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Course Electronic devices and circuits

Q1 $V_z = 20$ $I_z = 12.5$ & $Z_z = 22\Omega$

$I_{zk} = 0.25$

a) for I_{ZK} = $V_{out} = V_z = \Delta I_z Z_z$

$= 20 (12 - I_{zk}) Z_z$

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

$= 20V (0.01225)(22)$

$= 20V - 0.2695$

$\boxed{= 19.7305V}$

Calculating zener max current, the maximum power dessipation is 1w.

$$I_{zm} = \frac{P_D(max)}{V_Z} = \frac{1w}{20} = 0.05A$$

$\boxed{I_{zm} = 0.05A}$

for I_{ZM} : $V_{out} = V_z + \Delta I_z Z_z$

$= 20 + \Delta I_z Z_z$

$= 20V + (I_{zm} - I_z) Z_z$

$= 20V + (54.2mA)(22\Omega)$

$= 20V + (0.0542)(22\Omega)$

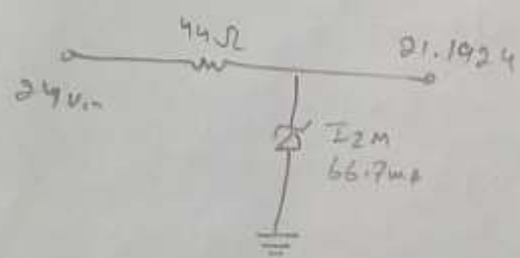
$= 20V + 1.1924$

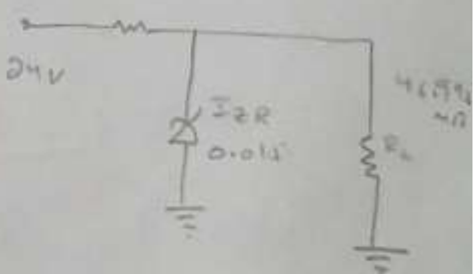
$V = 21.1924V$

(b) Calculating value of R for max Zener current that occures when there is no load.

$$R = \frac{V_{In} - V_{out}}{I_{zm}} = \frac{24V - 21.1924V}{I_{ZM}} = \frac{2.808}{66.7mA}$$

$R = 44\Omega$





(c) for the maximum load resistance (maximum load current) the Zener current is ($I_{zk} = 0.25mA$)

$$I_T = \frac{V_{In} + V_{out}}{R} = \frac{24 - 19.7305}{44}$$

$I_T = 0.0970 = 97.034\,mA$

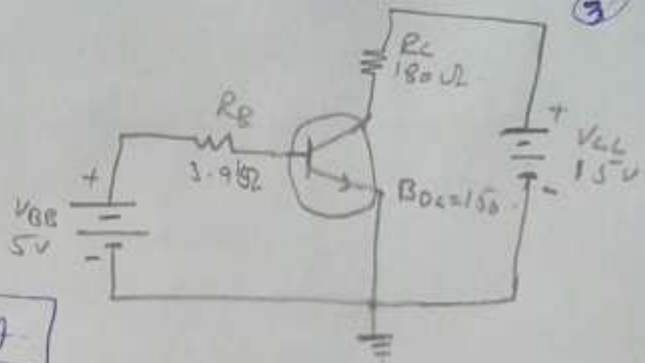
$I_L = I_T - I_{zk} = 97.034 - 0.25 = 96.784\,mA$

$R_L(min)\ \frac{V_{out}}{I_L} = 19.7305 / 96.784\,mA = \frac{19.7305}{0.0096735}$

$R_L(min) = 203.97\Omega$

Q2

$V_{BE} = 0.7V$



$I_B = \frac{V_{BB} - V_{BE}}{R_B}$

$= \frac{5V - 0.7V}{3.9k\Omega} = \boxed{1102 \mu A}$

$I_C = B_{DC} I_B \Rightarrow (150)(1102 \mu A) = \boxed{165.3 mA}$

$I_E = I_C + I_B = 165.3mA + 1102 \mu A = \boxed{166.4 mA}$

for V_{CE} & V_{CB}

$V_{CE} = V_{CC} - I_C R_C = 15V (165.3mA)(180\Omega)$

$= 15V - 29.7V = \boxed{-14.7V}$

$V_{CB} = V_{CE} - V_{BE} = -14.7V - 0.7V$

$\boxed{V_{CB} = -15.4V}$

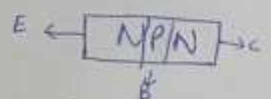
since the collector is at a lower voltage then the base, the collector base junction is forward - baised.

Q3 Discuss how is BJT used as an amplifier with the help of schematic diagram for a basic BJT amplifier? (4)

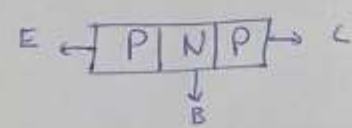
Ans: BJT (Bipolar junction transistor) are widely used as amplifier,

physical structure

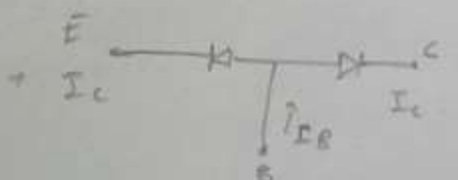
NPN

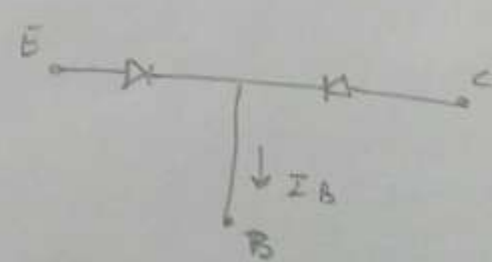


PNP



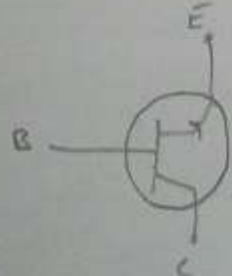
- 2 junction (N)
- 1 Junction (P).
- J_1 → emitter Base
- J_2 → collector base
- There is depletion region at J_1
- There is depletion region at J_2.



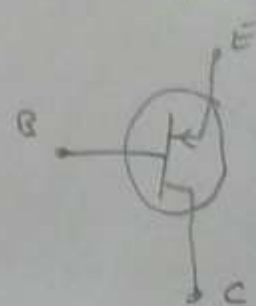


Symbol:

NPN



PNP.



Q 4

Transistor fully ON

Transistor fully OFF.

Input & base are at 0V

Collector current Ic = 0

$V_{CE} = V$

BE junction is reverse bias

BC junction is forward bais.

Maximum of saturation current Ic flows

BE junction is forward bias

BC junction is forward bias

$V_{CE} = 0V$

BE junction is less than 0.7V

OFF

ON

"————————"

Q5 Discuss that how JFET (n-channel) can be used as voltage control device.

Ans: The magnitude of the current flowing through the channel between Drain and the Source terminals is controlled by a voltage applied to the Gate terminal which is reversed-biased. In an N-channel JFET this Gate voltage is negative while for a P-channel JFET the Gate voltage is positive.

The JFET opperation can be compared to that of a garden pipe. The flow of water through a pipe can be controlled by crushing it to reduce the cross section and the electric charge flow through a JFET is controlled by forcing the current carrying channel. The current also depends on the electric field between the source and the discharge (similar to the pressure difference on both ends of the tube). Conduction of conducting channel is performed using the field effect. a voltage between the gate and the source is applied to reverse the gate n-source Pn

Pn-junction, thereby widening the jumper layer invading channel conduction and limiting its cross-sectional area. The depletion layer is so called because it is depleted of mobile carriers and is therefore electrically non-conductive for practical purpose.

When the drainage layer extends along the width of the conduit channel, reduction is achieved and drain-to-source conduction is interrupted. Pinching occurs at a particular reverse polarization (VGS) of the gate-source junction. The switch-off voltage (VP) varies considerably, even between devices of the same type. For example, VGS (off) for the Temic J202 device varies from -0.8V to -4v. The typical value from -0.3V to -10v.

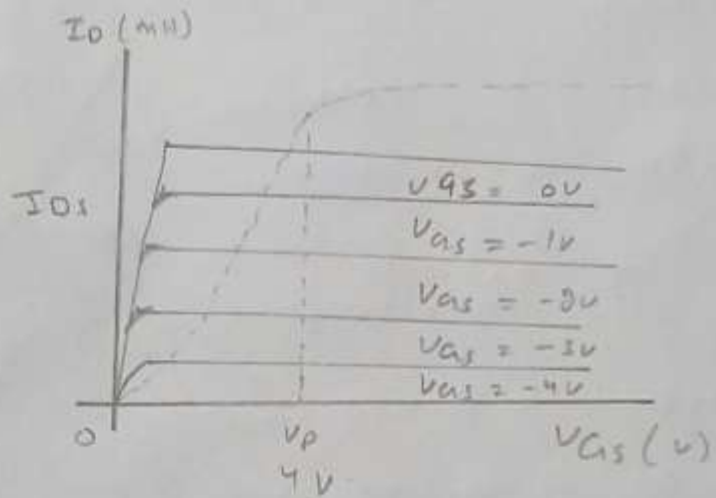
The turn off a channel device n requires a negative gate-source voltage (VGS). Conversely to turn off a P-channel device, a positive VGS is required.

In normal operation, the electric field developed by the gate blocks, to some extent the conduction of the source-drain. Some JFET devices are symmetrical with respect to origin and discharge.

Characteristics of JFETs (N-Channel).

we obtain both for different V_{GS} values.

→ The controlling voltage in V_{GS}.
→ Increase of n-channel → $V_{GS} < 0V$.
→ Increase of P-channel → $V_{GS} > 0V$.



Case 1. $V_{GS} = 0V$

$V_{DS} > I V_B$

$I_{DSS} = 8mA$
$V_P = -4$.

Case 2: $V_{GS} = -1V$

Case 3: $V_{GS} = -3$

Case 4: $V_{GS} = -4$.

Case 5: $V_{GS} = -5$

4 ———— 4

Q 6

a) $V_{CE} = ?$ $V_{in} = 0V$

when $V_{in} = 0V$ so transistor is in cut off mode and $V_{CE} = V_{CC} = 10V$

b) = Min. $I_B = ?$ $\beta_{DC} = 125$ $V_{CE(sat)} = 0$

$$I_C(sat) = \frac{V_{CC}}{R_C} = \frac{10V}{1.0k\Omega} = 10mA$$

$$I_B(min) = \frac{I_C(sat)}{\beta_{DC}} = \frac{10mA}{125} = 0.08\mu A$$

c) Max R when $V_{in} = 5V$

$V_{BE} = 0.7V$ then $R_B = ?$

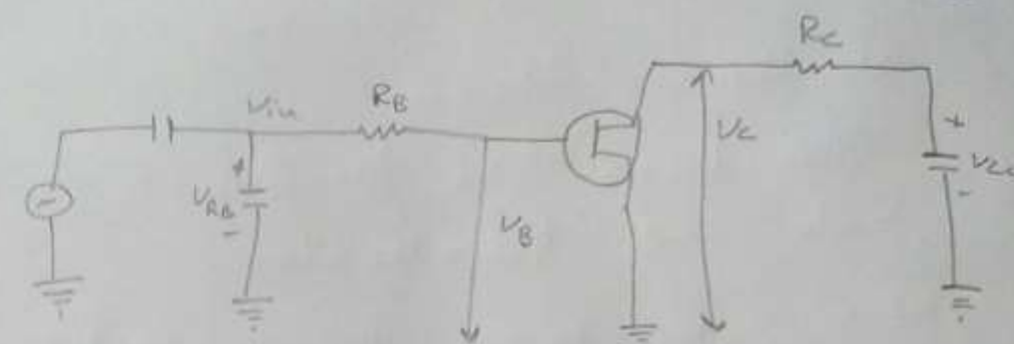
$$V_{RB} = V_{in} - V_{BE} = 5V - 0.7V = 4.3V.$$

Now we solve for max value of RB needed to allow a min I_B of $50\mu A$ using.

ohm's Law

$$R_B(max) = \frac{V_{RB}}{I_B(min)} = \frac{4.3V}{0.08\mu A} = \boxed{53.7k\Omega}$$

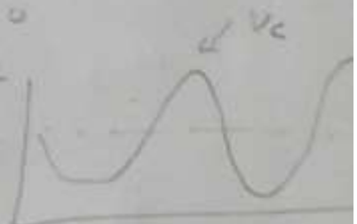
Q6



The ac base volt $= V_b = I_e r_e'$

The collector volt is $= V_c = I_c R_c$

since $I_c \cong I_e$ the ac collector voltage is $V_c \cong I_e R_c$



Consider V_E as transistor input volt and $V_b = V_s - I_b R_B$

Consider V_c as transistor output volt

Volt gain is $A_V = \frac{V_c}{V_b} = \frac{I_e R_c}{I_e r_e'}$

So $A_v = \frac{R_c}{r_e'}$

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