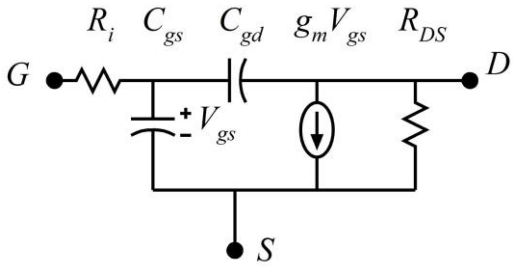
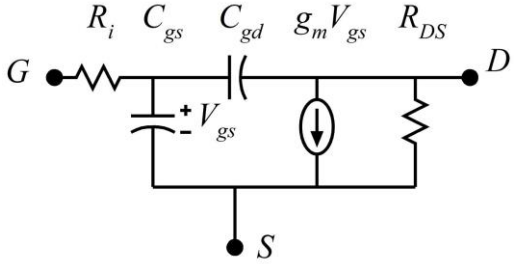
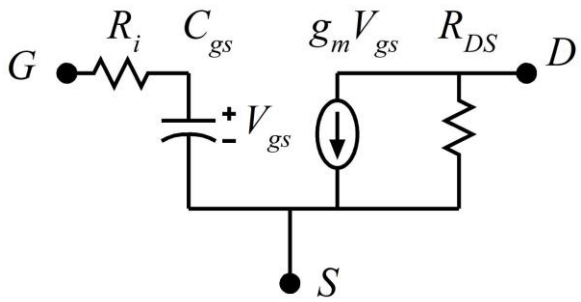
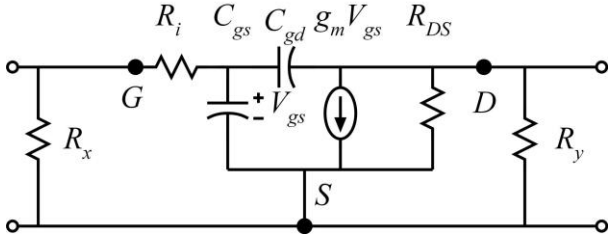
ECE 145a /218A problem set (device models, 2 port parameters, impedance matching). Note: please download the ADS directory ADS_for_218a, unarchive this in ADS, and use this for the simulation portion of the assignment.

Problem 1: Shown is a highly simplified small-signal model of a MOSFET. Ri=0 Ohms, gm=50 mS, Rds=200 Ohms, Cgs=30 fF, Cgd=0 fF The source is grounded. a) Compute by hand the four Y-parameters as a function of frequency. b) create a 2-port circuit of this device in ADS. Simulate using the provided gain_testbench, and make plots of the real and imaginary parts of the 4 Y-parameters. Use linear scales for both axes.	
Problem 2 **(218A only)**: Now set . Ri=10 Ohms, gm=50 mS, Rds=200 Ohms, Cgs=30 fF, Cgd=0 fF The source is grounded. a) Again compute the 4 Y-parameters (real and imaginary parts) by hand. Use numerical approximations so that all four of these are written as polynomials in $(j\omega)^n$, and truncate the polynomials to 2nd order in $(j\omega)$. Comment about how the effects of the various circuit elements show up in the Y parameters.	 b) Again simulate using the provided gain_testbench, and make plots of the real and imaginary parts of the 4 Y-parameters. This is an elementary introduction to device model extraction: S-parameters are measured of a transistor, converted to Y-parameters, and compared to that of a model.
Problem 3 **(218A only)**: Take. Ri, gm, Rds, Cgs, and Cgd as algebraic variables. Compute the 4 Y-parameters (real and imaginary parts) by hand. Use numerical approximations so that all four of these are written as polynomials in $(j\omega)^n$, and truncate the polynomials to 2nd order in $(j\omega)$.	In this derivation, assume that $\omega R_i C_{gs}$ and $\omega R_i C_{gd}$ are both <<1/ Comment about how the effects of the various circuit elements show up in the Y parameters, and how the measured transistor Y-parameters could be used to determine the equivalent circuit element values.

Problem 3: Ri=0 Ohms, gm=50 mS, Rds=200 Ohms, Cgs=30 fF, Cgd=0 fF . The source is grounded. a) Compute by hand the four S-parameters. Make a hand sketch of dB magnitude of S11 and S21 vs frequency on a log scale (DC-300 GHz) b) Simulate using the provided gain_testbench, and make plots of dB magnitude of S11 and S21 vs frequency (DC-300 GHz) on a log scale	 Please also make plots on the Smith chart of S11 and S22, and polar plots of S21 and S12.
Problem 4: (please DO work this problem) Simple common-source amplifier (bias networks are not shown) Ri=0 Ohms, gm=50 mS, Rds=200 Ohms, Cgs=30 fF, Cgd=0 fF a) Compute the values of Rx and Ry necessary to give 50 Ohm input and output impedance *at low frequencies*. (b) the circuit is then to be used in a 50 Ohm system, i.e. with 50 Ohm generator and load. Compute by hand all four S-parameters.	 (c) Explain precisely how S11, S22, S21 relate to gain, input and output impedance. (d) Simulate using the provided gain_testbench, and make plots of dB magnitude of all 4 S-parameters vs frequency (DC-300 GHz) on a *dB and log frequency* scale.