Problem 1

Cascode amplifier, so gain is

$$A_v = -\left(\frac{g_{m1}}{g_{03}}\right) \cong -8000$$

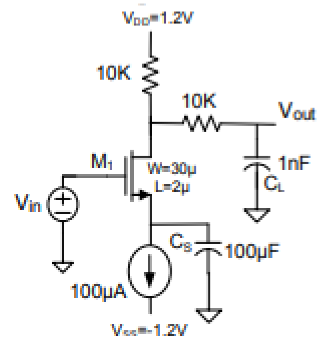
Problem 2

$$A_V = -\left(\frac{g_{m1}}{g_{01}}\right)\frac{\beta}{2} \cong -400{,}000$$

Problem3

$3 + A_v V_{in} = 3 + (1 * 10^{-6})(4 * 10^5) = 3.4V$

This means it would be very difficult to get the system to be biased correctly.



Problem 4

a) Due to the current source, $V_{DrainQ} = V_{DD} - (10000 * I_{source})$

$$V_{DrainQ} = 1.8 - (10000 * 0.0001) = 0.8V$$

b)

The standard equation is $-g_m R_D$, but would be more appropriate to use $-g_m Z_D$. So,

$$Z_D = \left(10k\Omega || \frac{Z_{C_L}}{10k\Omega + Z_{C_L}}\right)$$

$$Z_{C_L} = \frac{1}{sC}$$

$$\frac{Z_{C_L}}{10k\Omega + Z_{C_L}} = \frac{\left(\frac{1}{sC}\right)}{10k\Omega + \left(\frac{1}{sC}\right)} = \frac{1}{1 + s * 10k\Omega * 1nF}$$

$$Z_D = \left(10k\Omega || \frac{1}{1 + s * 10k\Omega * 1nF}\right) = \frac{1}{\frac{1}{10k\Omega} + s * 10k\Omega * 1nF}$$

$$Z_D = \frac{1}{\frac{1}{10k\Omega} + s * 10k\Omega * 1nF} = \frac{100000}{s + 10}$$

$$A_V = -g_m\left(\frac{100000}{s + 10}\right)$$

c)

$-3dB$ bandwidth would be at 10 Hz

Problem 5

The area of the resistor is $2\mu * 30\mu = 60\mu^2$ at $8566\ aF/\mu m^2$ is $513.96fF$.
This can be seen as in series with the $10k\Omega$ resistor, on the other side of V_{out}, creating a basic RC filter with

$$-3dB = \frac{1}{2\pi RC} = \frac{1}{2\pi(10k)(1.026p)} = 3.09\text{M Hz}$$

Problem 6

High

A	B	Out
1	1	1
1	0	1
0	1	1
0	0	1

OR

A	B	Out
1	1	1
1	0	1
0	1	1
0	0	0

A|~B

A	B	Out
1	1	1
1	0	1
0	1	0
0	0	1

A

A	B	Out
1	1	1
1	0	1
0	1	0
0	0	0

~A|B

A	B	Out
1	1	1
1	0	0
0	1	1
0	0	1

B

A	B	Out
1	1	1
1	0	0
0	1	1
0	0	0

(AB)|(~A~B)

A	B	Out
1	1	1
1	0	0
0	1	0
0	0	1

AND

A	B	Out
1	1	1
1	0	0
0	1	0
0	0	0

NAND

A	B	Out
1	1	0
1	0	1
0	1	1
0	0	1

XOR

A	B	Out
1	1	0
1	0	1
0	1	1
0	0	0

~B

A	B	Out
1	1	0
1	0	1
0	1	0
0	0	1

A~B

A	B	Out
1	1	0
1	0	1
0	1	0
0	0	0

~A

A	B	Out
1	1	0
1	0	0
0	1	1
0	0	1

~AB

A	B	Out
1	1	0
1	0	0
0	1	1
0	0	0

NOR

A	B	Out
1	1	0
1	0	0
0	1	0
0	0	1

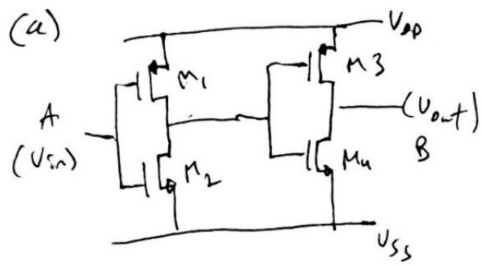
Low

A	B	Out
1	1	0
1	0	0
0	1	0
0	0	0

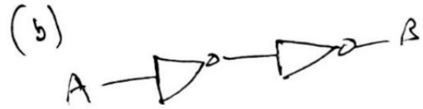
The named ones are the most commonly used

Problem 7

(a)



(b)



Problem 8

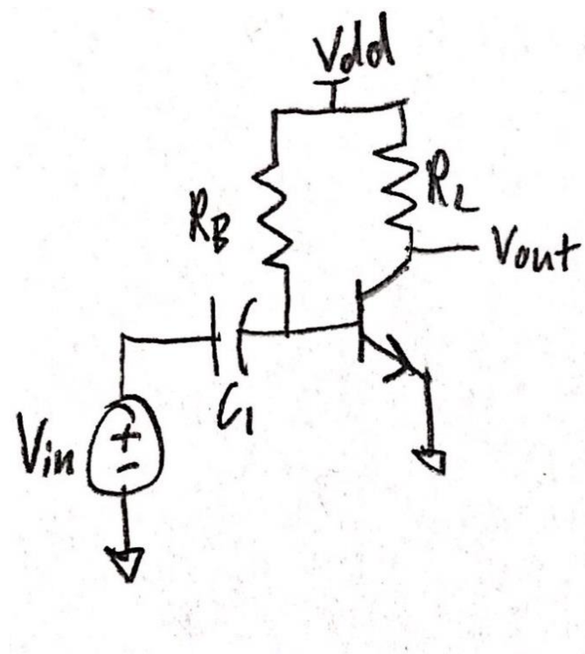
$Assume\ C_1\ is\ large, and\ set\ VDD = 10V$

$$I_C = \frac{V_{DD} - V_{outQ}}{R_L} = \beta_n I_B = 100 * \frac{V_{DD} - 0.6V}{R_B}$$

$$\frac{10V - 5V}{2k\Omega} = 100 * \frac{10V - 0.6V}{R_B}$$

$$R_B = 940\ k\Omega$$

Image of design is on the right.

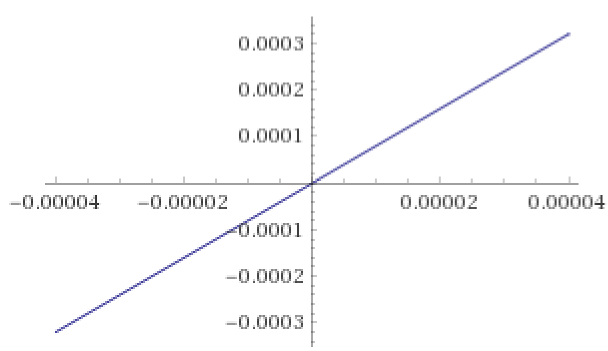


Problem 9

a)

$$I_{out} = \frac{A_{E1}}{A_{E0}}(I_{in} + I_{BS}) - I_{BO} = 8I_{BS} + 320 - 320 = 8\mathrm{I_{in}}$$

b) I used WolframAlpha

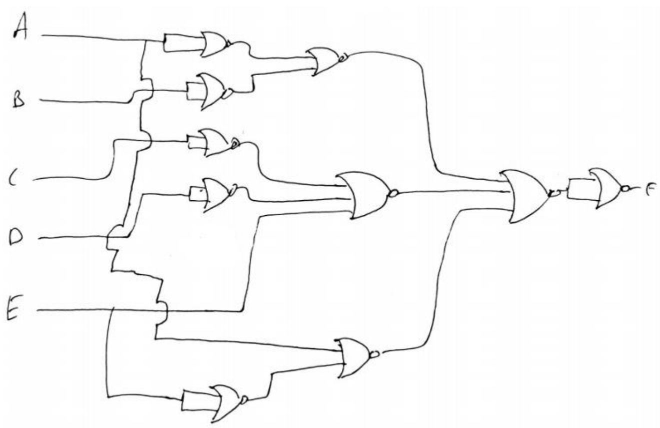


Problem 10

a.) $F = AB + CD\bar{E} + \bar{A}E$

b.) Assign F = (A & B) | (C & D & ~E) | (~A & E)

c.) $F = \overline{\overline{\overline{\bar{A}\bar{B}} + \overline{\bar{C} + \bar{D} + E} + \overline{A + \bar{E}}}}$



e.) Just replace all NOR gates in above schematic with transistor level NOR gate

Problem 11

$F = AB + \bar{C}\bar{B}$