Santa Clara University

Department of Electrical and Computer Engineering

No. _____ DAREN LIU Submitted on: _____

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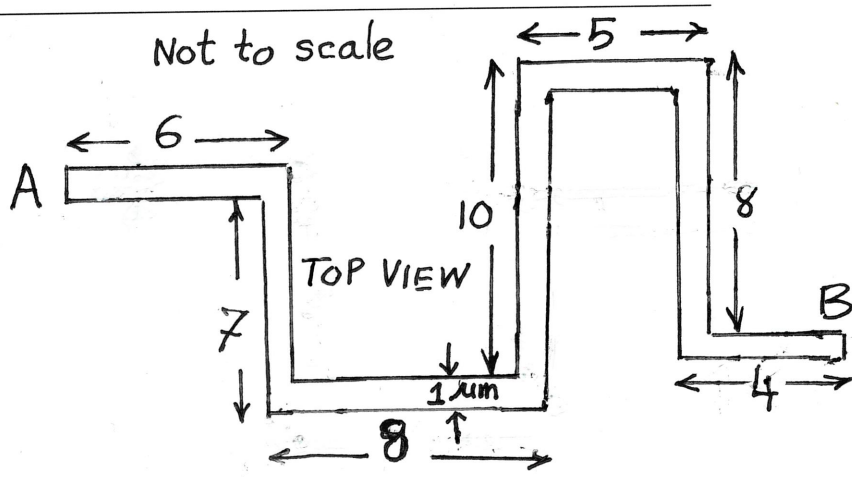
ELEN 153 **Problem Set #5** **Due: 11-05-2020, Thursday, 12:00 pm**
Fall 2020

1. Consider the interconnect pattern shown in Figure. The lengths indicated in the Figure are in μm. The line width is 1 μm and the line sheet resistance is 43.27 Ω /□. Find the resistance from A to B if each corner square contributes a factor of 0.672 of a 'straight-path' square.

(10)



2. An interconnect line is made from a material that has a resistivity of 7.25 μΩ-cm. The interconnect is 1580 Å thick with a width of 0.65 μm.
   a) Calculate the sheet resistance of the line.
   b) Find the line resistance for a 134 μm long Line.

(7)

3. An interconnect line can be made in either of a polysilicon thin film or a metal layer. If polysilicon thin film is selected, the sheet resistance of line is 35 Ω /□ with a width of 0.4 μm and a length of 26.74 μm. If a metal layer is selected instead, the sheet resistance is 0.095 Ω /□ with a width of 0.5 μm but requires a different routing length of 36.8 μm. Calculate the line resistance R_{line} for each case and determine the lower resistance alternate. What is the percentage increase in resistance if the larger resistance line is used?

(8)

4. An interconnect line runs over an insulating oxide layer that is 12,724 Å thick. The line has a width of 0.286 μm and is 62 μm long. The sheet resistance of the line is known to be 28 Ω /□.
   a) Find the line resistance R_{line}.
   b) Find the line capacitance C_{line}. Use oxide relative dielectric constant or permittivity to be 3.9. Express your answer in femtofarads (fF).
   c) Find the time constant τ for the line in units of picosecond (ps).

(15)

1) $43.27(5+5+6+8+3+6+3+(0.672 \cdot 6))$

$= 1732.18464$

2) a) $R_S = \frac{\rho}{t} = \frac{2.25 \cdot 10^{-6}}{1580 \cdot 10^{-10} \cdot 100} = 0.45886\ \Omega/\square$

b) $0.45886 \cdot (\frac{134}{0.65}) = 94.596$

3) $R_{line,p} = (35)(\frac{26.74}{0.4}) = 2339.75$

$R_{line,m} = (0.095)(\frac{36.8}{0.5}) = 6.992$

$\%\ inc = \left(\frac{2339.75 - 6.992}{6.992}\right) \cdot 100 = 33363\ \%$

4) a) $R_{line} = 28(\frac{62}{0.286}) = 6069.93\ \Omega/\square$

b) $C_{line} = \frac{\varepsilon_{ox}}{t_{ox}}(wl)$

$= \frac{3.9 \cdot 8.864 \cdot 10^{-14}}{12724 \cdot 10^{-10}(\frac{100}{1})}(62)(0.286)(\frac{1\ cm}{10000\ \mu m})^2$

$= 4.8176 \cdot 10^{-14}\ F = 0.4817\ fF$

c) $\tau = RC = (6069.93)(4.8176 \cdot 10^{-14}) = 2.924 \cdot 10^{-10}$