ECE 584
Chapter 1 Homework

Dr. George Engel

Due: One week after we finish covering relevant material.

You should use the 0.35 μm process data given to you in class to answer the following questions. Assume V_{DD} is 3.3 Volts.

Problem 1. Resistor Implementation

Assume matching is important. By design I mean determine both the width and the length of the resistor.

(a) Design a $8.2K$ $K\Omega$ RPOLYH unit resistor.

(b) Design a 0.65 $K\Omega$ RPOLY2 unit resistor.

(c) Design a 15.0 $K\Omega$ unit resistor with a zero tempco.

Problem 2. Capacitor Implementation

Assume matching is important. By design, I mean determine both the width and the length of the capacitor.

(a) Design a 0.8 pF double-poly unit capacitor.

(b) Design a 2.5 pF double-poly unit capacitor.

Problem 3. Transistor Used as a Resistor

(a) Design a 100 kΩ resistor by using a NMOS device. Assume the source voltage is 1.65 Volts and the gate is tied to V_{DD}. For what range of V_{DS} voltage will the "resistor" be reasonably linear?

(b) Design a 100 kΩ resistor by using a PMOS device. Assume the source voltage is 1.65 Volts and the gate is tied to **GND**. For what range of V_{DS} voltage will the "resistor" be reasonably linear?

Problem 4. Inversion Coefficient

Assume a NMOS transistor length of 2 μm in this problem and a quiescent drain-source current of 10 μA.

(a) Determine the width of the NMOS transistor so that the inversion coefficient, θ, is 0.05 *i.e.* weakly inverted.

(b) Determine the width of the NMOS transistor so that the inversion coefficient, θ, is 3 *i.e.* moderately inverted.

(c) Determine the width of the NMOS transistor so that the inversion coefficient, θ, is 100 *i.e.* strongly inverted.

Problem 5. Small-Signal Transconductance

Assume a NMOS transistor length of 2 μm in this problem and a quiescent drain-source current of 8 μA.

(a) Determine the small-signal transconductance when θ is 0.05.

(b) Determine the small-signal transconductance when θ is 3.

(c) Determine the small-signal transconductance when θ is 100.

Problem 6. Small-Signal Output Resistance

Assume a NMOS transistor length of 4 μm in this problem and a quiescent drain-source current of 10 μA.

(a) Determine the output resistance.

(b) Determine the saturation or *effective* voltage when θ is 30.

(c) Determine the saturation or *effective* voltage when θ is 3.