13.06.2020

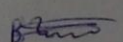
ELE 296 Basic Electric Circuits and Electronics
2019 - 2020 Spring

Homework

As a student of Hacettepe University who is enrolled in ELE 296 Basic Electrics Circuits and Electronics course, I hereby declare upon my word of honor that

- I will not recieve or give any unauthorized aid during any work (homework, reports, preliminary works, exams, etc.) that is to be used by the instructor as a basis of grading.
- I will not submit the work of any person.
- I will maintain only one user account and not let anyone else use my username and/or password.
- I will not engage in any activity that would falsify or misrepresent my results or the results of others.
- I will not post answers to problems that are being used to access student performance in any media.

I have read and understood the Honor Code and I will abide by its provisions. I am aware of the serious consequences as a result of the Honor Code (e.g., suspension, and even expulsion)

Name: İbrahim Burak
Surname: Tavukçu
Number: 21827852
Signature: 

Q2) İbrahim Burak Tavitaklı 21827852

1) We should place the positive probe on anode of diode and the negative probe on cathode of diode. Then we should read a moderately low resistance on ohmmeter. Then place the positive probe on cathode of diode and place negative probe on anode of diode. We should read a much higher resistance or infinite on ohmmeter. Then, diode is not faulty.

2-3) NPN → Connect positive to base and connect negative to either emitter or collector. If you get readings, then transistor is good and NPN.

PNP → Connect negative to base and connect positive to either emitter or collector. If you get readings, then transistor is good and PNP.

Readings must be less than infinite and more than zero.

4-5) n-channel forward resistance test → Connect positive to gate and negative to source or drain. Should read low readings

n-channel reverse resistance test → Connect positive to source or drain and negative to gate. Should read infinite.

p-channel forward resistance test → Connect positive to source or drain and negative to gate. Should read low readings.

p-channel reverse resistance test → Connect positive to gate and negative to drain or source. Should read infinite.

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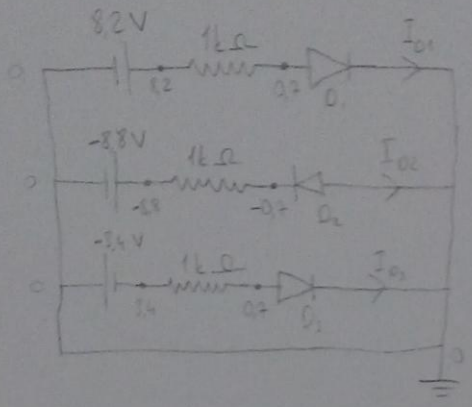
Q3)



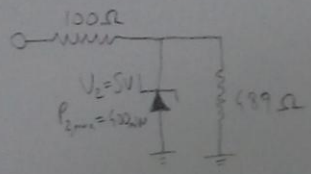
All of diodes working. Because direction of diodes same as direction of currents. Anodes of diodes are positive, cathodes of diodes are negative.

$$I_{D1} = \frac{8,2 - 0,7}{1k} = 7,5\ mA$$

$$I_{D2} = -\frac{-0,7 - (-8,8)}{1k} = -8,1\ mA$$

$$I_{D3} = \frac{3,4 - 0,7}{1k} = 2,7\ mA$$

Q4)



$$P = V.I \Rightarrow I_{z,max} = \frac{400}{5000} = 0,08\ A$$

$$V_L = \frac{R_L}{R + R_L} . V_i \geq 5V \Rightarrow V_i \geq \frac{589}{489} \cdot 5 = 6,02\ V$$

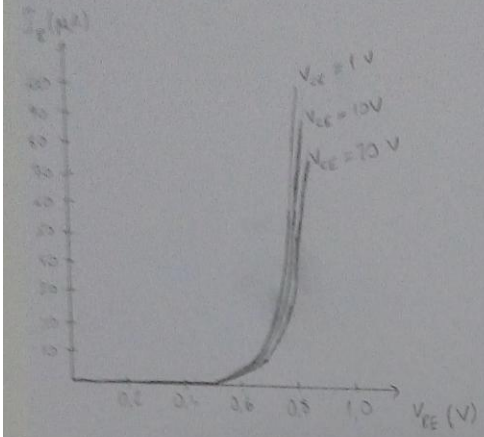
$$I_{z,max} = I_{R,max} - I_L = \frac{V_{i,max} - 5V}{R} - \frac{V_L}{R_L}$$

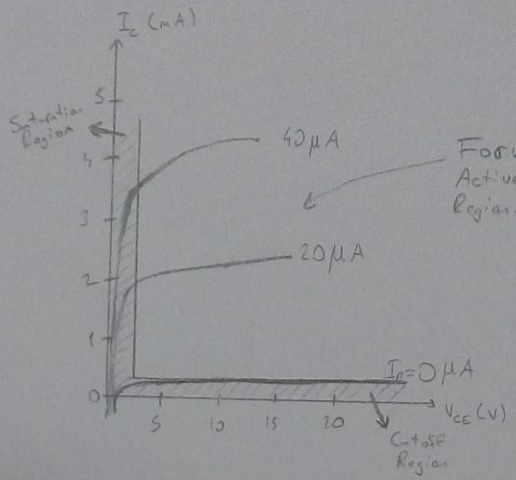
$$= \frac{V_{max} - 5}{100} - \frac{5}{489} = 0,08$$

$$\Rightarrow V_{i,max} = \left(0,08 + \frac{5}{489}\right) 100 + 5 = 14,02$$

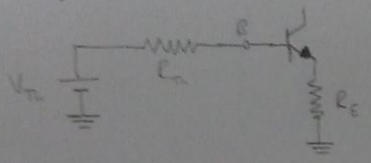
$$6,02V \leq V_i \leq 14,02\ V$$

Q5 - Ibrahim Burak Tanrikulu 21827852





Changed the circuit with Thévenin equivalent:



$R_{Th} = 396 \| 3,9k = 3,556 k\Omega$

$V_{Th} = \frac{3,9k}{396+3,9k} \cdot 12,8 = 1,16\ V$

KVL: $-V_{Th} + I_B R_{Th} + V_{BE} + (\beta+1) I_B R_E = 0$

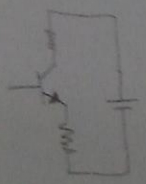
$I_B = \frac{1,16 - 0,7}{3,556k + 106,2 \cdot 1,5k} = 6,69\ \mu A$

$I_C = \beta I_B = 0,70\ mA$

$I_E = (\beta+1) I_B = 0,704\ mA$

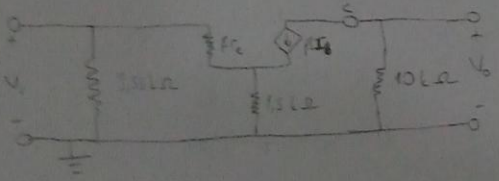
$V_E = I_E R_E = 1,06\ V$

$V_{CE} = V_B - V_E \Rightarrow V_B = 1,76\ V$



KVL: $-V_{cc} + I_C R_C + V_{CE} + I_E R_E = 0 \Rightarrow V_{CE} = 4,74$

$r_e = \frac{26}{0,704} = 36,93$



$Z_i = Z_{Th} \| Z_b = R_{Th} \| [\beta r_e + (\beta+1) R_E]$

$= 3550 \| [3885,22 + 159300] = 3474\ \Omega$

$Z_o = R_C = 1500\ \Omega$

$A_v = \frac{-\beta R_C}{\beta r_e + (\beta+1) R_E} = -6,45$

Q6) Ibrahim Burak Tanrikulu 21827852

$V_{CC} = 11\ V$

$V_{BE(ON)} = 0,7\ V$

$V_{BE(SAT)} = 1,14\ V$

$V_{CE(SAT)} = 0,23V$

Input 0V → Q_0 BE → off, Q_1 BE → on ⇒ Q_0 on cut-off, Q_1 on saturation

Input 5V → Q_0 BE → on, Q_1 BE → on ⇒ Q_0 on Forward Active, Q_1 on saturation

Input ≥6V → Q_0 BE → on, Q_1 BE → off ⇒ Q_0 on saturation, Q_1 on Reverse Active

V_{OH} : For V_{in} very low, Q_1 BE will be forward biased. BC also be forward biased. Therefore, Q_1 will be saturated.

$V_{BE,0} = V_{CE,1(SAT)} + V_{in} \Rightarrow Q_0$ will be cut off.

Therefore, $V_{out} = V_{OH} = V_{CC} = 11\ V$

V_{IL} : As V_{in} is increased, $V_{B,0}$ will also increase. Eventually, Q_0 will turn on.

$V_{in} = V_{IL} = V_{BE,0(ON)} - V_{CE,1(SAT)} = 0,7 - 0,23 = 0,47\ V$

V_{OL} : As V_{in} increased even more, Q_0 comes closer to saturation and eventually stucks.

$V_{out} = V_{OL} = V_{CE,0(SAT)} = 0,23\ V$

V_{IH} : The point where Q_0 is just saturating :

$V_{in} = V_{IH} = V_{BE,0(SAT)} - V_{CE,1(SAT)} = 1,14 - 0,23 = 0,91\ V$