HW #13

Problem 1)

$$A_V = \frac{-g_{m1}}{g_{o1}} = \frac{-I_{cq}/V_{to}}{+I_{cq}/V_{AF}} = -\frac{V_{AF}}{V_t} = -2846$$

Problem 2)

$$A_V = \frac{-g_{m1}}{g_{o1}} \cdot \frac{\beta}{2} = \frac{-V_{AF}}{V_t} \cdot \frac{\beta_n}{2} = -192,307.7$$

Problem 3) $V_{out} = A_V \cdot V_{in} = -192307.7 \times 1\mu V = -192.3_n V = -0.19V$

Problem 4)

$$V_{TRIP} = \frac{(V_{Tn}) + (V_{DD} + V_{TP})\sqrt{\frac{\mu_p}{\mu_n}\frac{W_2}{W_1}\frac{L_1}{L_2}}}{1 + \sqrt{\frac{\mu_p}{\mu_n}\frac{W_2}{W_1}\frac{L_1}{L_2}}}$$

$V_{TRIP} \approx 1.4150V$

Problem 5) $V_{Tn} = 0.4V \quad V_{TP} = -0.6V$

NEW $V_{TRIP} = 1.31506V$

NEW V_{TRIP} DECREASED FROM PROBLEM 4 V_{TRIP} BY 8%

Problem 6)

TRUTH TABLE

A	B	Y
0	0	0
0	1	0
1	0	0
1	1	0

$Y = 0$

A	B	Y
0	0	0
0	1	0
1	0	0
1	1	1

$Y = A \cdot B$

A	B	Y
0	0	0
0	1	0
1	0	1
1	1	1

$Y = A$

A	B	Y
0	0	0
0	1	1
1	0	0
1	1	1

$Y = B$

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	1

$Y = \overline{A \oplus B}$ XNOR

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

$Y = A + B$ AND

A	B	Y
0	0	1
0	1	0
1	0	1
1	1	1

$Y = A + \overline{B}$

A	B	Y
0	0	1
0	1	1
1	0	0
1	1	1

$Y = A + \overline{B}$

A	B	Y
0	0	1
0	1	1
1	0	0
1	1	0

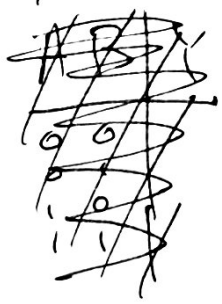
$Y = \overline{A}$ NOT

A	B	Y
0	0	1
0	1	1
1	0	1
1	1	1

$Y = 1$

A	B	Y
0	0	0
0	1	0
1	0	0
1	1	1

$Y = AB$



A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

$Y = \overline{A + B}$ NOR

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

$Y = A \oplus B$

NOR

A	B	Y
0	0	1
0	1	0
1	0	1
1	1	0

$Y = \overline{B}$

NOT

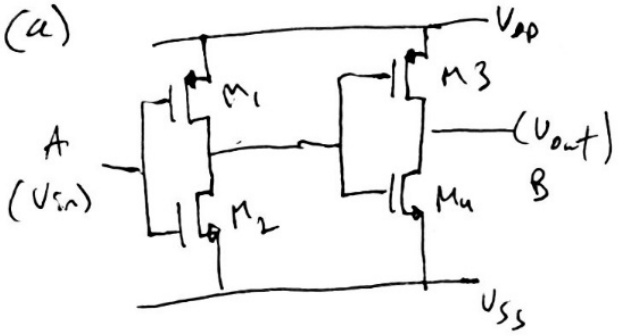
A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

$Y = \overline{A \cdot B}$

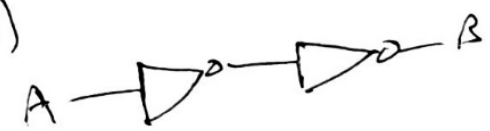
NAND

Problem 7)

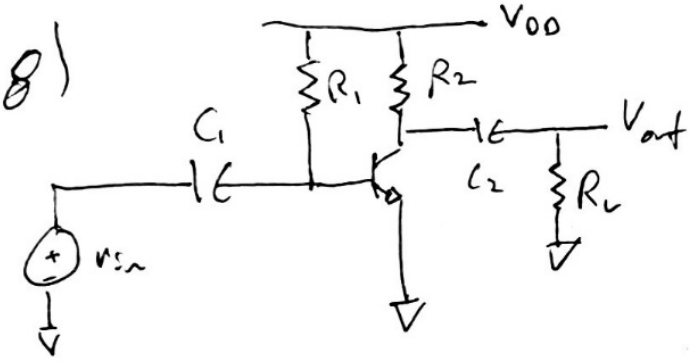
(a)



(b)



Problem 8)



$C_1 = C_2 = 10\mu F$ ← Large

$$I_C = \frac{V_{DD} - V_{out,Q}}{R_2} = \beta_n I_B = \left(\frac{V_{DD} - 0.6V}{R_1}\right)\beta_n$$

$\beta_n = 100$; $\frac{V_{DD} - 5V}{R_2} = 100\left(\frac{V_{DD} - 0.6V}{R_1}\right) = \frac{V_{DD} - 0.6V}{(R_1/100)}$

$R_1 = 100K\Omega$

$$R_2 = \left[\frac{V_{DD} - 0.6V}{(100K\Omega/100)}\right]^{-1}(V_{DD} - 5V) = \left(\frac{V_{DD} - 5V}{V_{DD} - 0.6V}\right) \cdot 1K\Omega$$

$V_{DD} = 10V \Rightarrow R_2 = \frac{5}{9.4} \times 1K\Omega = 0.53K\Omega = 532\Omega$

Problem 9)

(a) $\dfrac{(I_{out} + I_{BO})}{(I_{in} + I_{BS})} = \dfrac{A_{EO}}{A_{EO}} = 5$

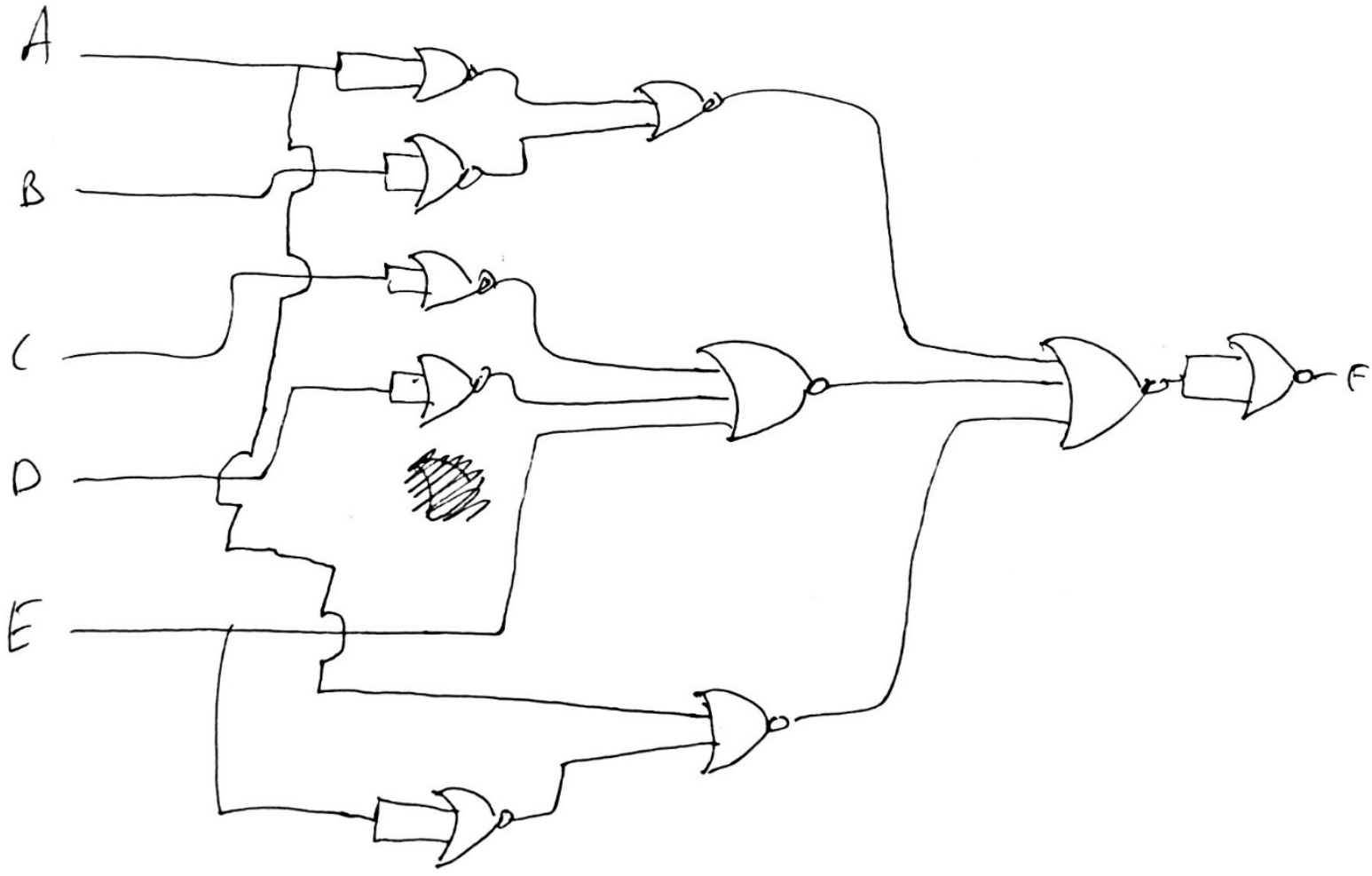
$$I_{out} + I_{BO} = 5 I_{in} + 5 I_{BS}$$

$$I_{out} = 5 I_{in} + (5 I_{BS} - I_{BO}) = 5 I_{in} + 0 = 5 I_{in}$$

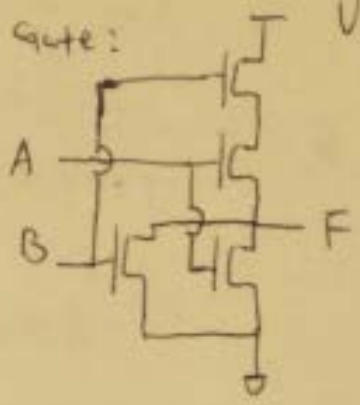
Problem 10)

(a) $F = A \cdot B + C D \bar{E} + \bar{A} E$

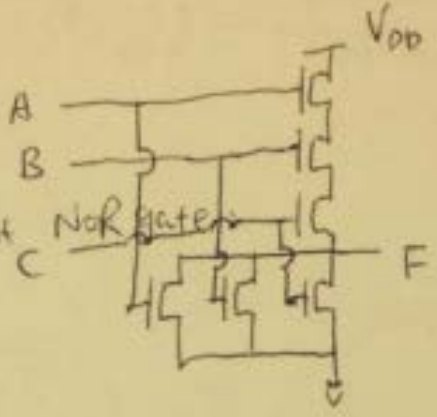
(c) $F = \overline{\overline{\bar{A} + \bar{B}} + \bar{C} + \bar{D} + E + \overline{A + \bar{E}}}$



(e.) For Nor gate, two input NOR gate:



three input NOR gate:



Replace the NOR gate with the above transistor level circuit, we can get a transistor level circuit for whole circuit.

And we also can use other gates to design the circuit.

11)

$$F = AB + \overline{C}\,\overline{B}$$