ECE 2126 PHYSICS OF SEMICONDUCTOR DEVICES

FISAC ASSIGNMENT

1. Draw the structure of an n-channel JFET and qualitatively discuss the I–V characteristics, including current directions and voltage polarities.

2. Calculate the internal pinch-off voltage and pinch-off voltage of n-channel JFET. Assume that the p-n junction of a uniformly doped silicon n-channel JFET at T=300 K has doping concentrations of $N_a=10^{18}$ cm^{-3} and $N_d=10^{16}$ cm^{-3}. Assume that the metallurgical channel thickness, a, is 0.75 μm.

3. Design the channel doping concentration and metallurgical channel thickness to achieve a given pinch-off voltage. Consider a silicon p-channel p-n JFET at T=300 K. Assume that the gate doping concentration is $N_d=10^{18}$ cm^{-3}. Determine the channel doping concentration and channel thickness so that the pinch-off voltage is 2.25 V.

4. Consider a GaAs n-channel p-n JFET at T=300 K with $Na=10^{18}$ cm^{-3}, $Nd=3\times10^{15}cm^{-3}$, and a=0.70 μm. Determine the forward-bias gate voltage required to open a channel region that is 0.10 μm thick with zero drain voltage.

5. Calculate the maximum current in an n-channel JFET Consider a silicon n-channel JFET at T = 300 K with the following parameters: $N_a=10^{18}$ cm^{-3}, $N_d=10^{16}$ cm^{-3}, a =0.75 μm, L =10 μm, W =30 μm, and μ_n =1000 cm^2/V-s.

6. Describe the basic operation of the MESFET and the mechanism of current saturation in it.

7. Consider an n-channel GaAs MESFET at T=300 K with a gold Schottky barrier contact. Assume the barrier height is ϕ_{Bn}= 0.89 V. The n-channel doping is $N_d=2\times10^{15}$ cm^{-3}. Design the channel thickness such that V_T=0.25 V.

8. The Schottky barrier height, ϕ_{Bn}, of a metal–n-GaAs MESFET is 0.90 V. The channel doping is $N_d=1.5\times10^{16}$ cm^{-3}, and the channel thickness is a=0.5 μm. T=300 K.

   (a) Calculate the internal pinch-off voltage V_{p0} and the threshold voltage V_T.

   (b) Determine whether the MESFET is a depletion type or enhancement type.

9. Consider an n-channel GaAs MESFET at T=300 K with ϕ_{Bn}=0.85 V and a=0.25 μm. Determine the channel doping concentration such that V_T=0.5 V

10. Consider an n-channel GaAs MESFET with a gate barrier height of ϕ_{Bn}=0.85 V. The channel doping concentration is $N_d = 5\times10^{15}$ cm^{-3} and the channel thickness is a = 0.40 μm. Calculate the internal pinch-off voltage and the threshold voltage.