EENG3106 Electronic Circuits Analysis I Laboratory
MOSFET *I-V* Characteristics

©David M. Beams
University of Texas at Tyler
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Purpose:

This experiment has two aims.

1. Determination of the I_D vs. V_{DS} characteristics of the VN10LP *n*-channel enhancement-mode MOSFET;
2. Determination of the small-signal transconductance of the VN10LP under specified quiescent operating conditions.

Experimental procedure:

1). Connect the test circuit of Fig. 1. The VN10LP devices are prone to damage from electrostatic discharge (ESD); they should be left in the conductive foam until they are to be inserted in the circuit. Insertion of the VN10LP is to be the *last* step in construction of the test circuit.

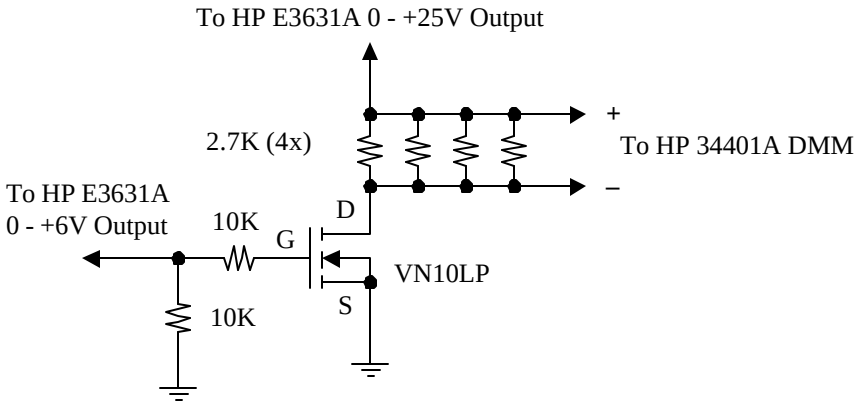

Figure 1. Test circuit for *n*-channel MOSFET I_D vs. V_{DS} characteristics. The source and substrate of the VN10LP are internally connected.

2). Boot the workstation and launch LabVIEW. Open the LabVIEW virtual instrument program BB_NMOS_V7F.vi.

3). Determine the threshold voltage $V_{GS(th)}$. For purposes of this experiment, the threshold voltage will be that which allows produces a drain current (I_D) in saturation of 20–30 μA. (The MOSFET is in saturation when the gate-to-drain voltage V_{GD} is less than the threshold voltage. The drain current in saturation is essentially independent of drain-to-source voltage V_{DS}). Small values of drain current may be read from the digital readout of drain current on the lower left-hand of the virtual instrument screen or may be read from the I_D vs. V_{DS} display by temporarily changing the maximal drain current of the display from 30 mA to 0.5 mA. Note that the resolution of the digital readout is 10 μA.

4). Use the virtual instrument to generate a series of I_D vs. V_{DS} curves with the gate-to-source voltage varied in steps of 0.2V starting at 0.2V above the threshold voltage until the maximal drain current approaches full scale of the display. See Fig. 2 for an example. (Repeat this step with steps of 0.1V starting at 0.1V above threshold if an I_D vs. V_{DS} display with at least four distinct curves is not obtained).

5). Measure the transconductance of the MOSFET at I_D = 5mA and 10mA at V_{DS} = 10V.
This may be accomplished by first determining experimentally the V_{GS} required to cause the I_D vs. V_{DS} curve to pass through the specified (I_{DS}, V_{DS}) point and subsequently dithering V_{GS} about this experimental value. Transconductance may be estimated as the ratio $\Delta I_D / \Delta V_{GS}$.

Results to be reported:

1). Report the measured threshold voltage.

2). Show the I_D vs. V_{DS} characteristics.

3). Report the transconductance values.

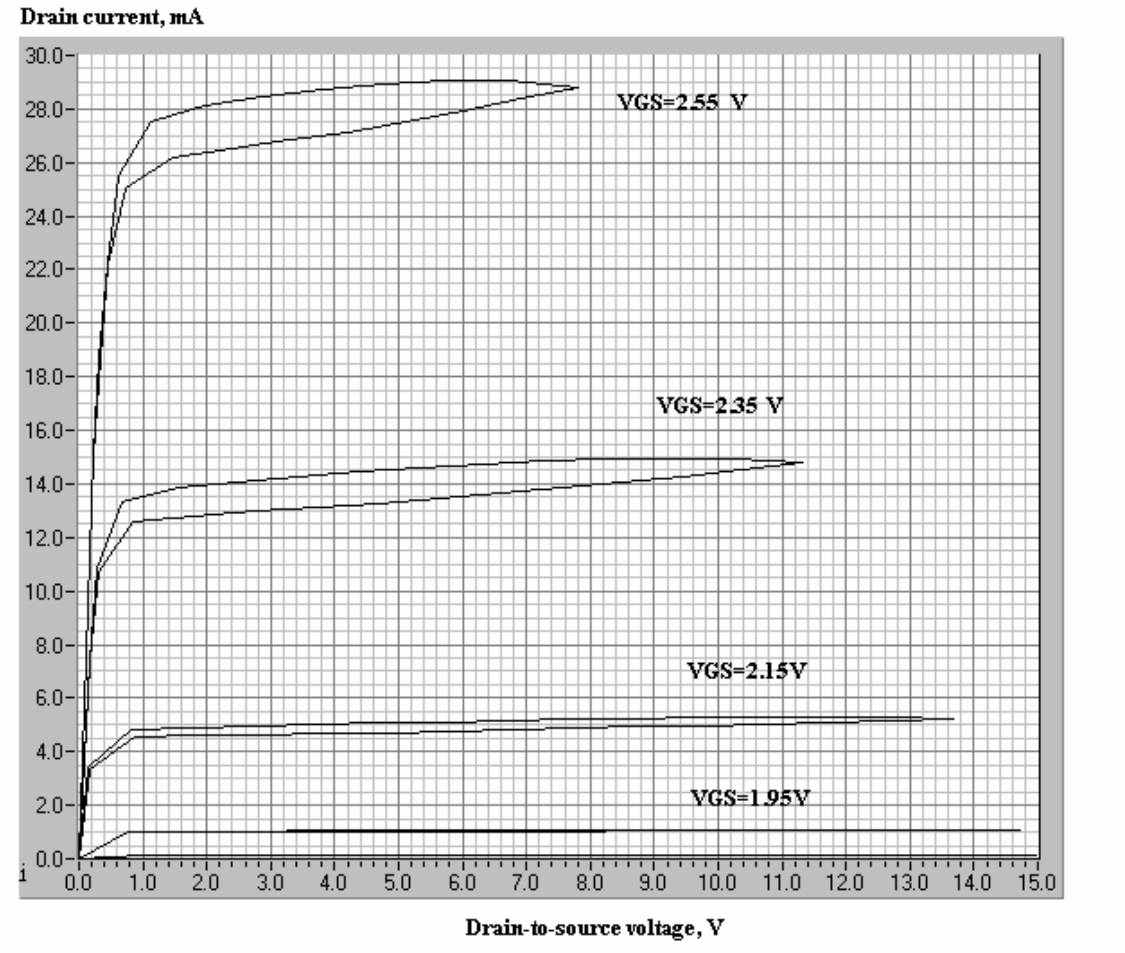

Fig. 2. Screen image of the I_D vs. V_{DS} characteristics of a VN10LP MOSFET acquired with Labview virtual instrument program BB_NMOS.vi (predecessor to the virtual-instrument program used in this experiment). The threshold voltage of this particular device was found to be 1.55V; curves were taken with V_{GS} increments of 0.2V beginning at V_{GS}=1.75V. The I_D vs. V_{DS} curve for V_{GS}=1.75V lies just above the abscissa and is not labeled due to lack of space.