PDPM-Indian Institute of Information Technology, Design and Manufacturing Jabalpur

Electronics Devices and Circuits (Code: EC204a)

Time: 2 Hours | *Mid-Term, Sep. 21, 2023* | Maximum Marks: 30

1. What is the concentration of holes in Si crystals having donor concentration of $1.4 \times 10^{24}/cm^3$ when the intrinsic carrier concentration is $1.4 \times 10^{18}/cm^3$? Find the ratio of electron to hole concentration. [2]

2. A silicon diode has reverse saturation current of 2.5 μA at 3000K. Find the forward voltage for a forward current of 10 mA. You may use $V_T = 26$ mV. [2]

3. How does the reverse saturation current of a $p-n$ diode vary with temperature? How does the diode voltage (at a constant current) vary with temperature? Calculate the anticipated factor by which the reverse saturation current of a germanium diode is multiplied when the temperature is increased from 25 to 80^0C. [1, 1, 2]

4. Describe the physical mechanism for Zener breakdown. [2]

5. Explain base-width modulation (the early effect) with the aid of plot of potential throughout the base region. [2]

6. A BJT has $\alpha = 0.99$, $I_B = 25\mu A$, and $I_{CBO} = 200$ nA. Find I_C and I_E. [2]

7. Analyze the circuit given in Fig.1 to determine all the node voltages and branch currents. Assume $\beta = 100$. [5]

8. If the Si transistor used in the circuit of Fig.2 has a minimum value of $\beta = 30$ and $I_{CBO} = 10\,nA$ at 25^0C. If $R_1 = 15K$ and $V_i = 1\ V$, find V_O and show that Q is cutoff. [5]

9. The CE transistor used in the circuit of Fig.3 has $\beta = 100$. Voltage and current conventions are the same as discussed in the class.

   a) Find V_{BB} if $V_{CC} = 10\ V$, $V_{CE} = -1\ V$, and $R_L = 250\Omega$.

   b) If $V_{CC} = 10\ V$, find R_L so that $I_C = -20\ mA$ and $V_{CE} = -4\ V$. Find V_{BB}. [3, 3]

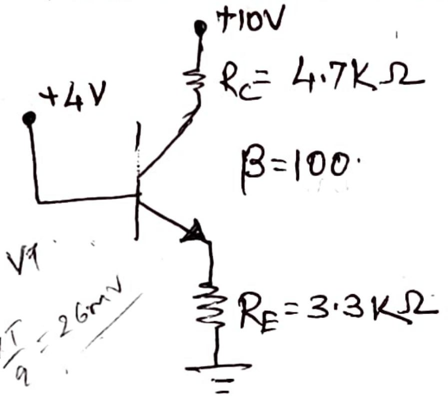

Fig. 1 (Q.7)

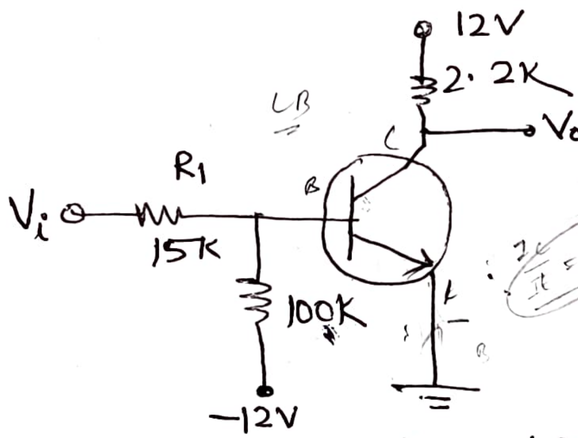

Fig. 2 (Q.8)

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End of exam

P.T.O.

$I_B + I_C = I_E$ — (i)

$I_C = \alpha I_E + I_{CBO}$ — (ii)

$\alpha = \frac{I_C}{I_E}$

$\beta = \frac{I_C}{I_B}$

$I_B + I_C = I_E$

$1 + \beta = \frac{I_E}{I_B}$ — (i)

$\frac{I_B}{I_E} = 1 - \alpha$ — (ii)

$1 + \beta = \frac{1}{1-\alpha}$

$\beta = \frac{1}{1-\alpha} - 1$

$\frac{1-(1-\alpha)}{1-\alpha}$

$\boxed{\frac{\alpha}{1-\alpha} = \beta}$

$1 - 0.99$, $\beta = 0.99$, $\frac{0.99}{0.01} = 99$, $\frac{99}{0.01} = 90$

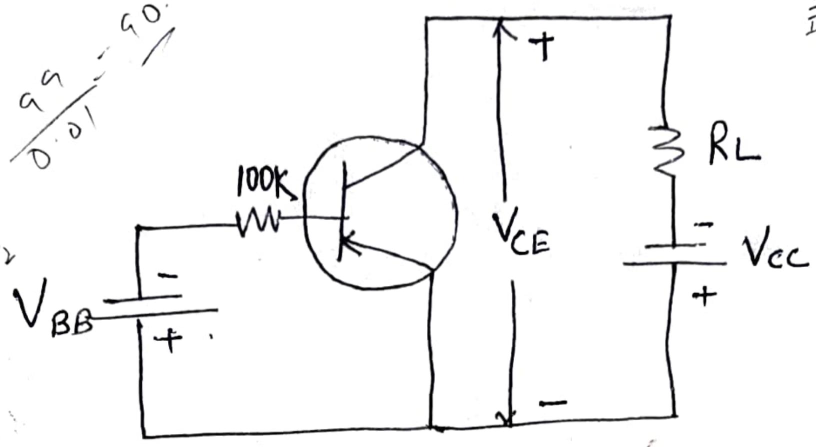
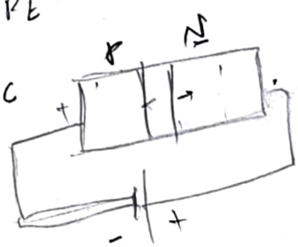


Fig.3 (Q.9)

$4 - V_{BE} - I_E R_E = 0$

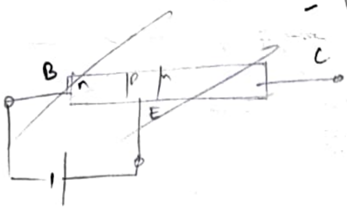
$10 - I_C R_C$

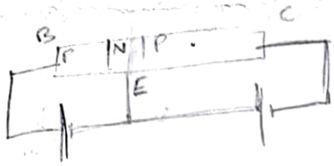


$\frac{1}{\beta} = \frac{1-\alpha}{\alpha}$ $\quad \frac{1}{\alpha} - 1 = \frac{1}{\beta}$ $\quad \frac{I_C}{I_E} = \alpha$

$\frac{1}{\beta} + 1 = \frac{1}{\alpha}$ $\quad \alpha = \frac{1}{\frac{1}{\beta} + 1} = \frac{\beta}{\beta+1}$

$\frac{I_C}{I_E} + \frac{I_C}{I_B} = \beta$





$\frac{I_B}{I_B} + \frac{I_C}{I_B} = \frac{I_E}{I_B}$

r.b

8.B

$1 + \beta = \frac{I_E}{I_B}$

$A' \times B' C'$

$\frac{I_B}{I_E} + \frac{I_C}{I_E} = \frac{I_E}{I_E}$

$I_C + I_B = I_E$

$\left(\frac{\alpha}{\alpha - 1}\right) = \beta . I_E$

$1 + \beta = \frac{I_E}{I_B}$

$\frac{I_B}{I_E} + \alpha = 1$

(VI)

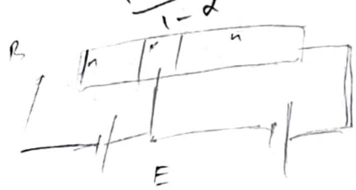
$1 - \frac{1}{1-\alpha}$ $\quad \frac{1}{1-\alpha} = 1 + \beta$ $\quad 1 - \alpha = \frac{I_B}{I_E}$

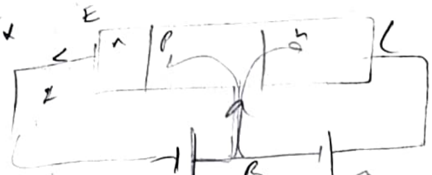
$\frac{1}{1+\beta} = 1 - \alpha$ $\quad \alpha = 1 - \frac{1}{1+\beta}$

$\frac{1-\alpha-1}{1-\alpha}$ $\quad 1 - \frac{1}{1-\alpha} = \beta$ $\quad \frac{1-\alpha-1}{1-\alpha} = \frac{\alpha}{1-\alpha}$

$\alpha = \frac{1+\beta-1}{1+\beta}$

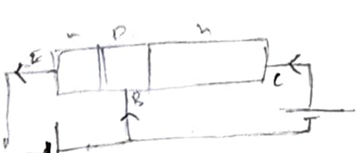
$\frac{I_C}{I_B} = \beta$





$\boxed{I_B + I_C = I_E}$

$\boxed{I_E = \alpha I_B + I_{CBO}}$



$\boxed{I_B + I_C = I_E}$

$\alpha = \frac{I_C}{I_E}$

$\beta =$

$\frac{I_C}{I_E} = \alpha$

$\alpha = \frac{\beta}{1+\beta}$

$I_C = \alpha I_E + I_{CBO}$.

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Electronics Devices and Circuits (Code: EC204a)

PART- B-

Time: 2 Hours | *End-Term, Nov. 24, 2023* | Maximum Marks: 70

1. Draw a family of common source drain characteristics fo an n-channel JFET. Explain the shape of these curves qualitatively. [10]

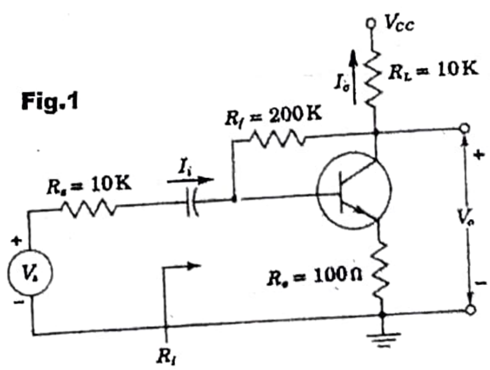
2. Define the pinch-off voltage of a JFET. Sketch the depletion region before and after pinch-off. [6]

3. Sketch and discus the cross section of a p-channel enhancement MOSFET. Draw two circuit symbols for this MOSFET. [6]

4. Draw a fixed biased circuit. Explain why the circuit is unsatisfactory if the transistor is replaced by another of the same type? [3,3]

5. For the circuit shown in Fig.1, calculate $A_I = I_o/I_i$, A_V, A_{Vs}, and $R-i$. Given $h_{ie} = 1100\Omega$, $h_{re} = 2.5 \times 10^{-4}$, $h_{fe} = 50$, and $1/h_{oe} = 40K$.

Fig.1



[15]

6. Draw and explain a circuit which uses a diode to compensate for changes (a) in V_{BE} and (b) in I_{CO}. [7]

7. A silicon transistor with $V_{BE,sat} = 0.8V$, $\beta = 100$, $V_{CE,sat} = 0.2V$ is used in circuit of Fig.2. Find the minimum value of R_c for which the transistor remains in saturation.

Student's name:

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$\frac{21\times10^{-6} A \times 10^{3}}{21\times10^{-4} A} = I_C$

$V_{CE} = I_C R_C + 10$

$0.2 = I_C R_C + 10$

$I_B = 21 \mu A$

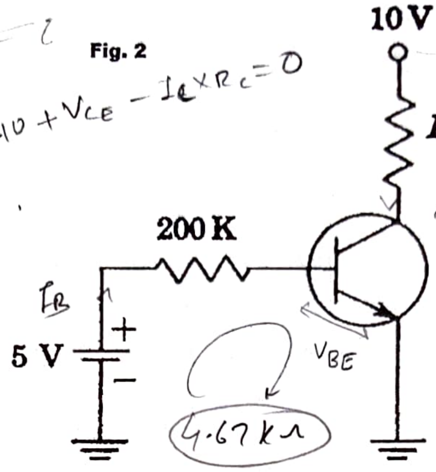
$\beta \Rightarrow \frac{I_C}{I_B}$

E B C

(C.E)

Fig. 2

$-10 + V_{CE} - I_C \times R_C = 0$



J_1 J_2

F.B R.B

B-E (F.B)

C E → R.B

$10 - I_C R_C -$

$V_{CE} + I_C R_C = 10$

$4.67 k\Omega$

$5 - I_B R_B - V_{BE} = 0$

$5 = V_{BE} + I_B \times 200 k\Omega$ ($V_{BE} = 0.8$)

$5 - 0.8 = I_B \times 200 k\Omega$

$\frac{4.2 \times 10^{-3}}{200}$

$0.021 \, mA = I_B = 21 \mu A$

[10]

8. For the circuit shown in Fig.3, assume $\beta = 100$. Find if the silicon transistor is in cutoff, saturation or in the active region. Find V_o.

$9.8 = I_C R_C$

$R_C = \frac{9.8}{21\times10^{-4}}$

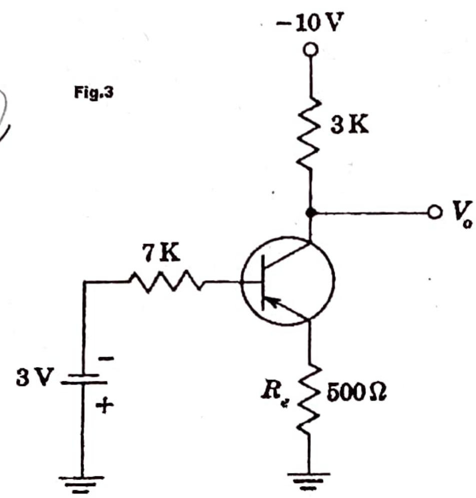
0.4667×10^{4}

4666.7

$4.67 k\Omega$

466.466

Fig.3



J_1	J_2	
F.B	R.B	active
F.B	F.B	ON saturation
R.B	R.B	off cutoff
R.B	F.B	→

[10]

Student's name:

End of exam