73\,V$

calculate the zener diode maximum current the power dissipation is 1W

$$I_{ZM} = P_{D(Max)} / V_Z = 1W / 20V = 50 mA.$$

for I_{ZM}

$$V_{out} = V_Z + \Delta I_Z Z_Z$$

$$= 20V + (I_{ZM} - I_Z) Z_Z$$

$$= 20V + (50mA - 12.5mA)\ 22\Omega$$

$$= 20V + (37.5mA)\ 22$$

$$= 20V + 0.825$$

$$V_{out} = 20.825\ V$$

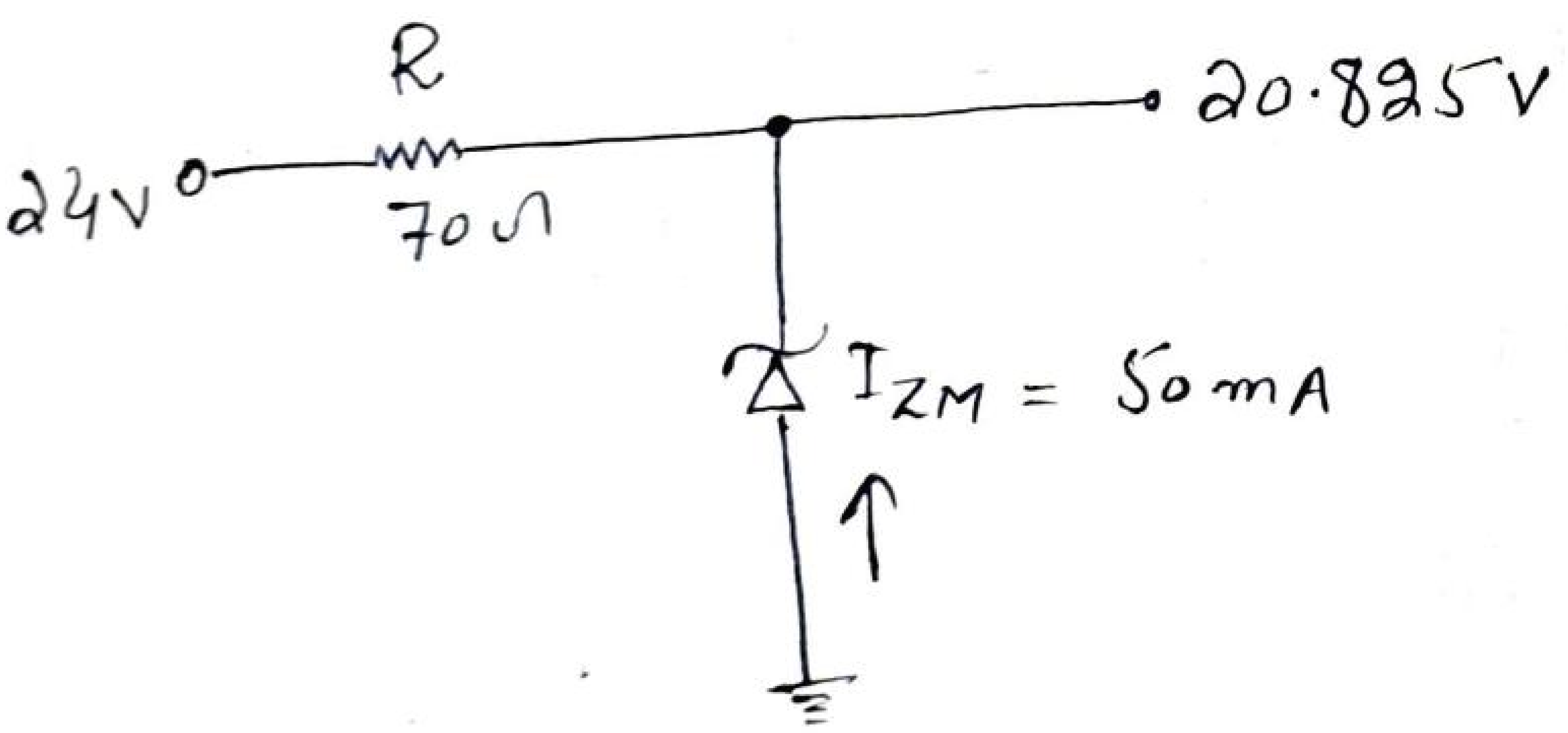
b) calculate the value of R for maximum Zener current when there is no load as shown in figure.

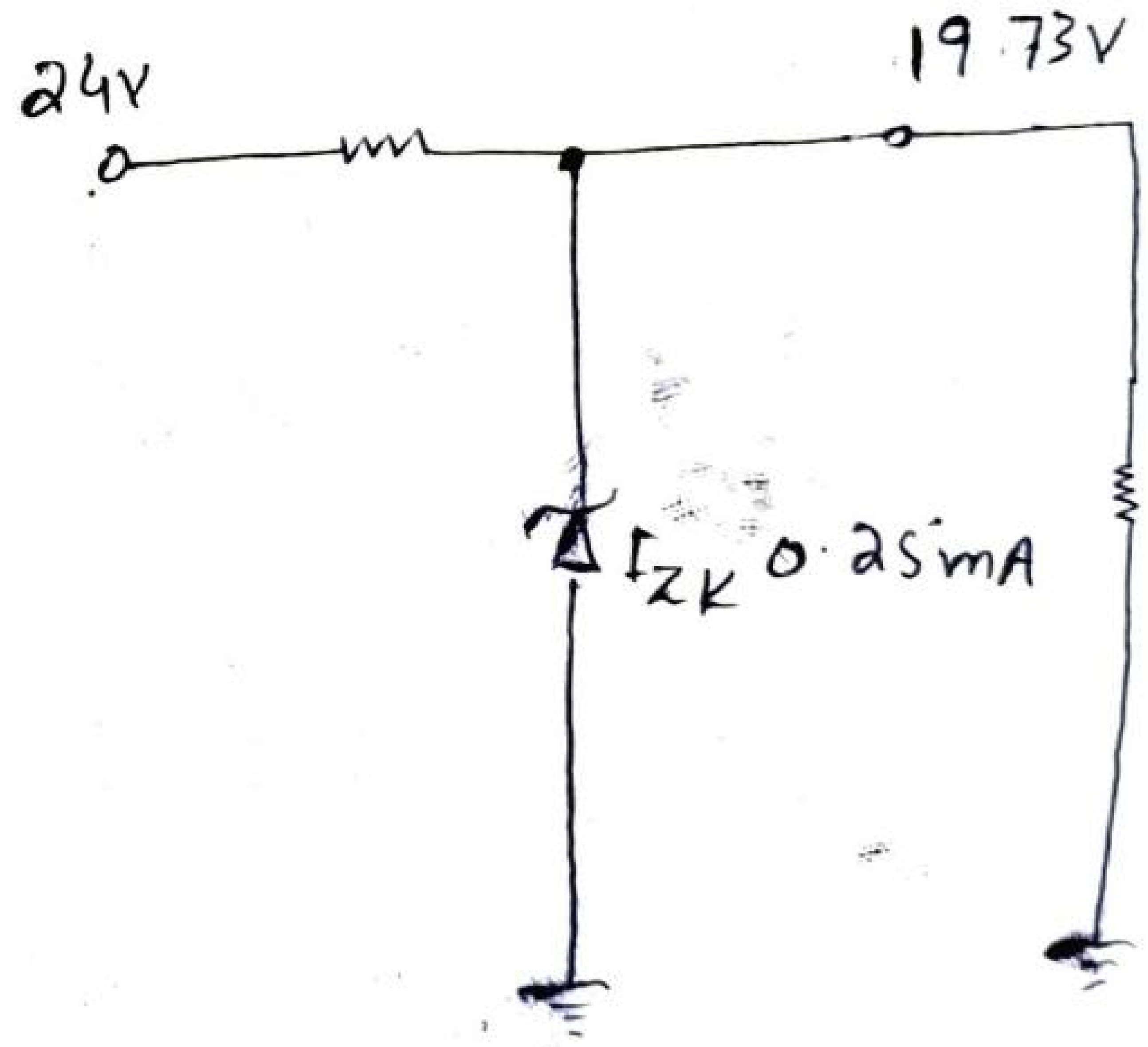
$$R = \frac{V_{IN} - V_{out}}{I_{ZM}}$$

$$= \frac{24V - 20.825V}{50mA}$$

$$R = 63.5\,\Omega$$

$R = 70\,\Omega$ (nearest largest standard)





c) for maximum load Resistance (maximum current) The zener diode current minimum ($I_{ZK} = 0.25$)

$$I_T = \frac{V_{IN} - V_{out}}{R} = \frac{24V - 19.73V}{70\,\Omega}$$

$$= 0.061\,A$$

Scanned by TapScanner

$= 0.061\ A$

$I_T = 61\ mA$

$I_L = I_T - I_{ZK}$

$= 61 - 0.25\ mA$

$I_L = 60.75\ mA$

$R_L = V_{out}/I_L = 19.3/60.75 = 19.3/60.75\ mA$

$= 19.3/0.0675$

$= 285.92\ \Omega$

$R_L = 286\ \Omega$

Question No (2)

Solution :- $V_{BB} = 5V$ $\quad$ $R_B = 3.9K\Omega$

$V_{BE} = 0.7V$ $\quad$ $B_{oc} = 150$

$V_{cc} = 15V$ $\quad$ $R_c = 180\Omega$

Required:-

$I_c, I_B, I_E, V_{BE}, V_{CE}, V_{CB}$.

solution:-

$$I_B = \frac{V_{BB} - V_{BE}}{R_B} = \frac{5v - 0.7V}{3.9K\Omega} = 0.0011A.$$

$$\Rightarrow I_c = B_{oc} I_B = 150(0.0011) = 0.165A$$

$$\Rightarrow I_E = I_c + I_B = 0.165A + 0.0011A = 0.166A$$

Now solve for V_{CE} and V_{CB}

$$V_{CE} = V_{cc} - I_c R_c = 15V - (0.165A)(180\Omega)$$

$$= 15V - 29.7$$

$$= -14.7V$$

$$V_{CB} = V_{CE} - V_{BE} \Rightarrow -14.7 - 0.7$$

$$= -15.4V$$

Since the collector is at lower voltage as the base, The collector base Junction is forward bais.

Q No (3)

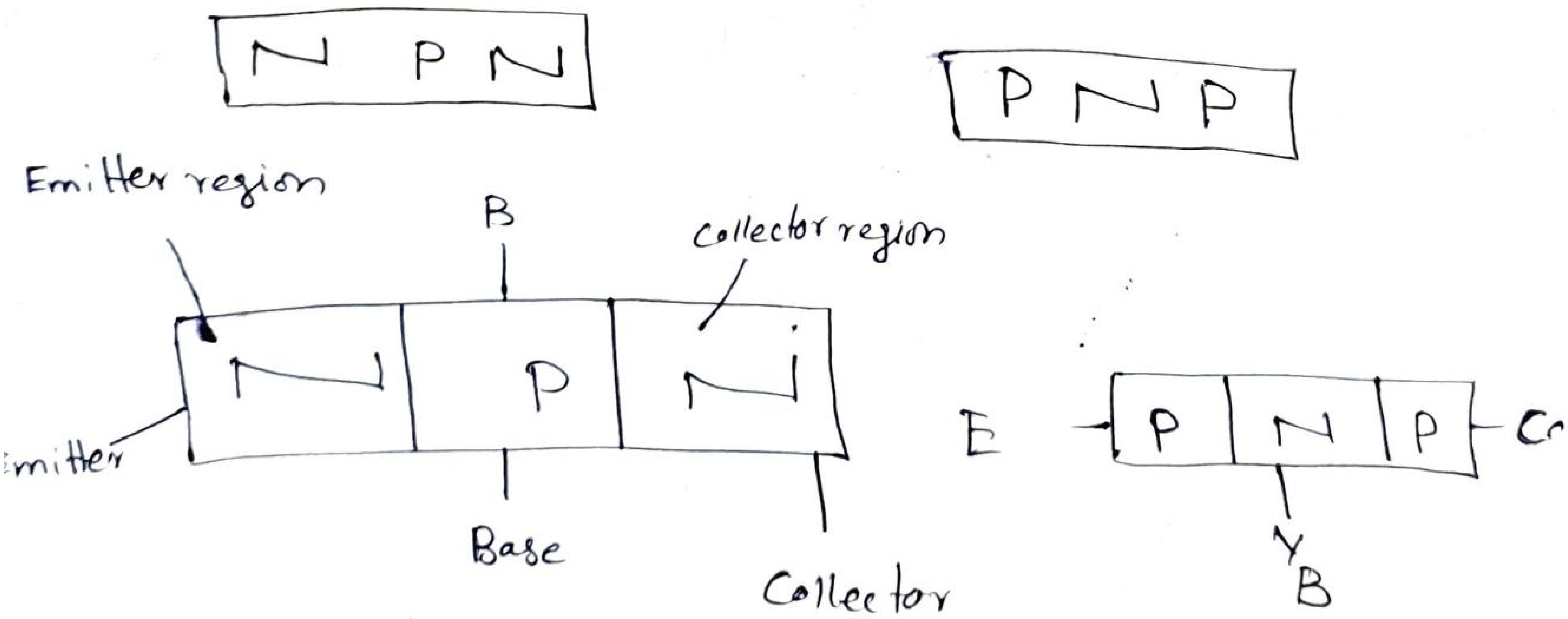
Answer:- Bipolar junction transistor:-

⇒ BJT:-

→ It is invented in Dec 1947 at bell labs at USA.

→ BJT is a three terminal device and it is used in amplification of weak signals and for switching purpose.

⇒ Physical Structure:-



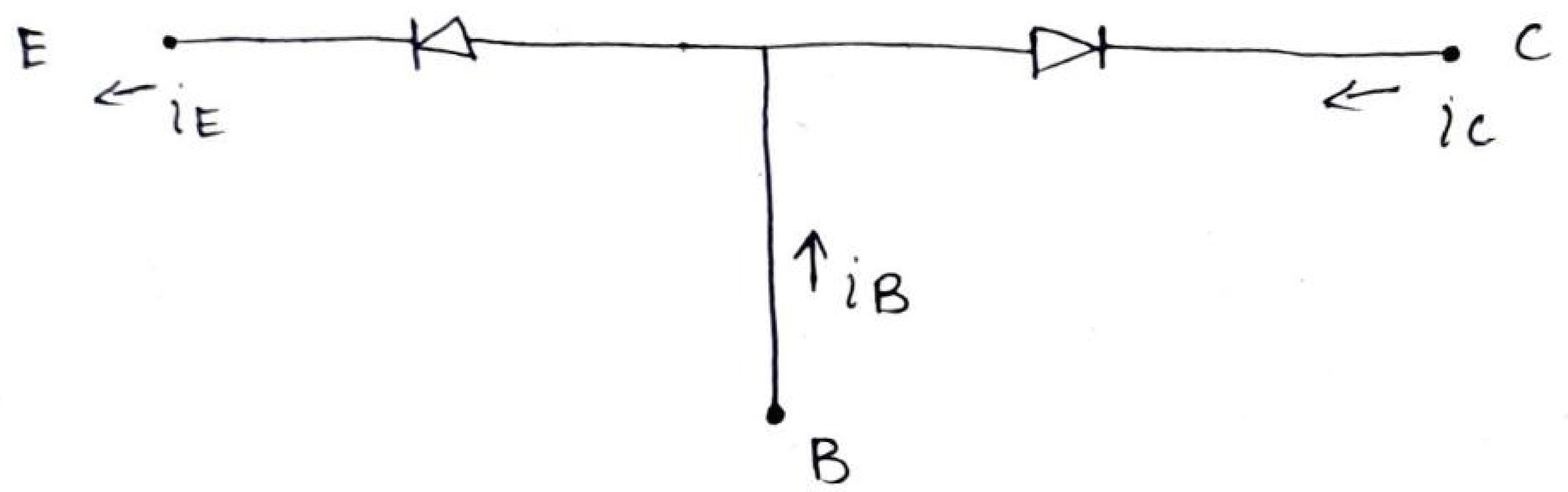
→ 2 junction N
→ 1 junction P   width C > E > B

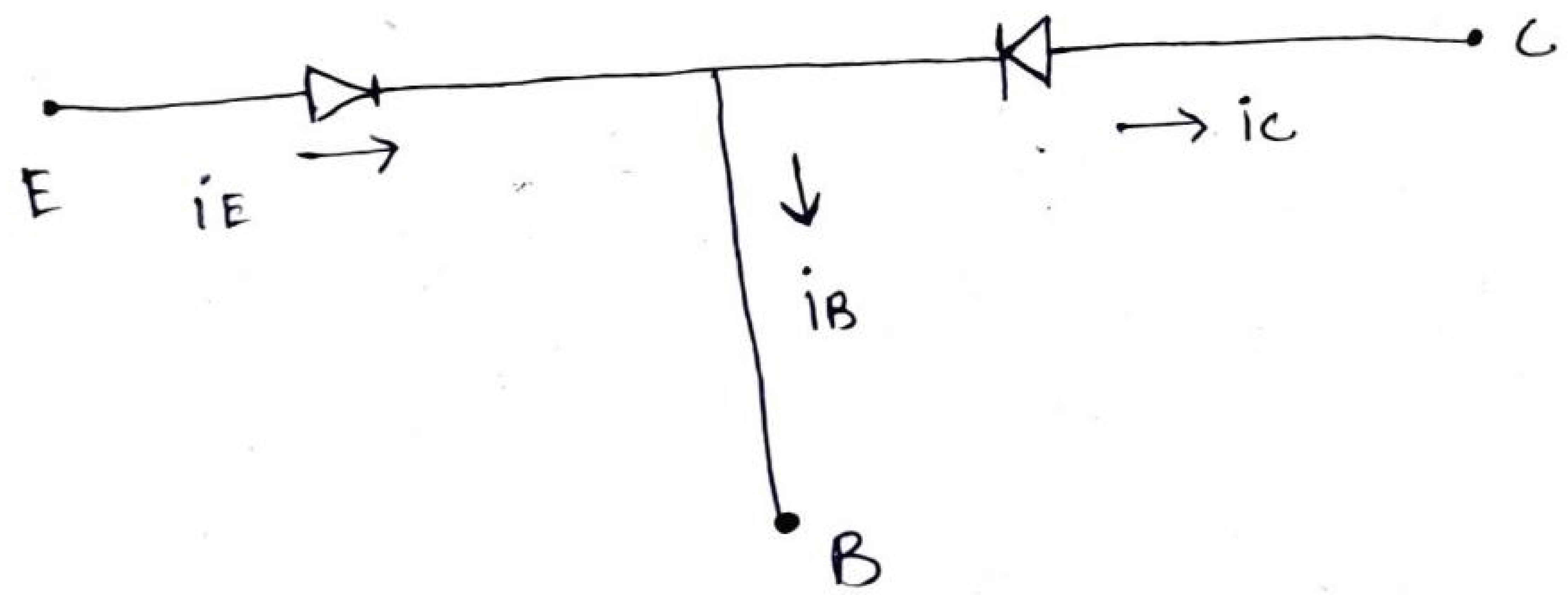
→ J1 → emitter base. doping E > C > B

→ J2 → collector Base.

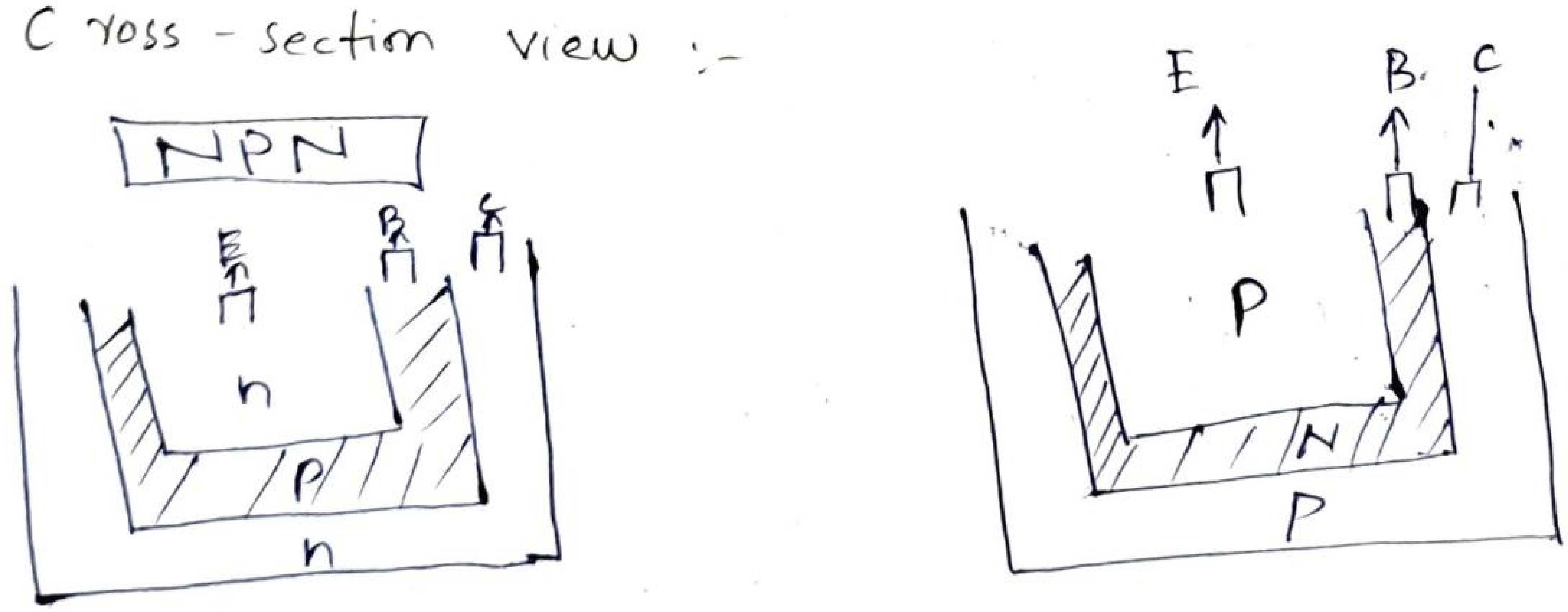
→ There is a depletion region at J1

→ There is a depletion region at J2.

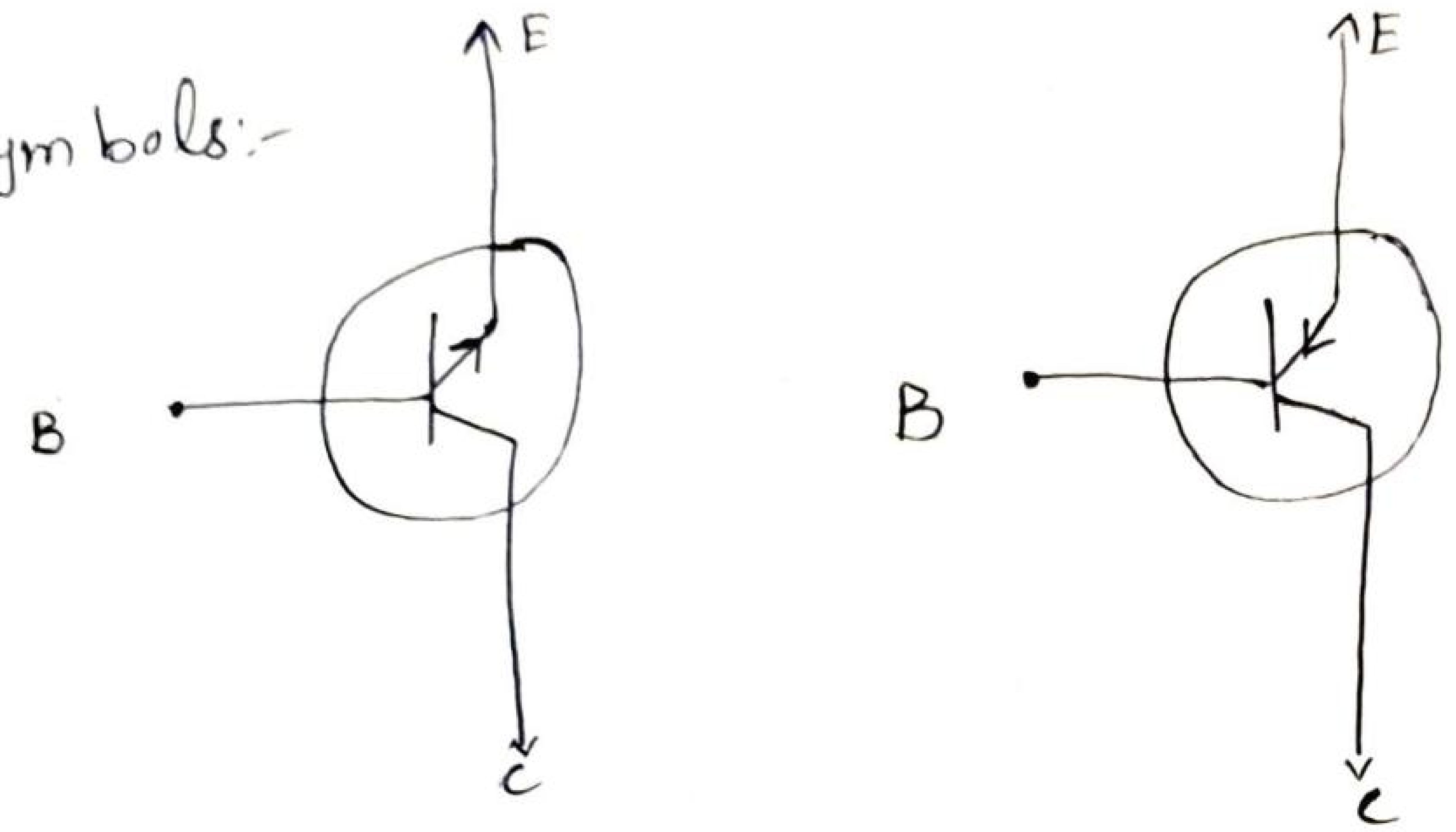




Cross-section view :-



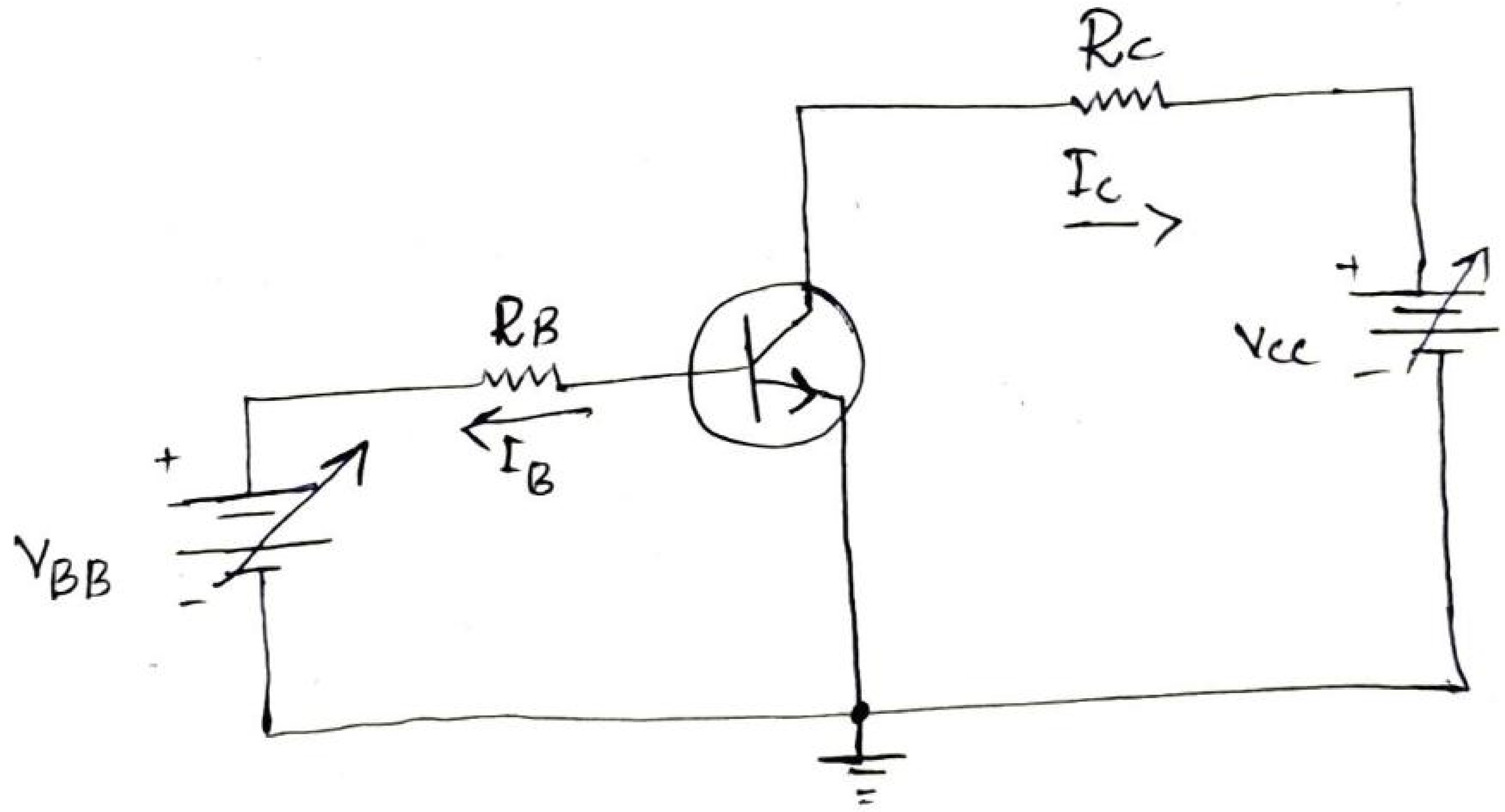
Symbols:-



Increase of NPN there will be more from B —> E

(b)

Solution:-

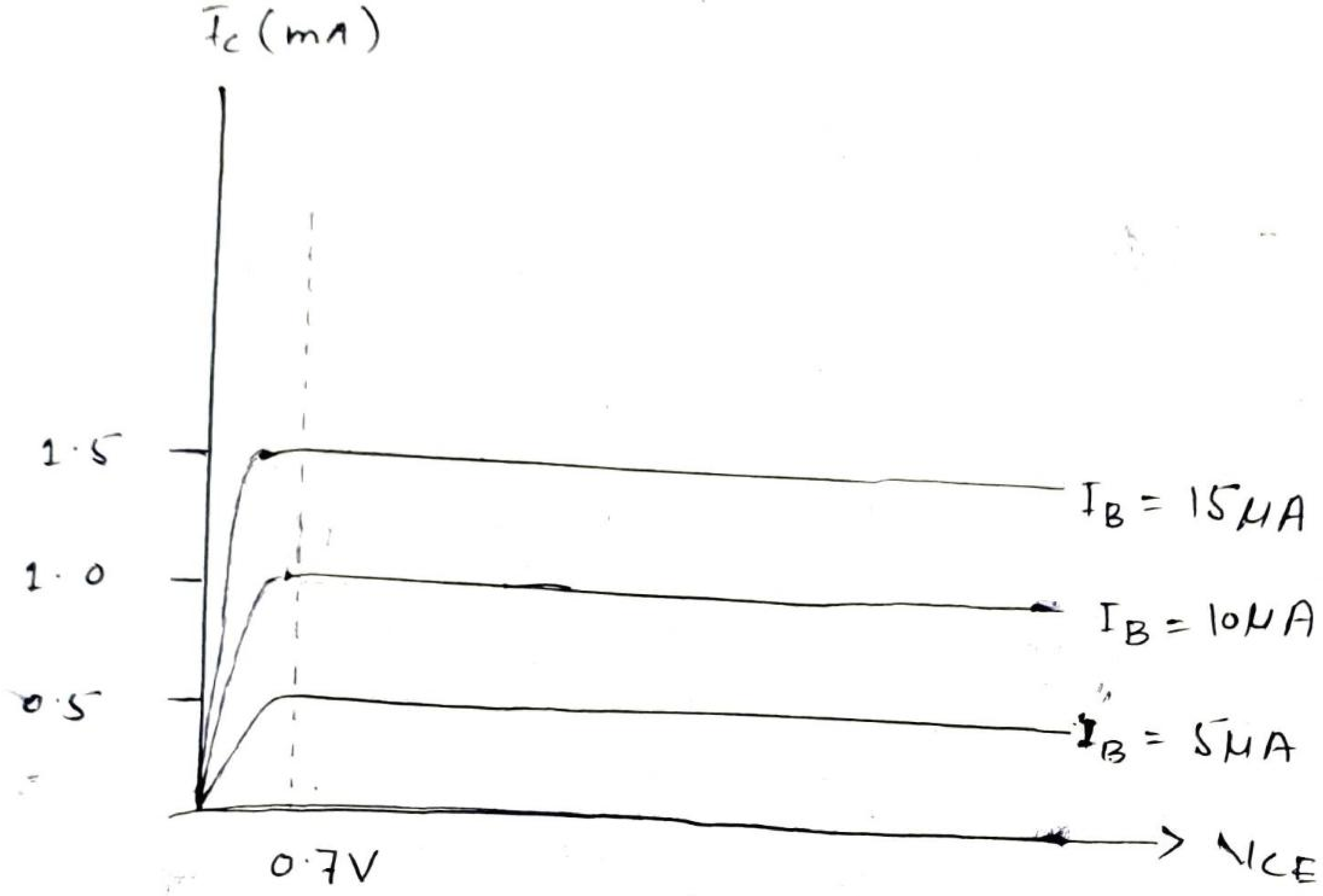


using the relationship $I_c = B_{DC} I_B$ value of I_c are calculated and tabulated in below table. The resulting curves are plotted.

Table:-

I_B		I_c
5μA	=	0.5 mA
10μA	=	1.0 mA
15μA	=	1.5 mA

P.



QN9(4)

Answer :-

i) Transistor is fully ON → ON

Transistor is fully OFF → OFF

Input and base are at 0V → OFF

Collector current $I_c = 0$ → OFF

$V_{CE} = V_{cc}$ → OFF

BE Junction is reversed bias → OFF

Bc Junction is forward bias — OFF

~~I_c flows ——————> ON~~

Maximum of saturation current I_c flows ——————> ON.

BE Junction is forward Bias ——> ON

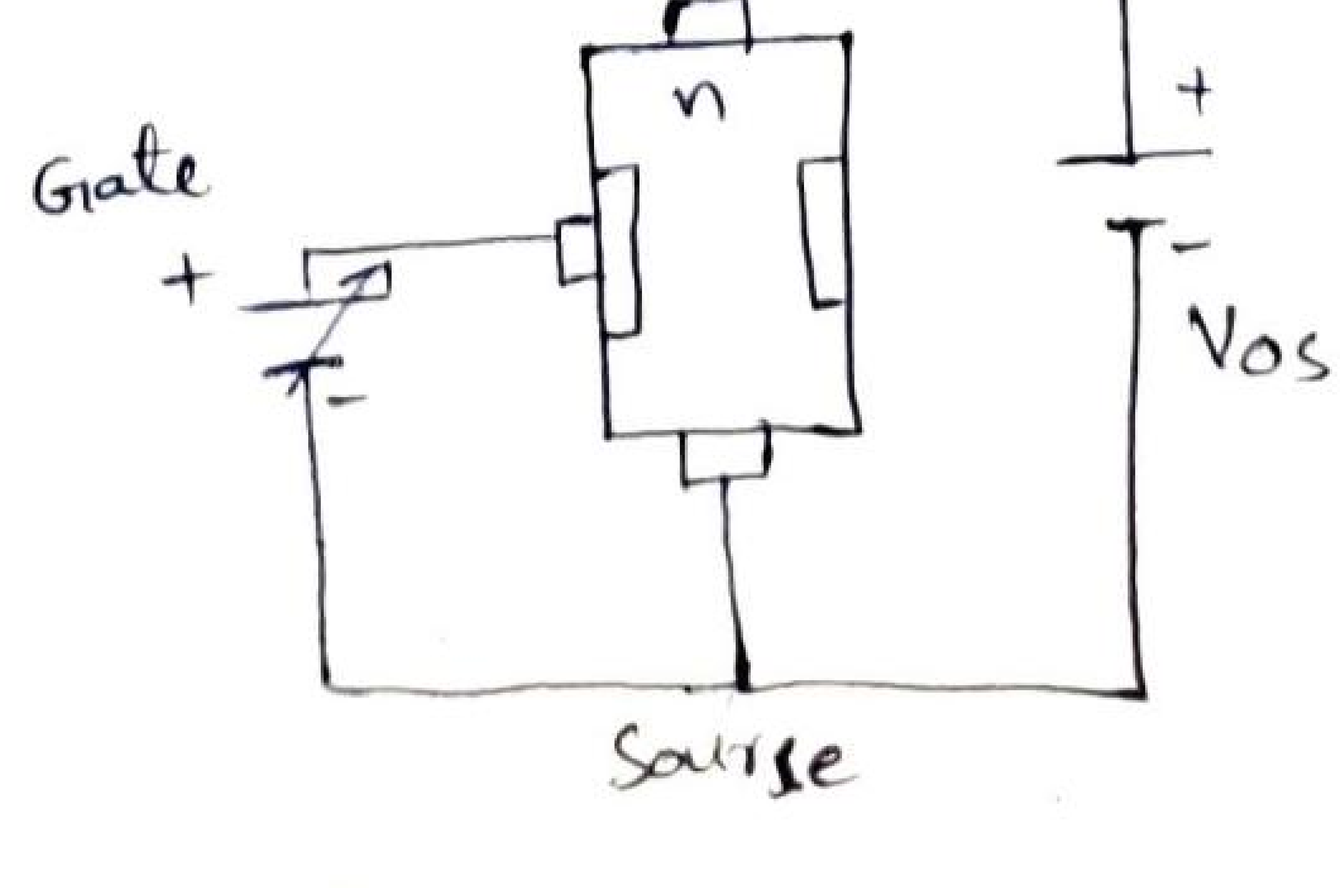
BC Junction is forward Bias ——> ON

$V_{CE} = 0V$ ——————> ON

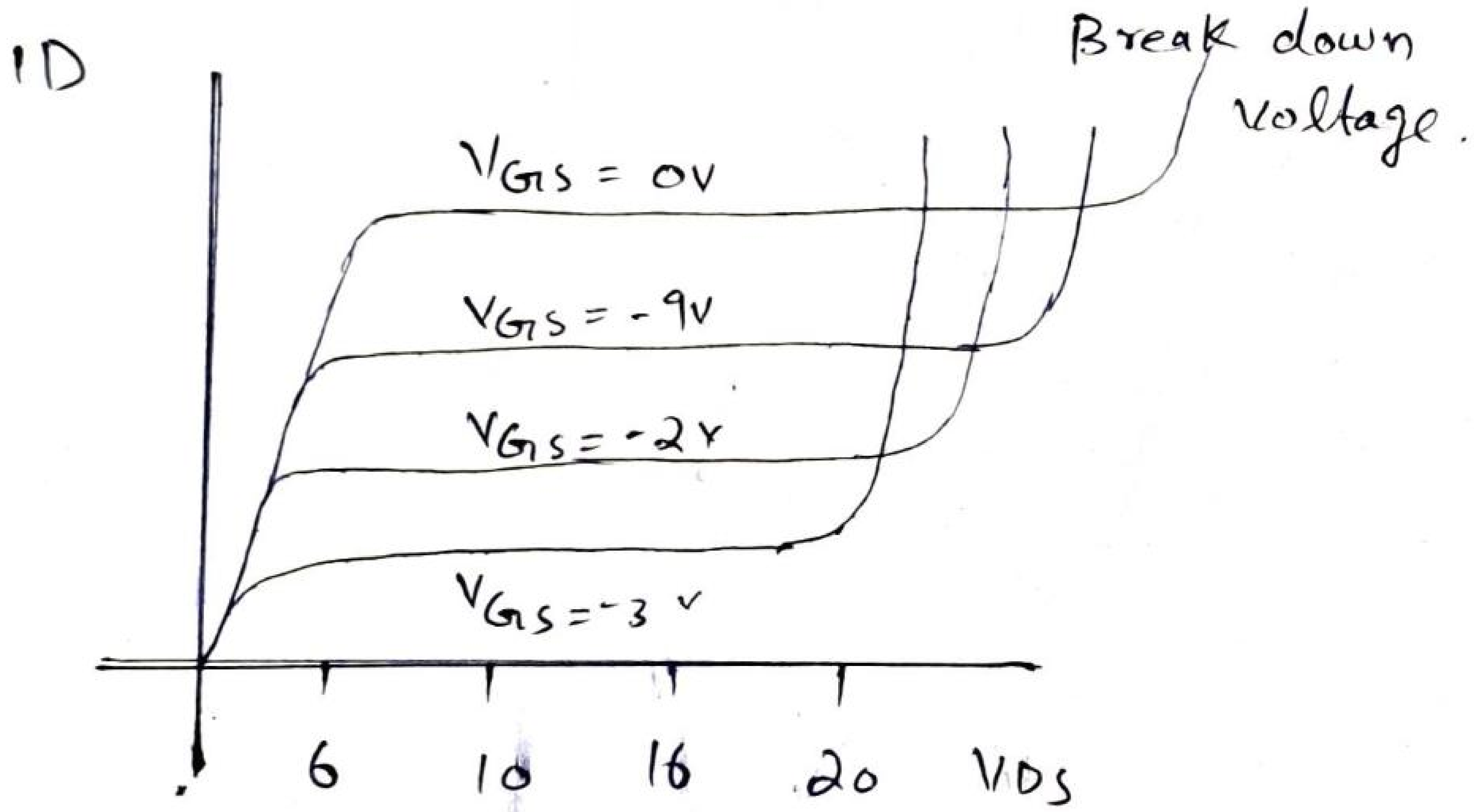
BE Junction is less then 0.7V ——> OFF.

QNO 5:-

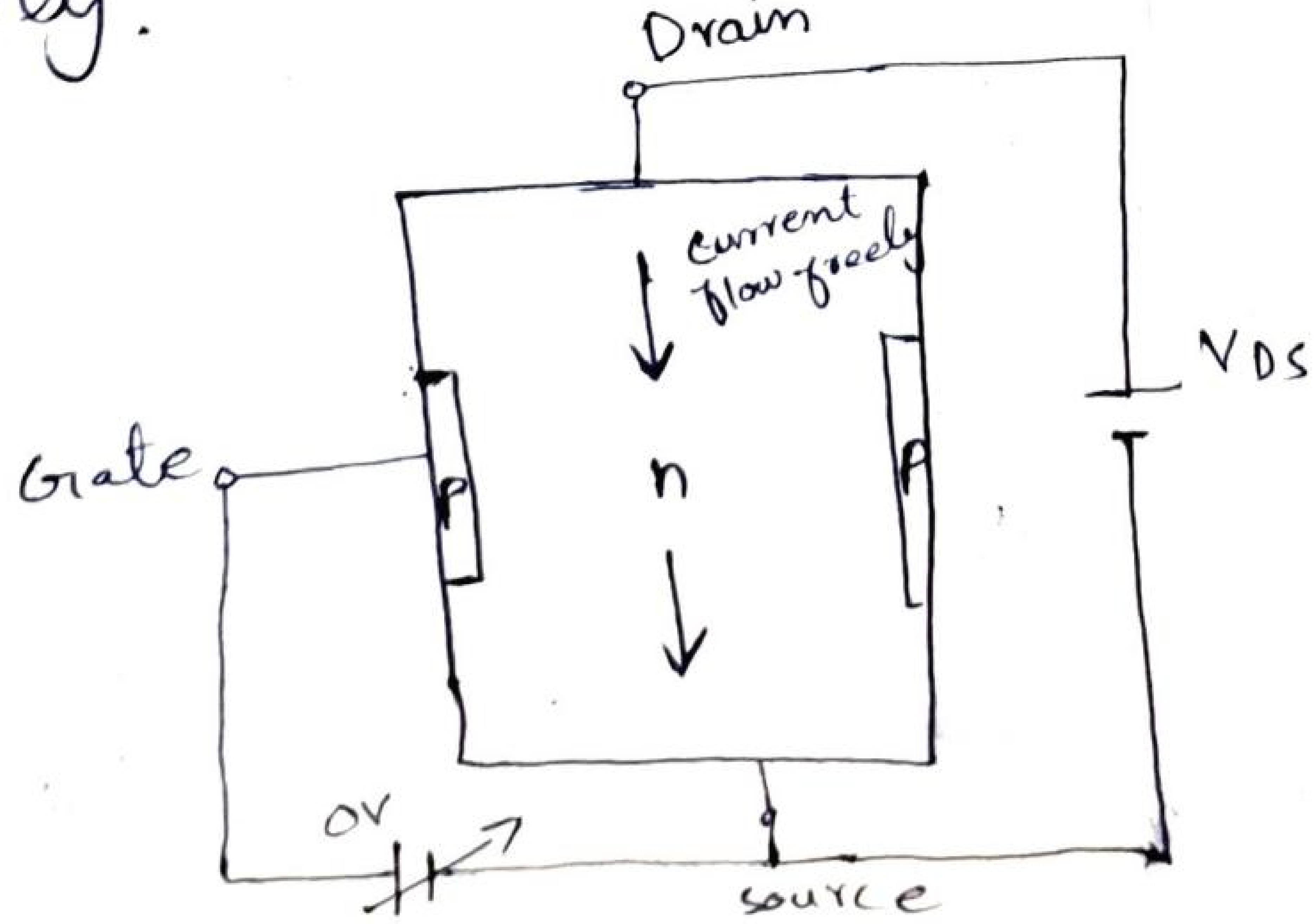
Ans:- JFET is a type of junction field effect transistor which is voltage controlled device as differ from BJT which is current controlled.



Actually in FET the drain to Source current is controlled by width of the channel the electric field is produced by the gate to Source voltage.

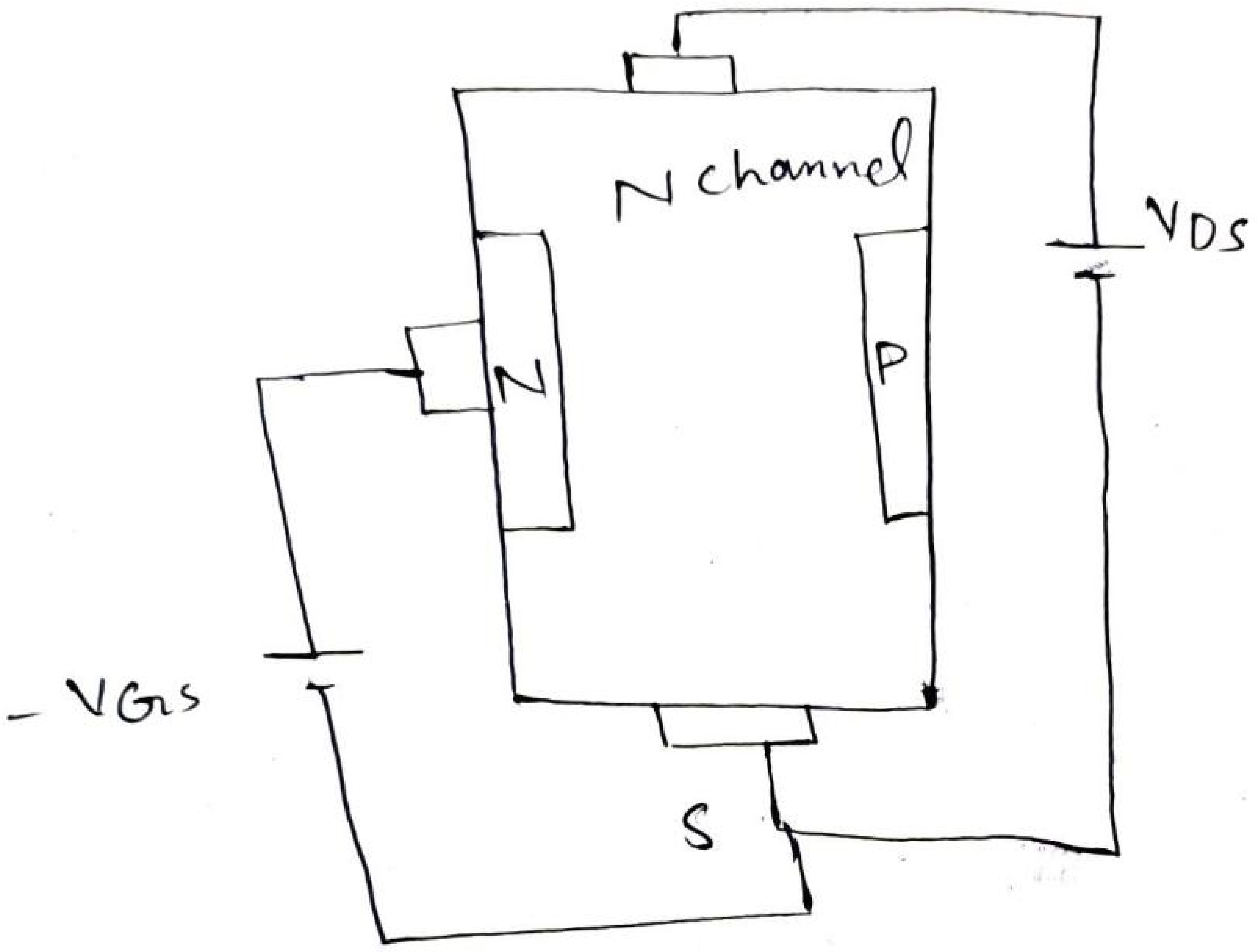


So if we see to the graph which the no voltage applied to the gate the current flows freely.



The channel are wider and drain current moves freely.

If we move VGS to negative value the channel width start to decreases and current cannot moves.



So VGS is more negative so no current flows and this effect is called Pinch off region no current or less ~~ct~~ current flow.

~~Q No (7)~~ Q No (6)

Sol:-

Given data:-

$B_{dc} = 125$

$V_{CE(sat)} = 0.4V$

$V_{CC} = 10V$

$R_C = 1K\Omega$

Required:-

$V_{CE} = ?$

a) when $V_{in} = 0V$. So transistor is in cuttoff. (acts like an open switch) and

$V_{CE} = V_{CC} - 10V$

b) Since $V_{CH(sat)}$ is neglected (assumed) to be 0V)

$I_{B(min)} = ?$

$I_{C(sat)} = V_{CC}/R_C = 10V/1k\Omega$

$= 10mA$ ..

$I_{B(min)} = I_{C(sat)}/B_{dc} = 10mA/125 = 80\mu A$