Cairo University
Faculty of Engineering
CCE Program

Department of Electronics and
Communications Engineering
ELCN 441 – Fall 2020

Problem Set #1: Passives & MOS Device & Single-Stage Amplifiers

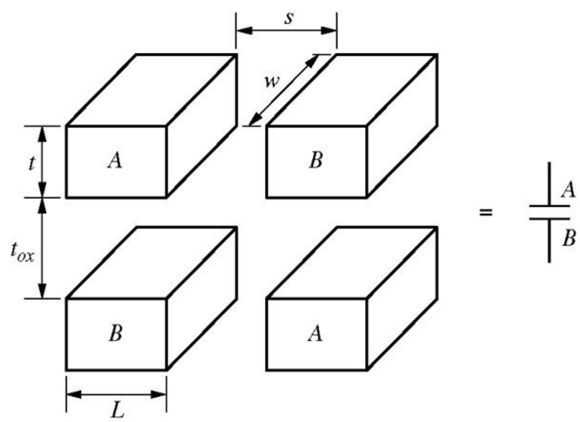
Problem 1

(a) If the resistivity of poly-silicon is 10^{-4} Ω.m and thickness of poly-silicon layer is 1μm, calculate the sheet resistance $R_{\square}$.

(b) If the distance between two metal layers is 100nm and the space between the two metals is filled with silicon oxide (ε=3$\times 10^{-11}$ F/m), calculate the capacitance per unit area.

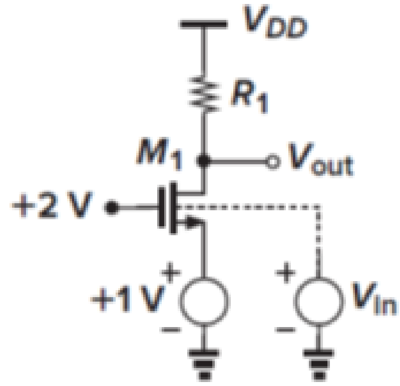
Problem 2

Find the value of the capacitor shown below for w=300μm, s=t=t_{ox}=L=1μm, and ε=3$\times 10^{-11}$ F/m.



Problem 3 (Book 2.8)

Sketch V_{out} as a function of V_{in} as V_{in} varies from 0 to V_{DD} for the circuit shown with V_{DD} = 3V. $\mu_n C_{ox}$=50μA/V^2, V_{TH} = 0.8V, 2ϕ_F = 0.7V, and γ=0.4$V^{0.5}$



Problem 4 (Book 2.27)

An NMOS device operating in the sub-threshold region has a ζ of 1.5. What variation in V_{GS} results in a tenfold change in I_D? If I_D=10μA, calculate g_m.

Problem 5 (Book 2.13 & 2.14)

(a) Show that the transit frequency of a MOS device is given by:

$$f_T = \frac{g_m}{2\pi(C_{GD} + C_{GS})}$$

(b) Calculate the transit frequency for a device in sub-threshold region (weak inversion) and compare that with the result obtained in (a).

Problem 6

For the source-follower circuit shown, M_1 and M_2 are identical.

$\mu_n C_{ox}$=50μA/V^2, (W/L)=2μm/1μm, V_{TH} = 0.8V, and V_b = 2V, λ = 0.02V^{-1}, Find:

(a) Gain (=V_{out}/V_{in}) and G_m if γ=0.
Repeat if body effect is not neglected (γ=0.4).

(b) R_{out} if γ=0. Repeat if body effect is not neglected (γ=0.4).

(c) Poles at the input and output. C_{ox}=10fF/μm^2 and C_{ov}=1fF/μm

Assume R_S=100Ω and C_L=10pF. Consider C_{gs} and C_{gd} only and use Miller theory.