i-Labs

Device Characterization Lab

In this lab exercise, you will obtain the current-voltage characteristics of an npn bipolar junction transistor (BJT) and an n-MOSFET. To do this, you will use the MIT Microelectronics WebLab. The npn BJT is available is device 3 of WebLab and the nMOSFET is device 2 on the devices menu.
The i-labs can be accessed at http://emuklabs.mak.ac.ug . Use the account you created last semester- in case you do not have one or you forgot your password, please send an email to alumu@tech.mak.ac.ug .

Take the measurements specified below. When you are happy with the results (as judged by the characteristics displayed through the web), download the data to your local machine for more graphing and further analysis in MS Excel. (A tutorial on this is available at the Intranet site http://fot/weblab/weblabbjt.pdf)

Note:
Do not use voltages higher than 3.0V for the V_{CE}(common-emitter voltage), and V_{GS}(gate-to-source voltage). Use V_{GS} in the range $2.0V \leq V_{GS} \geq 3.0V$. The base-emitter voltage, V_{BE} (base-emitter voltage) should not exceed 0.9V, otherwise the device may be damaged.
Values of the base current, I_B greater than 60μA should not be used as they will strain the device.

Part I

Obtain I-V characteristics for the BJT and the NMOS transistor.
Measure I_D (drain current) vs. V_{DS} (drain-to-source voltage) with V_{GS} as a parameter. For the BJT, measure I_C (collector current) vs. V_{CE} as a function of various I_B (base current).

Show your measurement results in the following graphs:

Graph 1: Output characteristics of the BJT, I_C vs. V_{CE}, for different values of I_B. For this graph, indicate the 3 regions of operation of a BJT, namely:

1. Linear
2. Cutoff
3. Saturation

Note down the temperature of the BJT.

Graph 2: The output characteristics of the nMOS, I_D vs. V_{DS}, for different values of V_{GS}.
Indicate the ohmic and active regions of this nMOS. Note down the temperature of this device too.

Graph 3: Obtain the transfer characteristics of the NMOS (V_{GS} vs I_{DS}) for various values of V_{DS}. From this plot, approximate the value of V_T, the threshold (sometimes called the pinch off) voltage. From your approximate value for V_T, what type (mode) of nMOSFET is this?

Graph 4: For the BJT, plot I_C vs. V_{BE}, for different values of V_{CE}.

Graph 5: For the BJT, plot I_B vs. V_{BE}, for different values of V_{CE}.

Part II :Small signal graphs.

The the output resistance of the nMOS is defined by $r_{oNMOS} = \frac{dV_{DS}}{dI_{DS}}$ (at a fixed V_{GS} value);

that of the BJT by $r_{oBJT} = \frac{dV_{CE}}{dI_C}$ (at a fixed value of I_B).

The BJT's transconductance, g_m is given by the equation $g_m = \frac{dI_C}{dV_{BE}}$.

For this part you will need to use the DELTA inbuilt function for most of the measurements here-consult the Weblab manual at the Intranet site: http://fot/weblab/User_Manual_Draft2.pdf)

Graph 6: plot the output resistance (r_{oNMOS}) of the NMOS as a function of V_{DS}, for different values of V_{GS}.

Graph 7: plot the output resistance (r_{oBJT}) of the BJT as a function of V_{CE}, for different values of I_B.
(Use a log scale for r_{oBJT})

Graph 8: plot the transconductance (g_m) of the BJT as a function of I_B, for V_{CE} = 1.5 V.

Summary

Any comments related to this exercise such connection speeds, timeouts, access to computers, clarity, difficulty in using the Java Client Applet, etc are all welcome. You can put them in writing or send them by email to the Weblab TA, Albert: alumu@tech.mak.ac.ug .

Your work should be handed in no later than 5:00pm Thursday, 2nd June 2005.