Assigment 2

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Question 1

Part a

As stated in the question, we are required to calculate C_{wire}, which can be expressed by the following equation:

$$C_{wire} = C_{pp} + C_{fringe} \tag{1}$$

Calculating parallel plate capacitance

Based on the lecture notes, this can be calculated in the following way:

$$C_{pp} = \frac{38 * 10^{-18}}{1 * 10^{-12}} * 250 * 10^{-6} * 0.4 * 10^{-6} = 3800 * 10^{-18} F = 3800aF \tag{2}$$

Calculating fringing capacitance

This can be found in the following way:

$$C_{fringe} = \frac{13 * 10^{-18}}{10^{-6}} * 250 * 10^{-6} = 3250 * 10^{-18} = 3250aF \tag{3}$$

Since fringe capacitance needs to include for both the side walls, the value needs to be doubled, that is:

$$C_{fringe} = 3250 * 2 = 6500aF \tag{4}$$

Calculating the capacitance of the wire

Based on (2) and (4), we can determine the capacitance of the wire in the following way:

$$C_{wire} = C_{pp} + C_{fringe} = 3800 + 6500 = 10300aF = 10.3fF \tag{5}$$

Part b

The goal is to calculate the R_{wire}, given that the sheet metal resistance (R_0) is $0.08\frac{\Omega}{sq}$. The width is given to to be 0.4μm, hence the goal is to fit as many squares of this size into the available length. This can be done in the following way:

$$R_{wire} = 0.08 * \frac{250 * 10^{-6}}{0.4 * 10^{-6}} = 50\Omega \tag{6}$$

Question 2

Part a

We are given that the current flowing through the wire is 4mA. Hence the IR drop can be given by:

$$IR_{drop} = 4 * 10^{-3} * 50 = 0.2V \tag{7}$$

Part b

We are given that the voltage source has an output impedance of 50Ω, and requried to calculate the propagation delay (t_p). Based off the lecture notes, we are aware the the t_p is a function of resistance when on R_{on} and the load capacitance C_L.

$$t_p = f(R_{on} \cdot C_L) = 0.69 * R_{on} * C_L \tag{8}$$

Since there is an impedance from the voltage source, R_{on} can be calculated to be:

$$R_{on} = R_{wire} + Z_{source} = 50 + 50 = 100\Omega \tag{9}$$

Based on (5) and (9) we can compute the t_p to be the following:

$$t_p = 100 * 10.3 * 10^{-15} = 7.107 * 10^{-13} = 71.07ps \tag{10}$$

Question 3