Physics 323

Experiment # 9 - FET Characteristics and Circuits

Introduction

This is a "quick and dirty" introduction to FET's through building and examining a 'pot-pourri' of circuits. You will use a 2N5485 which is a n-channel JFET (data attached). The connections are

Prelab

(a) Give the relationship between I_D and V_{GS} for a JFET and sketch the curve.

(b) Define the mutual transconductance, g_m, and derive a relationship for g_m from (a)

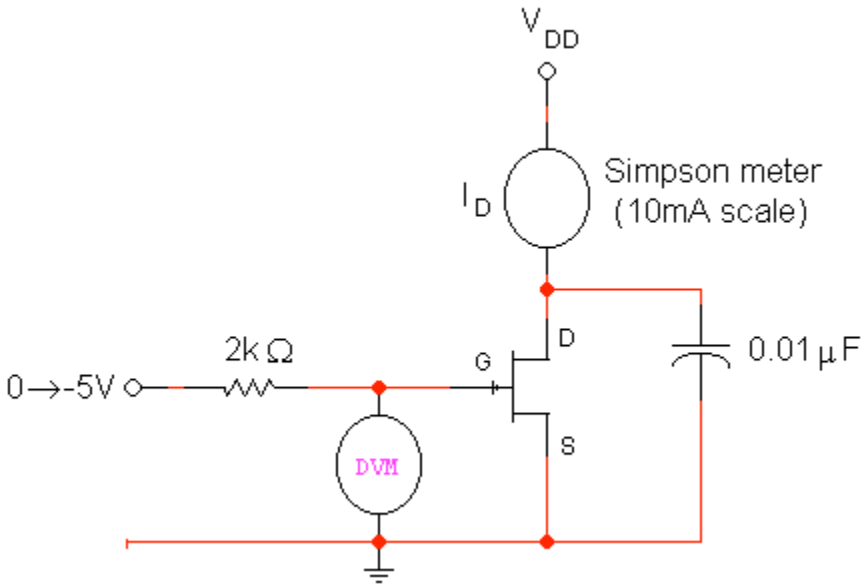
(c) Sketch the curves for I_D vs. V_{DS} and indicate on them where it would be suitable to operate the FET as (i) a current source (ii) a variable resistor.

(d) Draw a small signal model for a FET and derive a relationship for the voltage gain of a source follower.

Lab

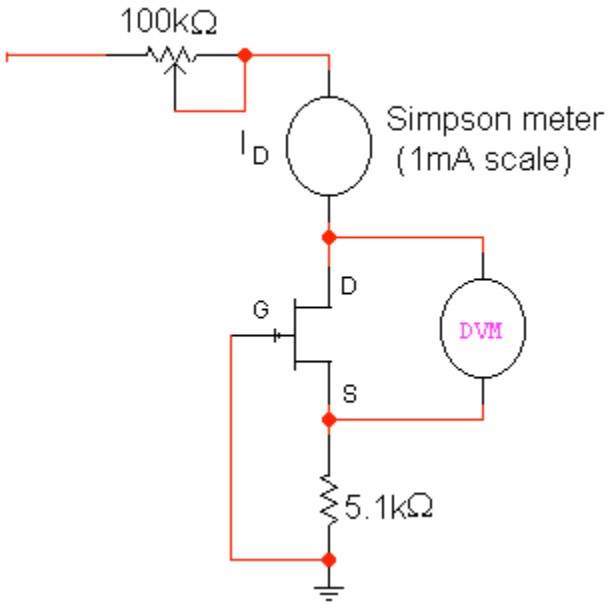
(1) FET Characteristics

Connect up the following circuit and measure I_D and V_{GS} to determine I_{DSS} and $V_P(=V_T)$. Compare with manufacturer's specifications.



(2) FET Current Source

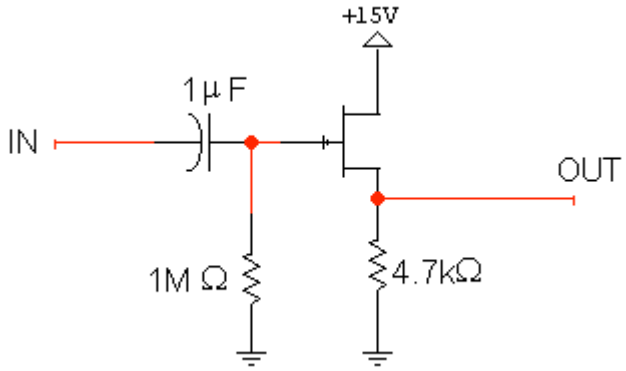
Vary the resistance of the load and measure V_{DS} and I_D. Determine V_{DS} when the constant current behaviour breaks down - is this what you would expect from (1)?



(3) Source Follower

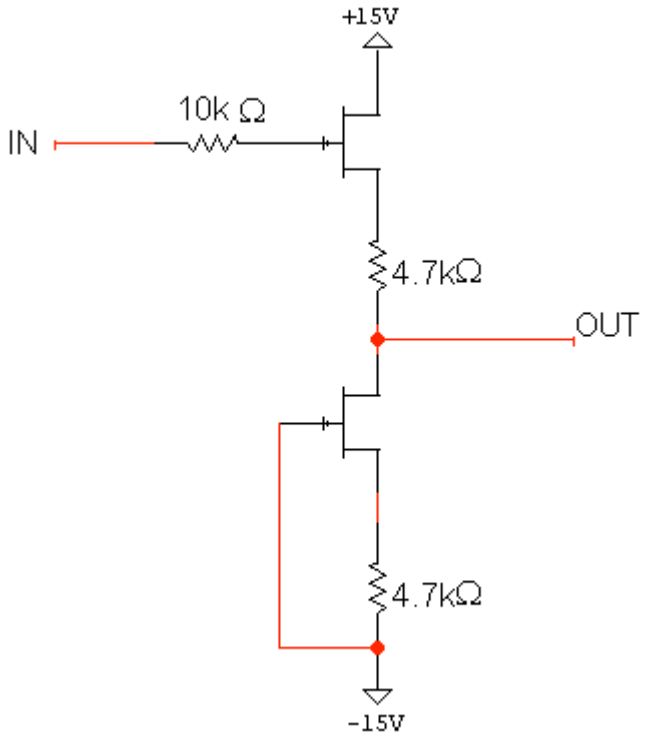
(a) Simple follower

Drive the source follower with a sine wave (~1 V p-p at 1 kHz). Measure voltage gain and V_S. Infer g_m (transconductance) at this quiescent I_D. Compare with data sheet g_m (measured at $V_{GS} = 0$ V) and use the data sheet value to predict the g_m under your circuit conditions for comparison with your measured value.



(b) Follower with current source load

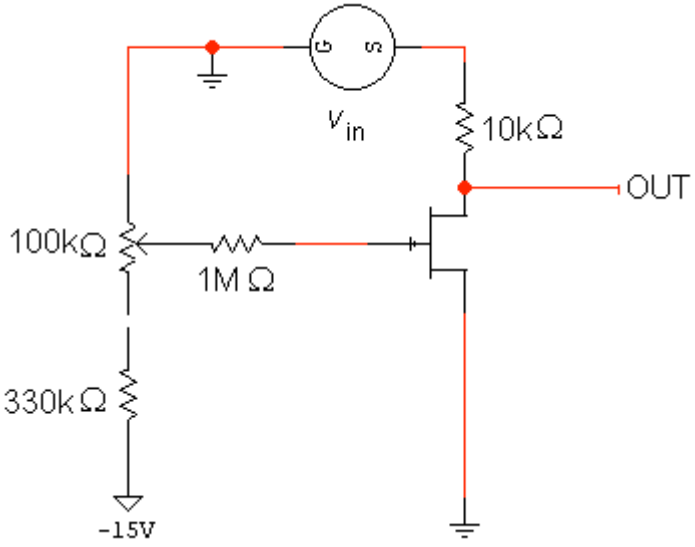
Measure gain with a 1 V, 1 kHz signal. Measure DC offset of the output. Why should it be zero and why isn't it?



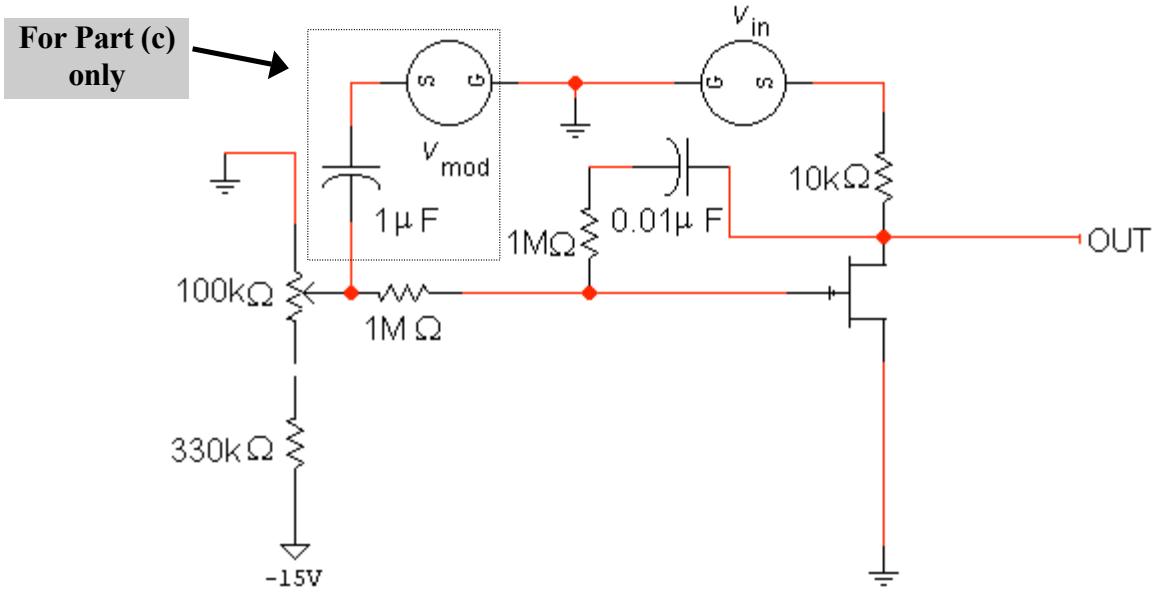
(4) FET as a variable resistor

(a) Simple attenuator

This circuit operates in the "linear region" i.e. not the "current source region". Drive the circuit with a small sine wave (~0.2 V at 1 kHz). Adjust the potentiometer and notice results i.e. measure gain and check distortion (more easily seen with triangular wave). Explain any distortion.



(b) Compensated attenuator
Compare performance of this circuit with (a).



(c) Amplitude modulation
(a) and (b) have shown that we can vary attenuation with a potentiometer!! However, the FET is useful since we can vary attenuation with a voltage. To demonstrate this let a second function generator drive the point that you drove with the potentiometer, so that it varies (modulates) the attenuation periodically. Try f_{mod} ~50 Hz, and V_{mod} ~0.2 V and watch the output (trigger the scope on the modulation).