Basics of Active and Nonlinear HF Electronics – Tutorial

We consider a FET and its nonlinear drain current source I_{DS} modeled by the below equation as a function of its control voltages V_{GS} and V_{DS} :

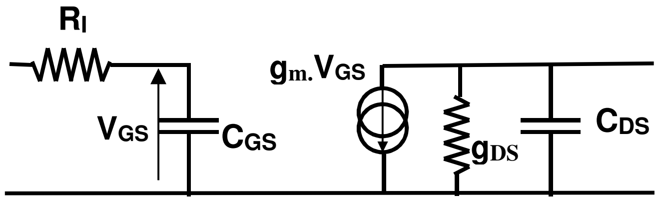
$$I_{DS} = I_{DSS}\left[1 - \frac{V_{GS}(t)}{V_P}\right]^2 (1 + K.V_{DS}(t))$$

The model is accurate in the variation range $-1.5V < V_{GS} < 0V$; $1V < V_{DS} < 7V$

with I_{DSS} = 60 mA; V_P = -1.5 V; K = 0.05; C_{GS} = 0.5 pF; C_{DS} = 0.1 pF; R_I= 4 Ω .

The FET is biased at V_{GS0} = - 0.75 V and V_{DS0} = 4 V

The small signal linear model of the FET in these conditions is shown below:



Study of parallel-cells of FET

1) Draw the I_{DS}-V_{DS} curves in the variation range
2) Determine the values of transconductance g_m and drain conductance g_{DS} at the selected bias point.
3) Determine the small-signal linear model corresponding to n parallel-cells of the FET. Determine the variation laws that give equivalent elements ($C_{GS}(n)$ …) of the parallel-cells as a function of the number of cells n and the equivalent elements ($C_{GS}(1)$ …) of a single-cell FET.
4) Determine the maximum power gain G_{MAX} for an ideal power matching at small-signal (linear) level. Determine its cutoff frequency f_C and its maximum frequency f_{MAX}.
5) After determining the optimum power load in large signal class A operation, determine the maximum gain G_{MAX} in this loading condition. Estimate the maximum output power value in class A. Compare these values to G_{MAX} and its associated maximum output power when the FET is ideally matched to give optimum gain in small signal operation.
6) Same questions 4) and 5) in the case of n-parallel FETs