Home Work Assignment #1B

ELE 447

University of Rhode Island, Kingston, RI 02881-0805, U.S.A.

Physical Constants:

$q = 1.6x10^{-19}C$ $\epsilon_o = 8.85x10^{-14}F/cm$ $\epsilon_{Si_3N_4} = 7.5\epsilon_o$

$\epsilon_{ox} = 3.9\epsilon_o = 3.45x10^{-13}F/cm$ $\epsilon_{Si} = 11.7\epsilon_o = 1.04x10^{-12}F/cm$

---

1) Find the capacitance of the parallel plate capacitor shown in figure 1 using dielectrics of air, SiO_2, Si and Si_3N_4 for each of the geometries provided:

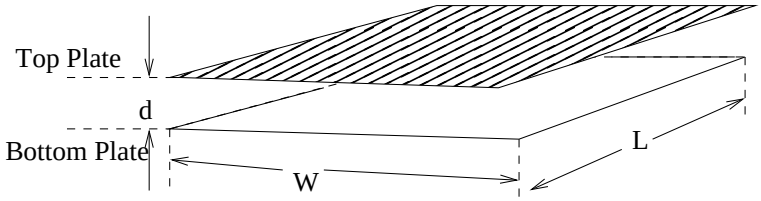

Figure 1. Circuit for Problem 1.

a) $d = 2mm$, $L = 40mm$ and $W = 30mm$

b) $d = 10^{-2}\mu m$, $L = 0.6mm$ and $W = 0.3mm$

c) $d = 20\mathring{A}$, $L = 3\mu m$ and $W = 8\mu m$

d) Find the capacitance of the parallel and series combination of a 850 fF, 30fF and a 130 fF capacitor.

2) Find the electric field between the top and bottom plates for the capacitor shown in figure 1 for distances given (assume that the voltage across the terminals is $5V$):

a) $d = 2mm$

[1] Tel: (401) 874-5482; fax: (401) 782-6422; e-mail: davis@ele.uri.edu

b) $d = 10^{-2}\mu m$

c) $d = 20\mathring{A}$

3) The definition of the rise is defined as time difference between the time V_o changes from 10% to 90% of the maximum output level. Conversely, the definition for the fall time is defined as the time difference between the time that V_o changes from 90% to 10% of the maximum output level.

a) Using a simple "pull-up" RC model, show that:
$t_{rise} = 2.2RC$.

b) Using a simple "pull down" RC model, show that:
$t_{fall} = 2.2RC$.

c) Suppose that V_{dd} changes from 5 Volts to 3.3 Volts. How do the expressions for rise time and fall time change ?

d) Suppose the rise time was re-defined to be the time difference between the time V_o changes from 0 Volts to 70% of the maximum level of 5 volts. Also assume that the fall time is again the converse (e.g. V_o from 70% to 0 Volts). How do the expressions for rise and fall time change ?

e) Repeat part (d) for a maximum level of 3.3 volts.