CG2027 Assignment 2

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1. a)

Area capacitance $= (19AF/\mu m^2) \times 200\mu m \times 0.2\mu m$

$= 760AF$

Fringe Capacitance $= (61AF/\mu m) \times 200\mu m \times 2$ → fringe capacitance contributed from both side of wire

$= 24.4fF$

C_{wire} = Area capacitance + Fringe capacitance

$= 760AF + 24.4fF$

$= \underline{25.16fF}$

Fringe capacitance dominates when width is small

b)

Wire resistance $= \dfrac{(0.04\,\Omega/sq) \times 200\mu m}{0.2\mu m}$

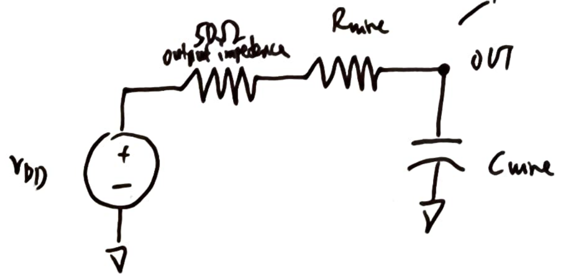
$= 40\Omega$

2. a) IR drop $= 4mA \times 40\Omega$

$= 0.16V$

b)

→ lumped model



$$\frac{V_{OUT}(t_{pHL})}{V_{DD}} = e^{-\frac{t_{pHL}}{RC}} = \frac{1}{2}$$

$t_{pHL} = 0.69RC$

$$\frac{V_{OUT}(t_{pLH})}{V_{DD}} = 1 - e^{-\frac{t_{pLH}}{RC}} = \frac{1}{2}$$

$t_{pLH} = 0.69RC$

$t_p = \dfrac{t_{pLH} + t_{pHL}}{2}$

$= 0.69RC$

$= 0.69 \times (50\Omega + 40\Omega) \times 25.16fF$

$= 1.562ps$

3. a) At steady state, capacitor acts as an open circuit

when $V_{in} = 0V$, NMOS is OFF

resistance of NMOS >> $90k\Omega$

$$V_{out} = \frac{R_{NMOS}}{R_{NMOS} + 90k\Omega} V_{DD} \approx V_{DD}$$

$$\approx \underline{1V}$$

when $V_{in} = 1V$, NMOS is ON

resistance of NMOS when ON = $10k\Omega$

$$V_{out} = \frac{10k\Omega}{10k\Omega + 90k\Omega} V_{DD} = \underline{0.1V}$$

b) At steady state, capacitor acts as an open circuit

when $V_{in} = 0V$, NMOS is OFF, PMOS is ON

resistance of NMOS >> resistance of PMOS

$$V_{out} = \frac{R_{NMOS}}{R_{NMOS} + R_{PMOS}} V_{DD} \approx V_{DD}$$

$$\approx \underline{1V}$$

when $V_{in} = 1V$, NMOS is ON, PMOS is OFF

resistance of NMOS << resistance of PMOS

$$V_{out} \approx \underline{0V}$$