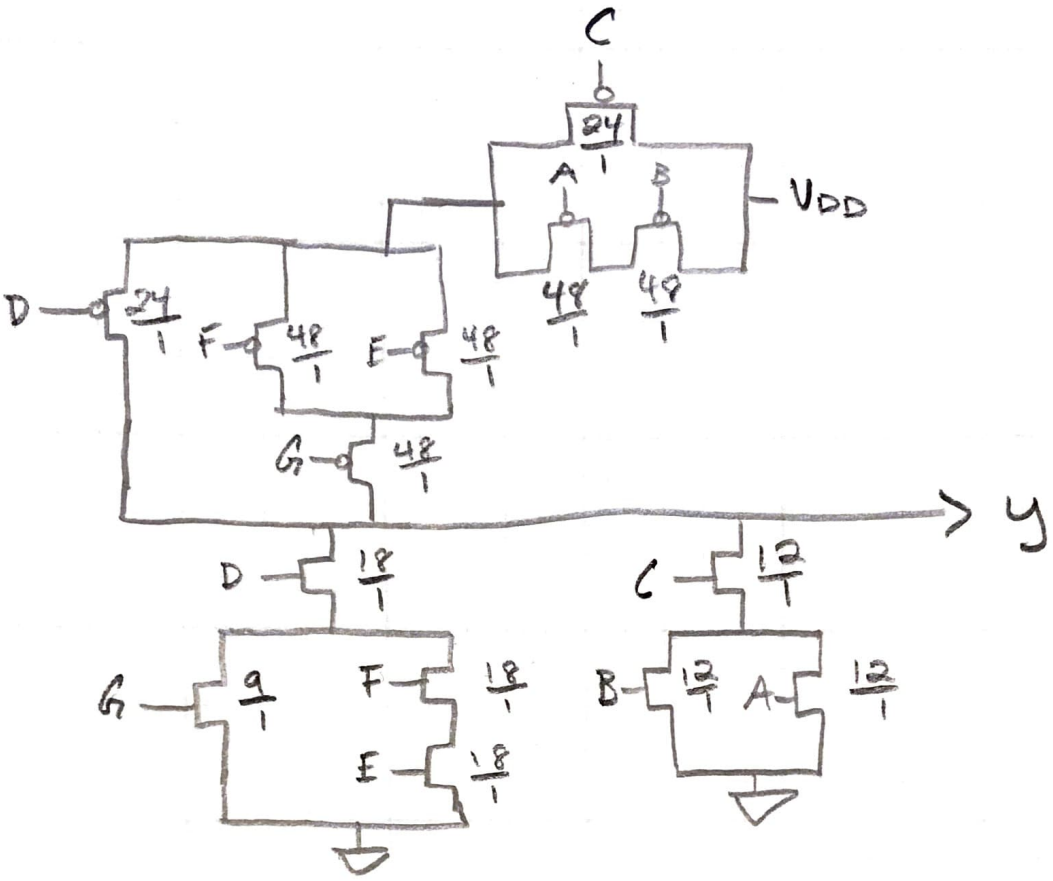
1.) $y = \overline{(G+FE)D + C(B+A)}$ $\quad \frac{W}{L}n = \frac{3}{1}$ $\quad \frac{W}{L}p = \frac{6}{1}$



2.) NMOS: $F \& E = \frac{18}{1} + \frac{18}{1} = \frac{9}{1}$, $F/E \& G = \frac{9}{1} + \frac{9}{1} = \frac{18}{1}$

$[D \& (F/E \& G)] = \frac{18}{1} + \frac{18}{1} = \frac{9}{1}$

$B \& A = \frac{12}{1} + \frac{12}{1} = \frac{24}{1}$

$(B \& A) \& C = \frac{24}{1} + \frac{12}{1} = \frac{8}{1}$

$[D \& (F/E \& G)] \& [(B \& A) \& C]$

$= \frac{9}{1} + \frac{8}{1} = \boxed{\frac{17}{1}}$

PMOS: $F \& E = \frac{48}{1} + \frac{48}{1} = \frac{96}{1}$ $\quad (F \& E) \& G = \frac{96}{1} + \frac{48}{1} = \frac{96}{3} = \frac{32}{1}$

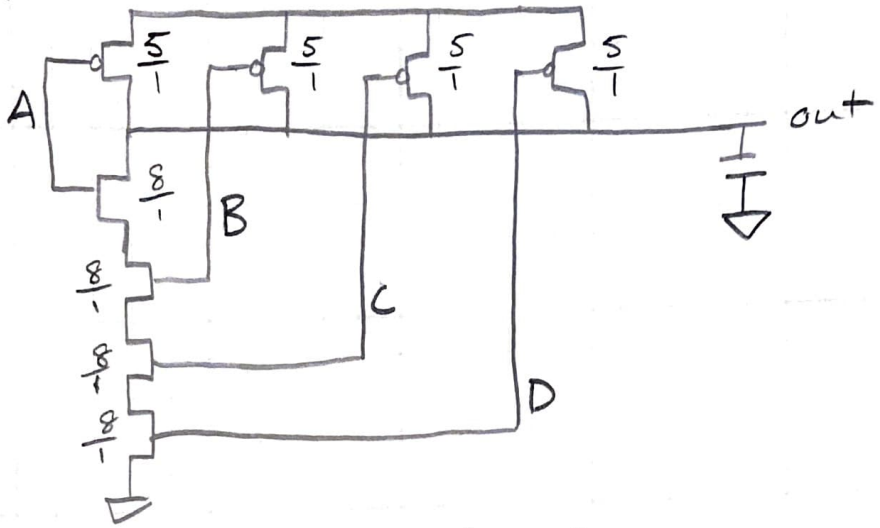
$D \& [(F \& E) \& G] = \frac{32}{1} + \frac{24}{1} = \frac{56}{1}$

$A \& B = \frac{48}{1} + \frac{48}{1} = \frac{24}{1}$

$(A \& B) \& C = \frac{24}{1} + \frac{24}{1} = \frac{48}{1}$

$[(A \& B) \& C] \& [D \& [(F \& E) \& G]] = \frac{48}{1} + \frac{56}{1} = \boxed{\frac{25.846}{1}}$

7.73 a.)



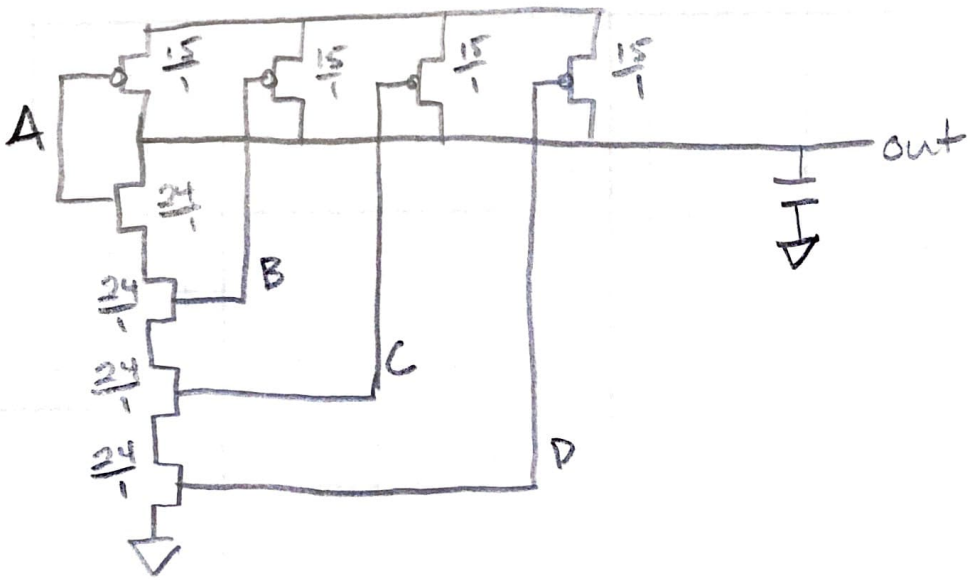
$\frac{W}{L}nmos = 4\left(\frac{W}{L}\right)_{ref} = 4\left(\frac{2}{1}\right) = \frac{8}{1}nmos$

$\frac{W}{L}pmos = \frac{5}{1}pmos$

b.) $\tau_{pHL} = \tau_{pLH} \rightarrow \frac{0.63}{KP\left(\frac{5}{1}\right)} = \frac{0.63}{KP\left(\frac{W}{L}\right)_{nmos}}$

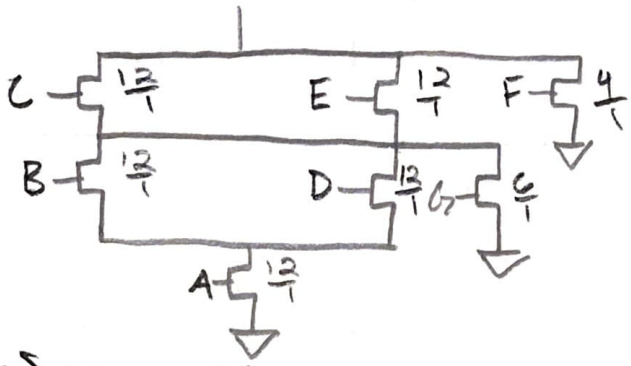
$\tau_{pHL} = \frac{0.63}{KP\left(\frac{W}{L}\right)_{nmos}}$ $\quad \frac{W}{L}nmos = 3\left(\frac{8}{1}\right) = \frac{24}{1}$

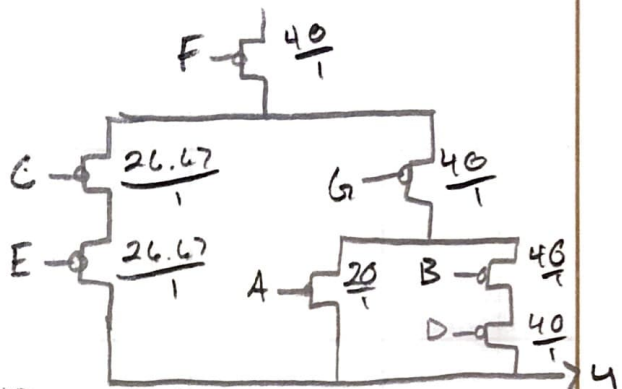
$\tau_{pLH} = \frac{0.63}{KP\left(\frac{5}{1}\right)}$ $\quad \frac{W}{L}pmos = 3\left(\frac{5}{1}\right) = \frac{15}{1}$



7.85 a.) $y = \overline{[A(B+D)+G](C+E)+F}$

b.) $N_{mos} = 2(\frac{3}{1}) = \frac{4}{1}$ $\quad pmos = 2(\frac{5}{1}) = \frac{10}{1}$





C.) $B+D = \frac{24}{1}$ $\quad (B+D)+A = \frac{24}{1} + \frac{12}{1} = \frac{8}{1}$ $\quad [(B+D)+A]+G = \frac{14}{1}$

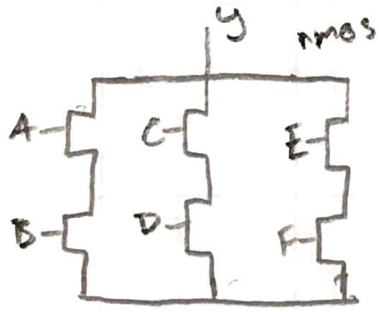
nmos $C+E = \frac{12}{1} + \frac{12}{1} = \frac{24}{1}$ $\quad (C+E) + \frac{14}{1} = \frac{8.84}{1}$ $\quad \frac{8.84}{1} + F = \boxed{\frac{12.8}{1}}$

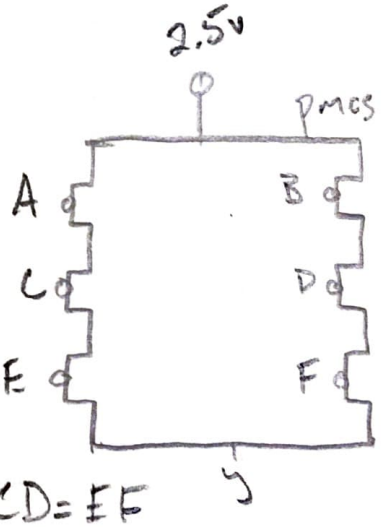
pmos $C+E = \frac{13.4}{1}$ $\quad B+D = \frac{20}{1}$ $\quad A+B/D = \frac{20}{1} + \frac{20}{1} = \frac{40}{1}$

$C/E+G/A/B/D = \frac{13.4}{1} + \frac{20}{1} = \frac{33.4}{1} + \frac{40}{1} = \boxed{\frac{18.2}{1}}$

7.86 a.) $y = \overline{EF+CD+AB}$

b.)





cd.) Nmos: $AB \rightarrow \frac{4}{1} + \frac{4}{1} = \frac{2}{1} = CD = EF$

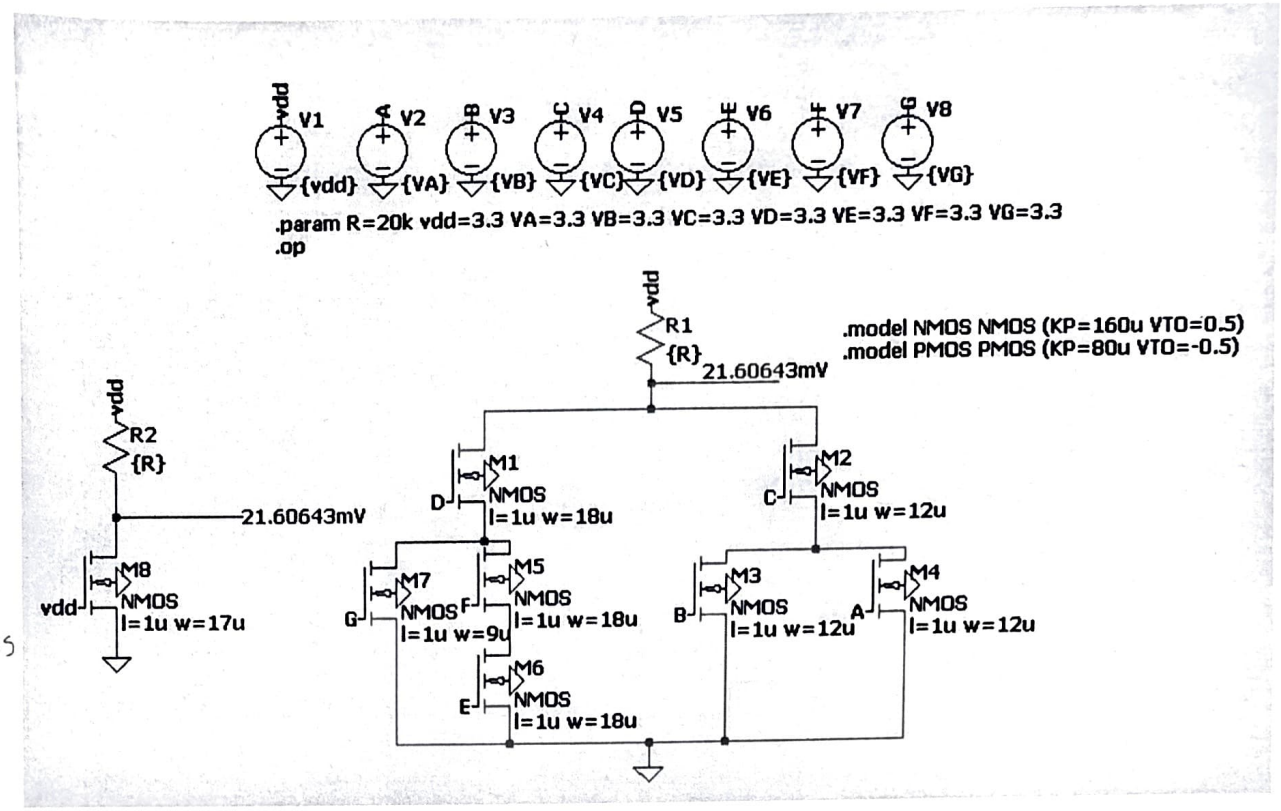
$ABCDEF = \frac{2}{1} + \frac{2}{1} + \frac{2}{1} = \boxed{(\frac{6}{1})_{nmos}}$

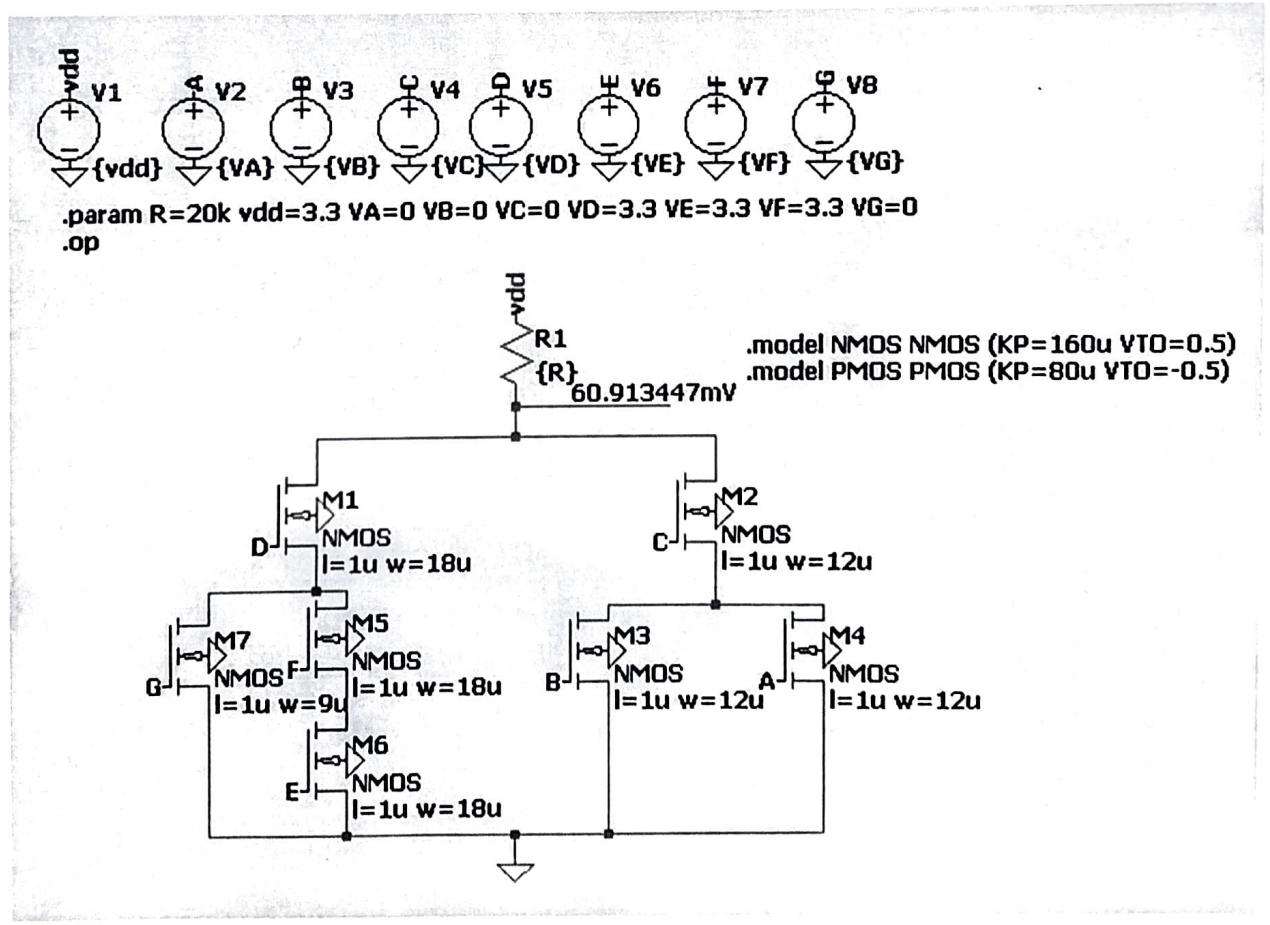
pmos: $ABC + DEF = \frac{15}{1} + \frac{15}{1} + \frac{15}{1} = \frac{5}{1}$

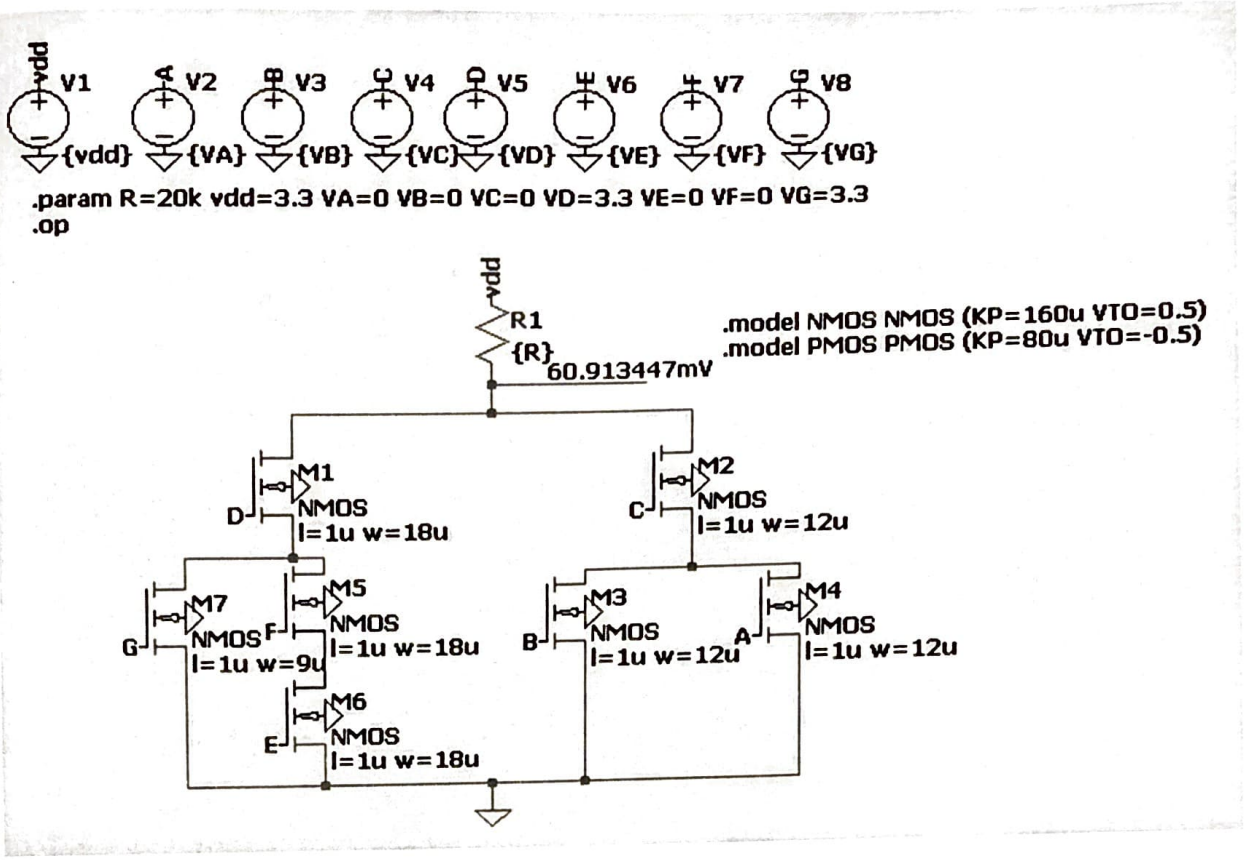
$ABCDEF = \frac{5}{1} + \frac{5}{1} = \boxed{(\frac{10}{1})_{pmos}}$

① Best Case

② The rest are input combinations



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V3
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V5
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V7
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{VF}
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R1
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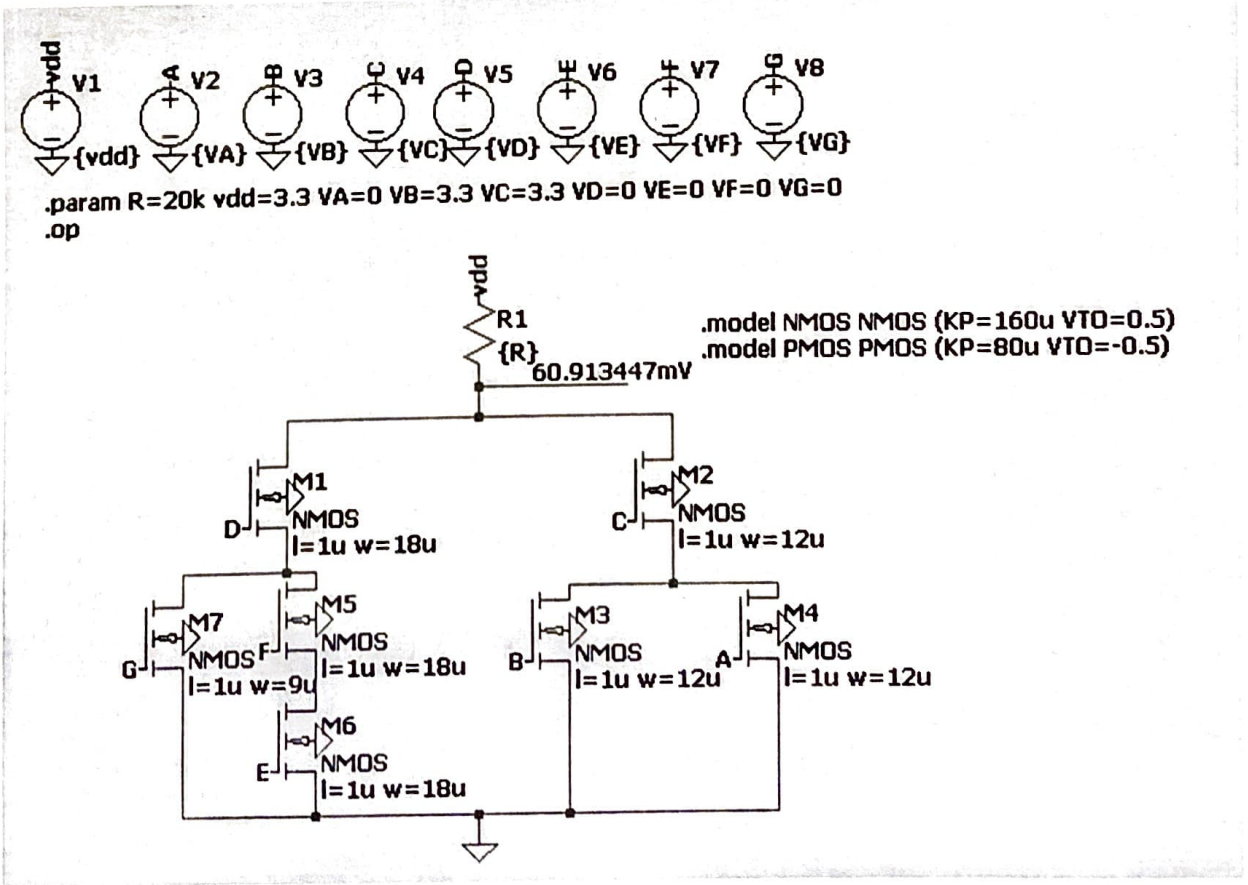
.model PMOS PMOS (KP=80u VTO=-0.5)
M1
NMOS
l=1u w=18u
M2
NMOS
l=1u w=12u
M3
NMOS
l=1u w=12u
M4
NMOS
l=1u w=12u
M5
NMOS
l=1u w=18u
M6
NMOS
l=1u w=18u
M7
NMOS
l=1u w=9u
D
C
B
A
F
E
G


V1
V2
V3
V4
V5
V6
V7
V8
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{VA}
{VB}
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{VF}
{VG}
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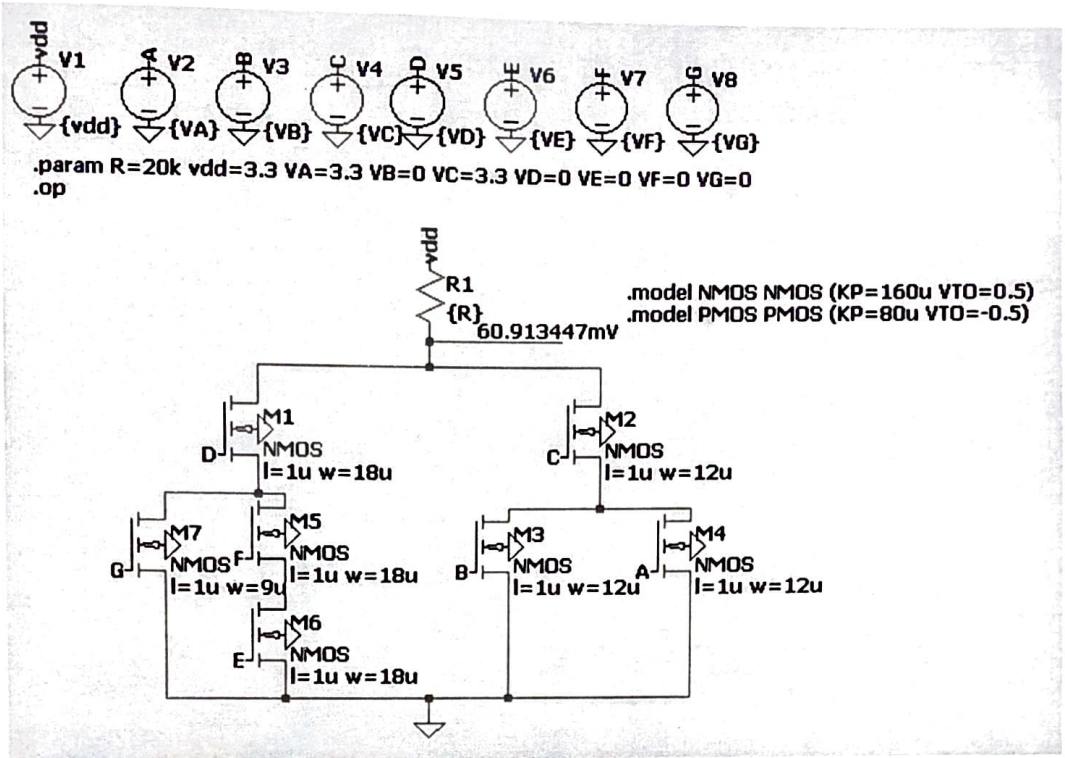
.op
R1
{R}
60.913447mV
.model NMOS NMOS (KP=160u VTO=0.5)
.model PMOS PMOS (KP=80u VTO=-0.5)
M1
NMOS
l=1u w=18u
M2
NMOS
l=1u w=12u
M3
NMOS
l=1u w=12u
M4
NMOS
l=1u w=12u
M5
NMOS
l=1u w=18u
M6
NMOS
l=1u w=18u
M7
NMOS
l=1u w=9u
D
C
B
A
F
E
G


V1
V2
V3
V4
V5
V6
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V8
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{VD}
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{VF}
{VG}
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vdd
R1
{R}
60.913447mV
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.model PMOS PMOS (KP=80u VTO=-0.5)
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D
M2
NMOS
l=1u w=12u
C
M7
NMOS
l=1u w=9u
G
M5
NMOS
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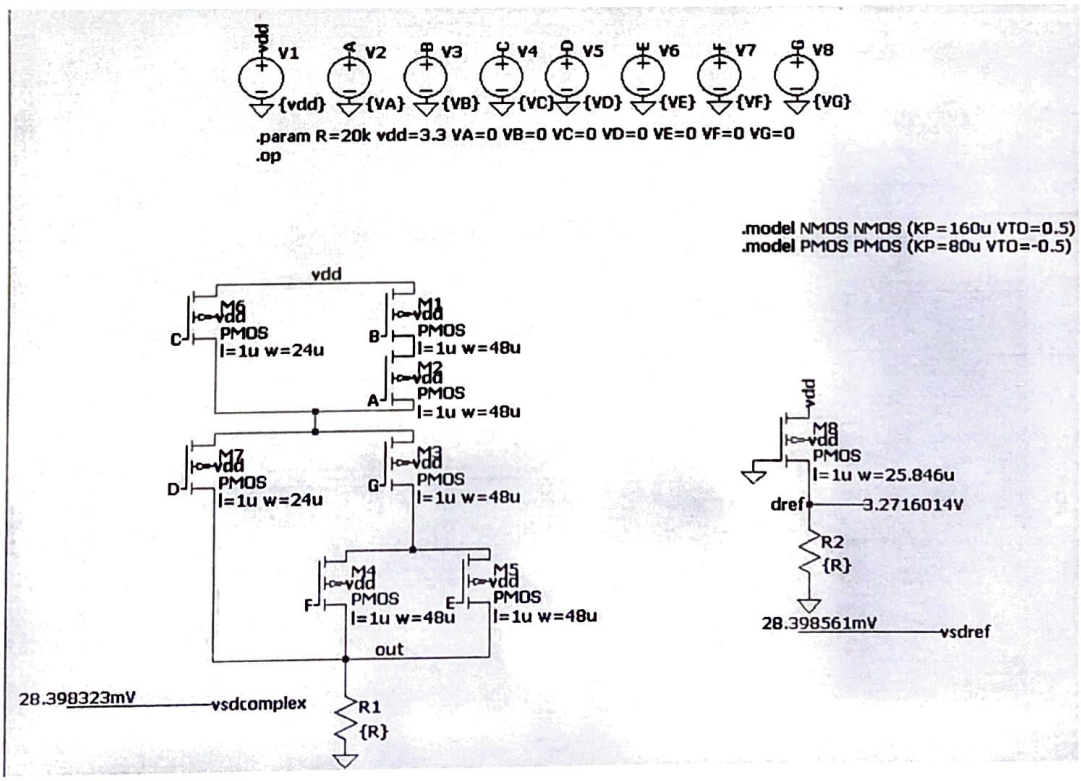
F
M6
NMOS
l=1u w=18u
E
M3
NMOS
l=1u w=12u
B
M4
NMOS
l=1u w=12u
A


V1
V2
V3
V4
V5
V6
V7
V8
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.model PMOS PMOS (KP=80u VTO=-0.5)
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M6
PMOS
l=1u w=24u
C
M1
PMOS
l=1u w=48u
B
M2
PMOS
l=1u w=48u
A
M7
PMOS
l=1u w=24u
D
M3
PMOS
l=1u w=48u
G
M4
PMOS
l=1u w=48u
F
M5
PMOS
l=1u w=48u
E
out
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PMOS
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3.2716014V
R2
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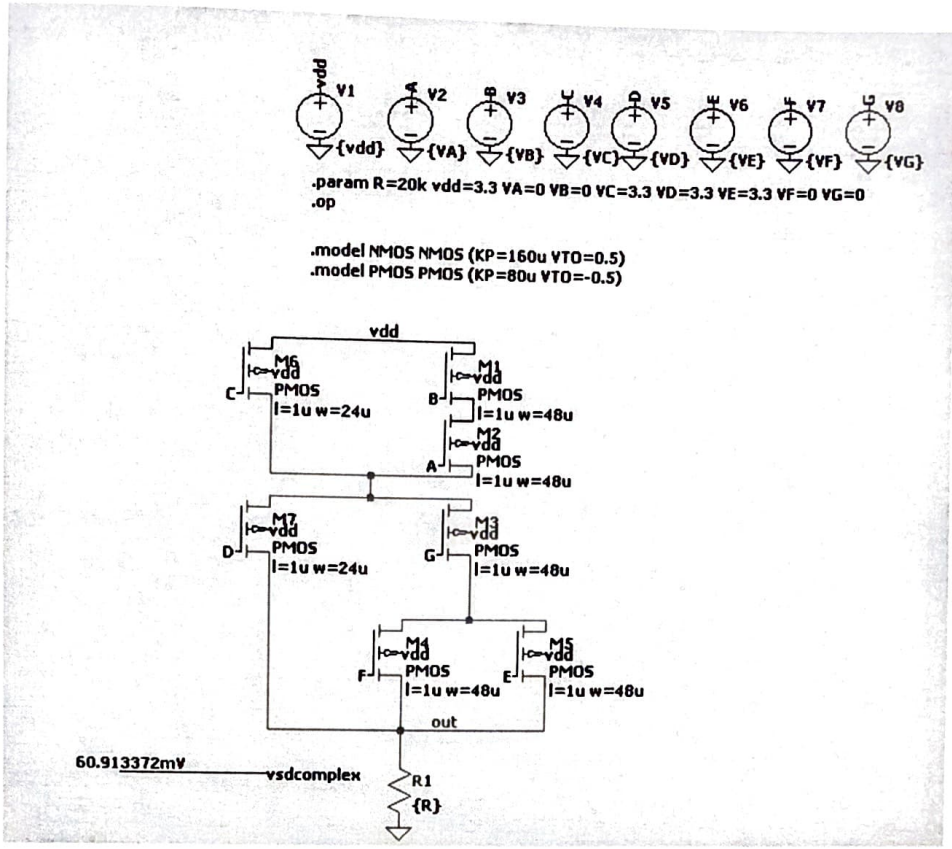
vsdref


V1
V2
V3
V4
V5
V6
V7
V8
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.model PMOS PMOS (KP=80u VTO=-0.5)
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vdd
PMOS
l=1u w=24u
C
M1
vdd
PMOS
l=1u w=48u
B
M2
vdd
PMOS
l=1u w=48u
A
M7
vdd
PMOS
l=1u w=24u
D
M3
vdd
PMOS
l=1u w=48u
G
M4
vdd
PMOS
l=1u w=48u
F
M5
vdd
PMOS
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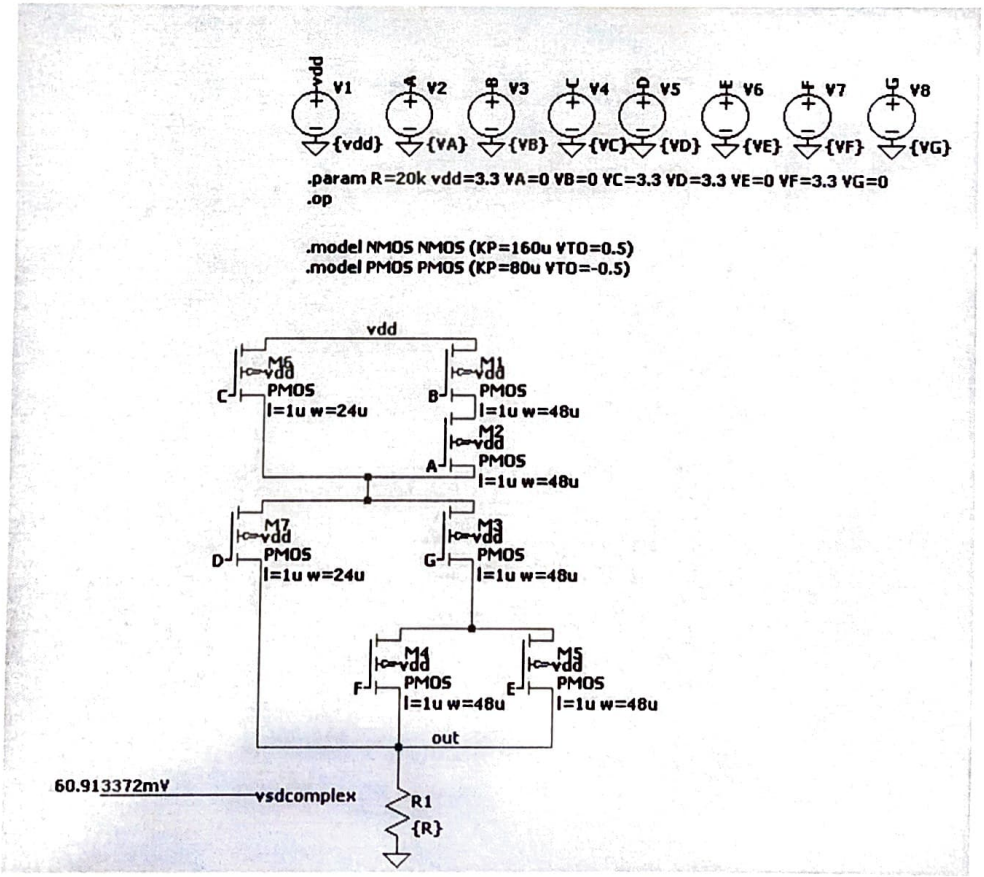
E
out
60.913372mV
vsdcomplex
R1
{R}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{VD}
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PMOS
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C
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vdd
PMOS
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B
M2
vdd
PMOS
l=1u w=48u
A
M7
vdd
PMOS
l=1u w=24u
D
M3
vdd
PMOS
l=1u w=48u
G
M4
vdd
PMOS
l=1u w=48u
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PMOS
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E
out
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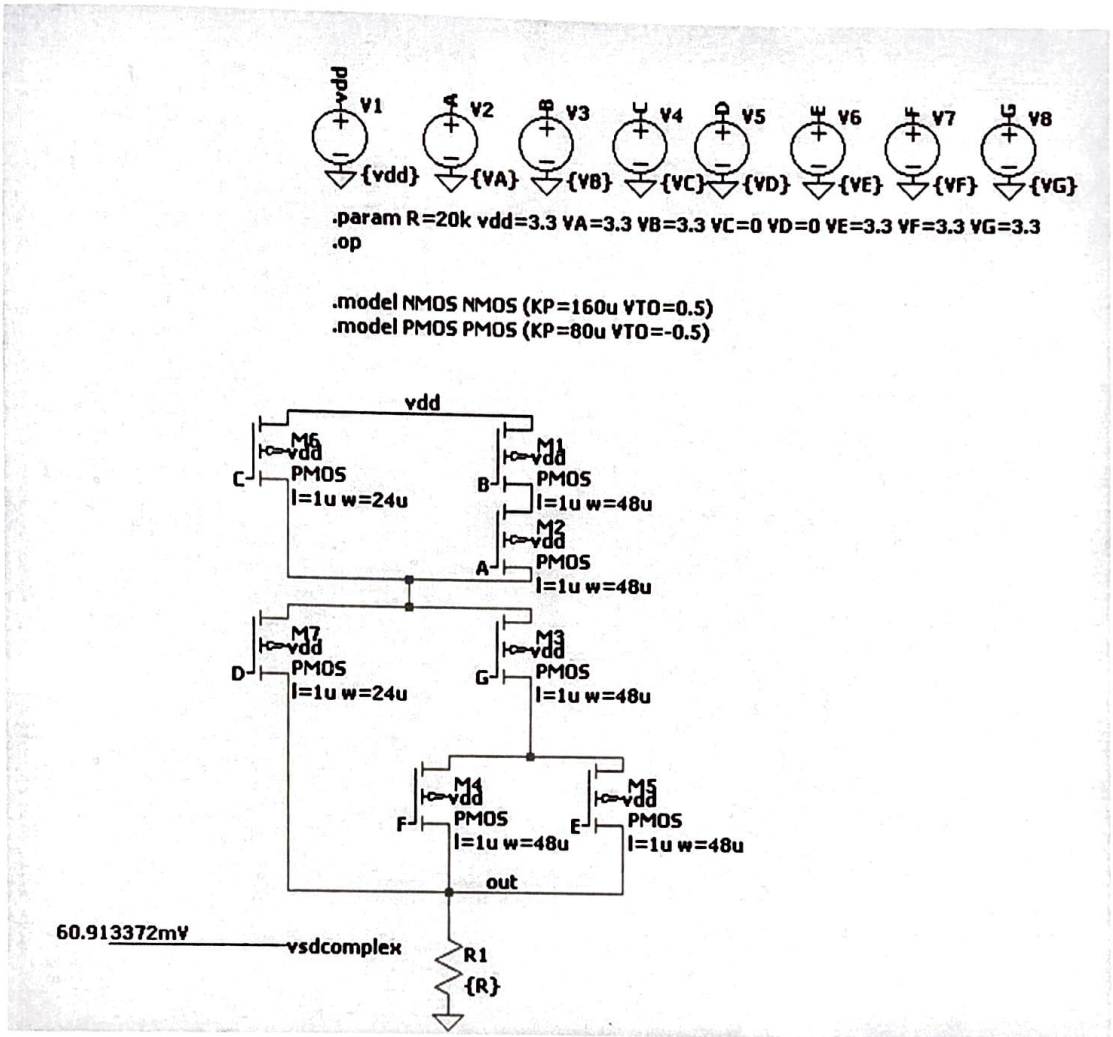
vsdcomplex
R1
{R}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vdd
E
PMOS
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out
60.913372mV
vsdcomplex
R1
{R}