

Semiconductor Device Theory: MESFET – Theoretical Exercise

Dragica Vasileska and Gerhard Klimeck
(ASU, Purdue)

1. A GaAs MESFET is fabricated using an epitaxial layer doped to $N_D = 10^{17} \text{ cm}^{-3}$ that is $0.2 \text{ } \mu\text{m}$ thick. The Schottky barrier metallization has a barrier height of 0.75 eV .
 - (a) Evaluate the built-in voltage V_{bi} .
 - (b) Evaluate the pinch-off voltage V_{po} .
 - (c) Evaluate the threshold voltage V_T .
 - (d) Is the resulting transistor a depletion or enhancement mode device?
 - (e) What is the depletion layer thickness with zero gate voltage?

2. Write a program to evaluate the drain current as a function of V_D for a specified gate voltage. Use the transistor parameters of problem 1. The program should be valid for all channel lengths; assume that $\mu_n = 5000 \text{ cm}^2/\text{V}\cdot\text{s}$ and $v_s = 1.3 \times 10^7 \text{ cm/s}$.
 - (a) Plot $I_D(V_D)$ with $V_G = 0$ for a transistor with $L = 10 \text{ } \mu\text{m}$ and $Z = 100 \text{ } \mu\text{m}$.
 - (b) Repeat (a) for $L = 0.2 \text{ } \mu\text{m}$ and $Z = 100 \text{ } \mu\text{m}$.
 - (c) Compare V_{Dsat} in (b) with the value $V_{Dsat} = E_s L$ which is the extreme velocity saturation limit. Does this limit apply to a transistor with $L = 0.2 \text{ } \mu\text{m}$?