# McKelvey School of Engineering

## Spring Semester 2023

## CSE463M-563M: Digital Integrated Circuit Design and Architecture

## Homework #4

1)  **2-input CMOS NOR gate design problem (including layout)**

   Design a two input CMOS NOR gate with the following specifications:
   - logic threshold of $V_{TH}$ = 2.5V when all inputs are connected to $V_{TH}$
   - minimum rise time of $\tau_{rise}$ < 2ns for load capacitance of 100fF.

   Present the following for your homework:
   a) Show all hand calculations used to get the appropriate size of all transistors.
   b) Draw the schematic of the two input NOR gate and create a symbol.
   c)  Simulate the NOR gate. Plot the DC characteristics when all inputs are connected together. Plot the transient characteristics for all transitions of the inputs and verify that the specifications were met.
   d)  Draw the layout of the NOR gate. Measure the size of the layout and use the ruler in layout to show the dimensions.
   e)  Run a DRC, extract the layout and LVS the design. Cut and Paste the messages generated in the CIW (the main Cadence window) when the DRC is executed. Print the LVS result – make sure it has successfully passed LVS.

2)  **2-input CMOS NAND gate design problem (including layout)**

   Design a two input CMOS NAND gate with the following specifications:
   - logic threshold of $V_{TH}$ = 2.5V when all inputs are connected to $V_{TH}$
   - minimum fall time of $\tau_{fall}$ < 2ns for load capacitance of 100fF.

   Repeat the same steps as in Problem 1 and print all results as requested in Problem 1.

## 1.1)  NOR

a)

$$V_{th}(NR2) = \frac{V_{DD}}{2} => K_p = 4K_n$$

$$V_{DD} = 5\,V, V_{th}(NR2) = 2.5\,V,$$

$$\boxed{\frac{W_p}{L_p} = 4\frac{W_n}{L_n}}$$

+ I'm going to set PMOS L=600n and NMOS L=600n. And I would get the result like below.

$$\boxed{\begin{array}{l} W_P = 3.6u,\ L_P = 600n \\ W_L = 900n,\ L_L = 600n \end{array}}$$

+ To get the result of t_fall and t_rise, I applied equations below.

$$\tau_{fall} = \frac{C_{load}}{2 \cdot k_n(V_{DD} - V_{T0n})}\left[\frac{2(V_{T0n} - 0.1V_{DD})}{V_{DD} - V_{T0n}} + \ln\left(\frac{2(V_{DD} - V_{T0n})}{0.1V_{DD}} - 1\right)\right]$$

$$\tau_{fall} = \frac{C_{load}}{2 \cdot \mu_n C_{ox}\frac{W_n}{L_n}(V_{DD} - V_{T0n})}\left[\frac{2(V_{T0n} - 0.1V_{DD})}{V_{DD} - V_{T0n}} + \ln\left(\frac{2(V_{DD} - V_{T0n})}{0.1V_{DD}} - 1\right)\right]$$

$$2 \cdot 10^{-9} > \frac{100 \cdot 10^{-15}}{2 \cdot 120 \cdot 10^{-6} \cdot \frac{W_n}{L_n} \cdot (5 - 0.8)}\left[\frac{2(0.8 - 0.1 \cdot 5)}{5 - 0.8} + \ln\left(\frac{2(5 - 0.8)}{0.1 \cdot 5} - 1\right)\right]$$

$$\frac{W_n}{L_n} > \frac{100}{4 \cdot 120 \cdot (5 - 0.8)}\left[\frac{2(0.8 - 0.1 \cdot 5)}{5 - 0.8} + \ln\left(\frac{2(5 - 0.8)}{0.1 \cdot 5} - 1\right)\right]$$

$$\boxed{\frac{W_n}{L_n} > 0.1439}$$

$$\tau_{rise} = \frac{C_{load}}{\frac{1}{2}k_p(V_{DD} - |V_{T0p}|)}\left[\frac{2(|V_{T0p}| - 0.1V_{DD})}{V_{DD} - |V_{T0p}|} + \ln\left(\frac{2(V_{DD} - |V_{T0p}|)}{0.1V_{DD}} - 1\right)\right]$$

$$\tau_{rise} = \frac{C_{load}}{\frac{1}{2}\cdot\mu_p C_{ox}\frac{W_p}{L_p}(V_{DD} - |V_{T0p}|)}\left[\frac{2(|V_{T0p}| - 0.1V_{DD})}{V_{DD} - |V_{T0p}|} + \ln\left(\frac{2(V_{DD} - |V_{T0p}|)}{0.1V_{DD}} - 1\right)\right]$$

$$2\cdot10^{-9} > \frac{100\cdot10^{-15}}{\frac{1}{2}\cdot40\cdot10^{-6}\cdot\frac{W_p}{L_p}\cdot(5 - 0.8)}\left[\frac{2(0.8 - 0.1\cdot5)}{5 - 0.8} + \ln\left(\frac{2(5 - 0.8)}{0.1\cdot5} - 1\right)\right]$$

$$\frac{W_p}{L_p} > \frac{100}{40\cdot(5 - 0.8)}\left[\frac{2(0.8 - 0.1\cdot5)}{5 - 0.8} + \ln\left(\frac{2(5 - 0.8)}{0.1\cdot5} - 1\right)\right]$$

$$\boxed{\frac{W_p}{L_p} > 1.7279}$$

+ To get the result of t_PHL and t_PLH, I applied equations below.

$$\tau_{PHL} = \frac{C_{load}}{2\cdot\mu_n C_{ox}(V_{DD} - V_{T0n})}\left(\frac{L_n}{W_n}\right)\left[\frac{2V_{T0n}}{V_{DD} - V_{T0n}} + \ln\left(\frac{4(V_{DD} - V_{T0n})}{V_{DD}} - 1\right)\right]$$

$$\tau_{PHL} = \frac{100\cdot10^{-15}}{2\cdot120\cdot10^{-6}\cdot(5 - 0.8)}\cdot\frac{600}{900}\cdot\left[\frac{2\cdot0.8}{5 - 0.8} + \ln\left(\frac{4(5 - 0.8)}{5} - 1\right)\right]$$
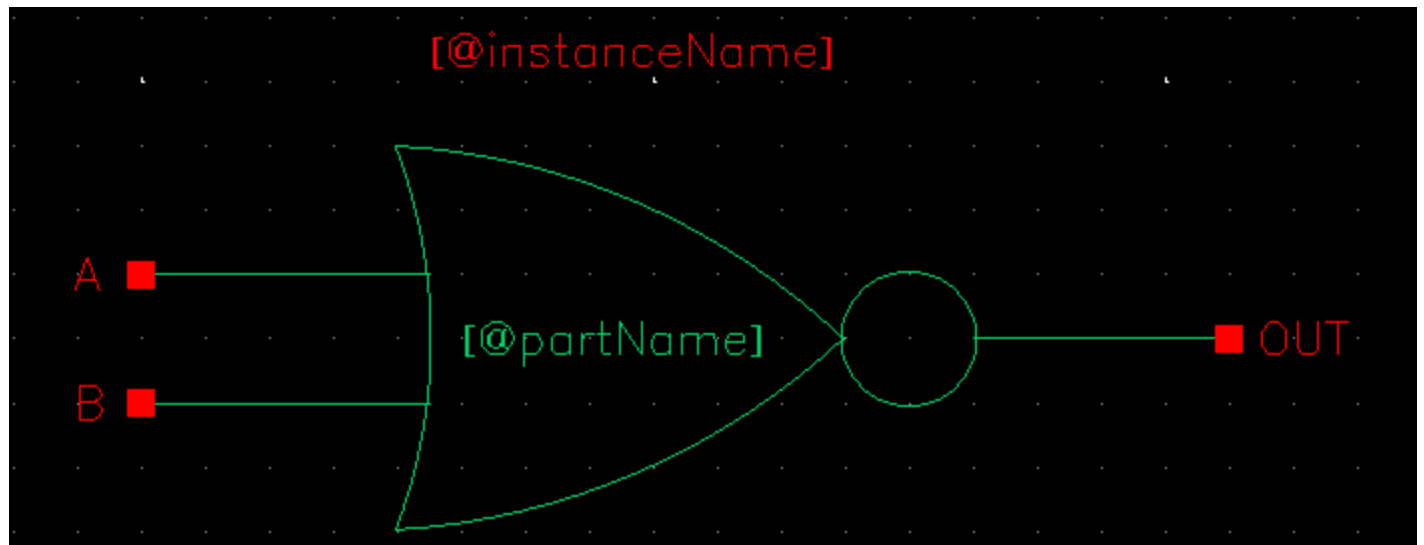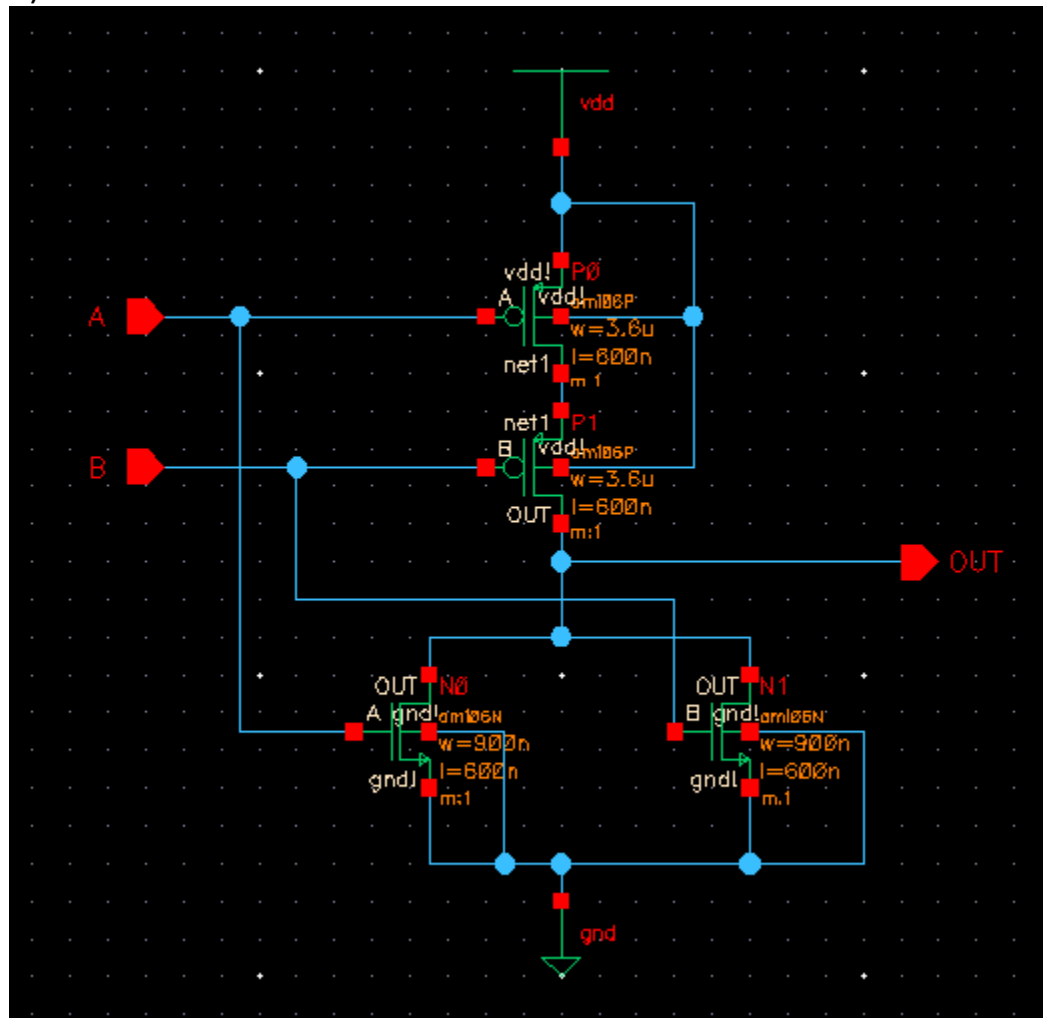
$$\boxed{\tau_{PHL} = 0.08198\ ns}$$

$$\tau_{PLH} = \frac{C_{load}}{\frac{1}{2}\cdot\mu_p C_{ox}(V_{DD} - |V_{T0p}|)}\left(\frac{L_p}{W_p}\right)\left[\frac{2|V_{T0p}|}{V_{DD} - |V_{T0p}|} + \ln\left(\frac{4(V_{DD} - |V_{T0p}|)}{V_{DD}} - 1\right)\right]$$

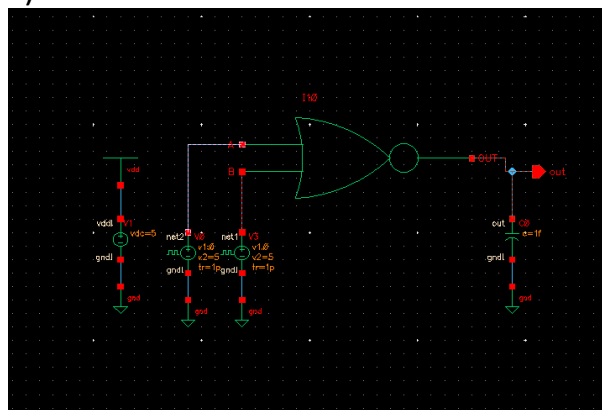$$\tau_{PLH} = \frac{100\cdot10^{-15}}{\frac{1}{2}\cdot40\cdot10^{-6}\cdot(5 - 0.8)}\cdot\frac{600}{3600}\cdot\left[\frac{2\cdot0.8}{5 - 0.8} + \ln\left(\frac{4(5 - 0.8)}{5} - 1\right)\right]$$

$$\boxed{\tau_{PLH} = 0.2459\ ns}$$

b) NOR

c)



DC Response                                                                 Mon Mar 13 23:26:12 2023   1
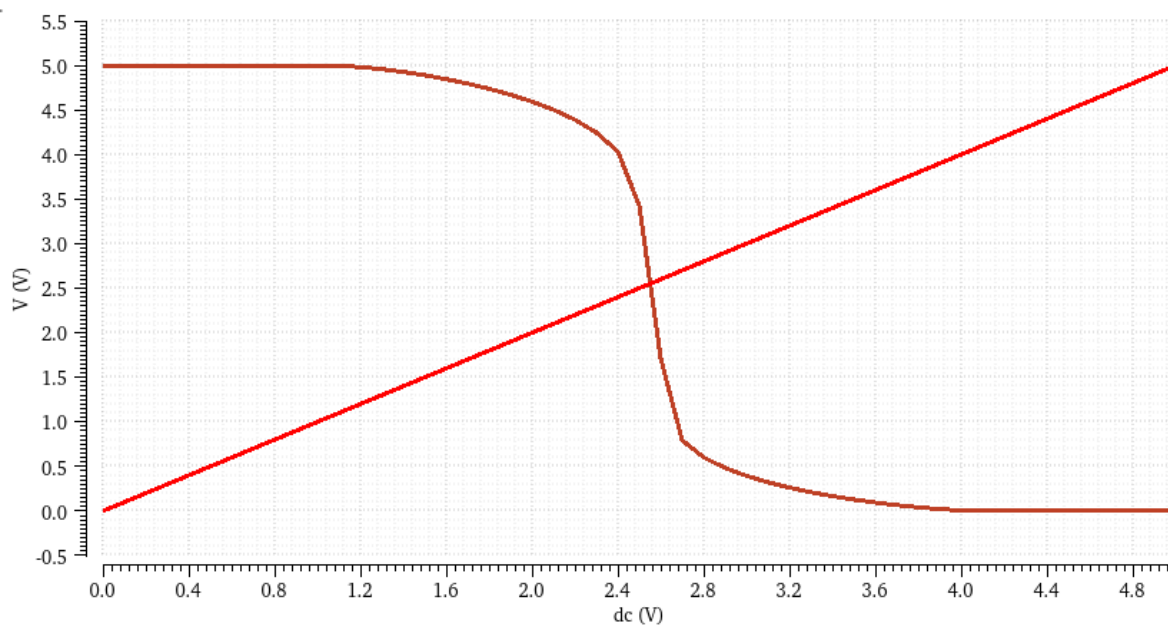
| Name | Vis |
|------|-----|
| /out | 👁 |
| /net1 | 👁 |

Transient Response                                                         Mon Mar 13 23:28:26 2023   1

| Name | Vis |
|------|-----|
| /net2 | 👁 |
| /net1 | 👁 |
| /out | 👁 |

d)

e)
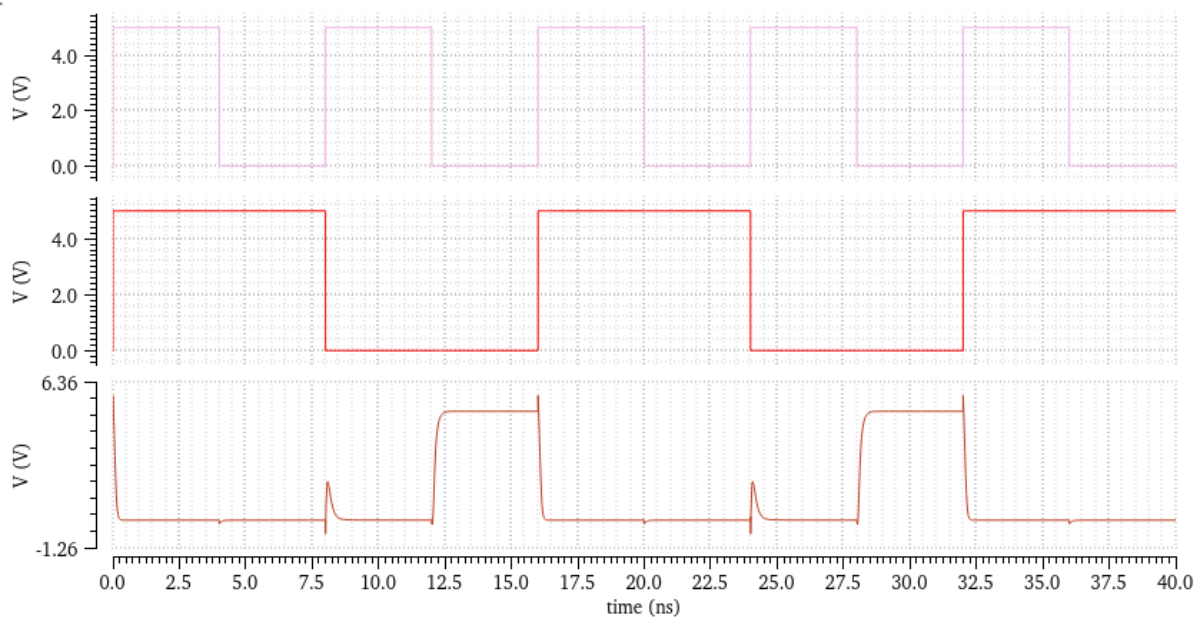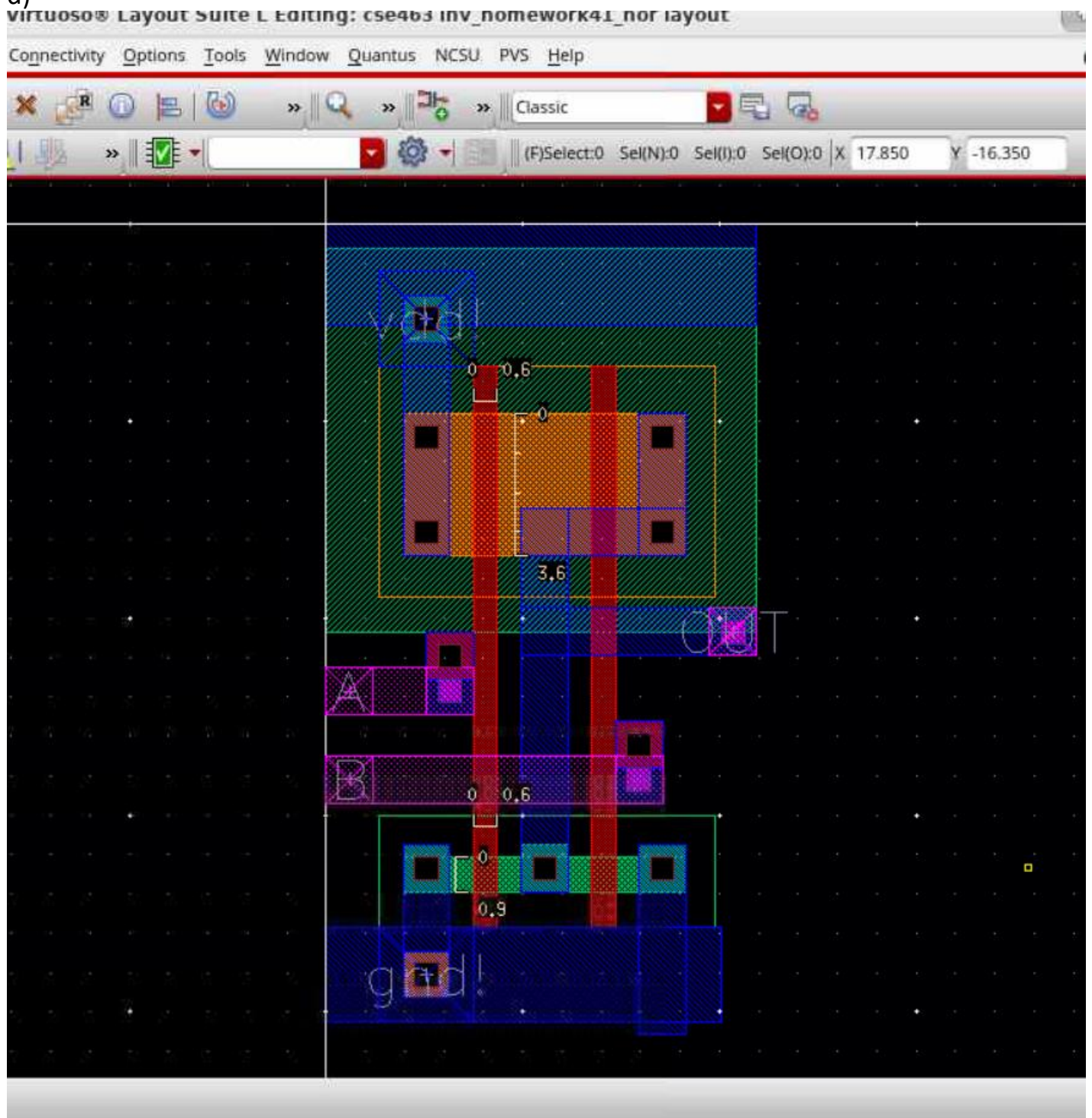
# + DRC Check result

```
DRC started at Mon Mar 13 23:32:29 2023

Validating hierarchy instantiation for:
library: cse463
cell:   inv_homework41_nor
view:   layout
Rules come from library NCSU_TechLib_ami06.
Rules path is divaDRC.rul.
Inclusion limit is set to 1000.
Running layout DRC analysis
Flat mode
Full checking.
executing: nodrc = geomOr("nodrc")
executing: gwell = geomOr(geomAndNot(("gwell" "drawing") nodrc))
executing: nwell = geomOr(geomAndNot(("nwell" "drawing") nodrc))
executing: pwell = geomOr(geomAndNot(("pwell" "drawing") nodrc))
executing: nactive = geomOr(geomAndNot(("nactive" "drawing") nodrc))
executing: pactive = geomOr(geomAndNot(("pactive" "drawing") nodrc))
executing: active = geomOr(geomAndNot(("active" "drawing") nodrc) nactive pactive)
executing: gselect = geomOr(geomAndNot(("gselect" "drawing") nodrc))
executing: nselect = geomOr(geomAndNot(("nselect" "drawing") nodrc))
executing: pselect = geomOr(geomAndNot(("pselect" "drawing") nodrc))
executing: poly = geomOr(geomAndNot(("poly" "drawing") nodrc))
executing: metal1 = geomOr(geomAndNot(("metal1" "drawing") nodrc))
executing: cc = geomOr(geomAndNot(("cc" "drawing") nodrc))
executing: metal2 = geomOr(geomAndNot(("metal2" "drawing") nodrc))
executing: via = geomOr(geomAndNot(("via" "drawing") nodrc))
executing: glass = geomOr(geomAndNot(("glass" "drawing") nodrc))
executing: pad = geomOr(geomAndNot(("pad" "drawing") nodrc))
executing: res_id = geomOr("res_id")
executing: metal3 = geomOr(geomAndNot(("metal3" "drawing") nodrc))
executing: via2 = geomOr(geomAndNot(("via2" "drawing") nodrc))
executing: highres = geomOr(geomAndNot(("highres" "drawing") nodrc))
executing: elec = geomOr(geomAndNot(("elec" "drawing") nodrc))
executing: ce = geomOr(geomOr(geomAndNot(("ce" "drawing") nodrc)) geomAnd(cc elec))
executing: cp = geomOr(geomOr(geomAndNot(("cp" "drawing") nodrc)) geomAnd(cc geomAndNot(poly ce)))
executing: ca = geomOr(geomOr(geomAndNot(("ca" "drawing") nodrc)) geomAnd(cc geomAndNot(active ...
executing: nActive = geomAnd(active nselect)
executing: pActive = geomAnd(active pselect)
executing: nBulk = geomOr(nwell)
executing: pBulk = geomOr(geomNot(nwell) geomAndNot(pwell nwell))
executing: nOhmic = geomAnd(nActive nwell)
      nNotOhmic = geomAndNot(nActive nwell)
executing: pOhmic = geomAndNot(pActive nwell)
      pNotOhmic = geomAnd(pActive nwell)
executing: nDiff = geomAndNot(nNotOhmic geomOr(poly elec))
executing: pDiff = geomAndNot(pNotOhmic geomOr(poly elec))
executing: nDiffContact = geomAnd(ca nDiff)
executing: pDiffContact = geomAnd(ca pDiff)
executing: nOhmicContact = geomAnd(ca nOhmic)
executing: pOhmicContact = geomAnd(ca pOhmic)
executing: Gate = geomAnd(geomOr(nNotOhmic pNotOhmic) poly)
executing: fieldPoly = geomAvoiding(poly Gate)
executing: elecGate = geomAnd(geomOr(nNotOhmic pNotOhmic) elec)
executing: fieldElec = geomAvoiding(elec elecGate)
executing: CapacitorElec = geomInside(elec poly)
executing: TransistorElec = geomOverlap(elec geomNot(poly))
executing: fieldPoly = geomAndNot(fieldPoly res_id)
executing: poly = geomAndNot(poly res_id)
executing: fieldElec = geomAndNot(fieldElec geomOr(res_id highres))
executing: elecRes = geomButting(geomAnd(res_id elec) fieldElec (keep == 2))
executing: elecHighres = geomButting(geomAnd(highres elec) fieldElec (keep == 2))
executing: elec = geomAndNot(elec geomOr(res_id highres))
executing: nBulk = geomAndNot(nBulk res_id)
executing: nwell = geomAndNot(nwell res_id)
executing: geomConnect((via nOhmicContact nOhmic nwell nBulk metal1) (via pOhmicContact pOhmic ...
```

```
executing: dubiousData(("gwell" "drawing") "Improperly formed shape - gwell")
executing: dubiousData(("nwell" "drawing") "Improperly formed shape - nwell")
executing: dubiousData(("pwell" "drawing") "Improperly formed shape - pwell")
executing: dubiousData(("active" "drawing") "Improperly formed shape - active, nactive or pacti...
executing: dubiousData(("gselect" "drawing") "Improperly formed shape - gselect")
executing: dubiousData(("nselect" "drawing") "Improperly formed shape - nselect")
executing: dubiousData(("pselect" "drawing") "Improperly formed shape - pselect")
executing: dubiousData(("poly" "drawing") "Improperly formed shape - poly")
executing: dubiousData(("metal1" "drawing") "Improperly formed shape - metal1")
executing: dubiousData(("ca" "drawing") "Improperly formed shape - ca")
executing: dubiousData(("cp" "drawing") "Improperly formed shape - cp")
executing: dubiousData(("metal2" "drawing") "Improperly formed shape - metal2")
executing: dubiousData(("via" "drawing") "Improperly formed shape - via")
executing: dubiousData(("glass" "drawing") "Improperly formed shape - glass")
executing: saveDerived(geomGetNon45(gwell) "Non-Manhattan shape - gwell")
executing: saveDerived(geomGetNon45(nwell) "Non-Manhattan shape - nwell")
executing: saveDerived(geomGetNon45(pwell) "Non-Manhattan shape - pwell")
executing: saveDerived(geomGetNon45(active) "Non-Manhattan shape - active, nactive or pactive")
executing: saveDerived(geomGetNon45(gselect) "Non-Manhattan shape - gselect")
executing: saveDerived(geomGetNon45(nselect) "Non-Manhattan shape - nselect")
executing: saveDerived(geomGetNon45(pselect) "Non-Manhattan shape - pselect")
executing: saveDerived(geomGetNon45(poly) "Non-Manhattan shape - poly")
executing: saveDerived(geomGetNon45(metal1) "Non-Manhattan shape - metal1")
executing: saveDerived(geomGetNon45(ca) "Non-Manhattan shape - ca")
executing: saveDerived(geomGetNon45(cp) "Non-Manhattan shape - cp")
executing: saveDerived(geomGetNon45(metal2) "Non-Manhattan shape - metal2")
executing: saveDerived(geomGetNon45(via) "Non-Manhattan shape - via")
executing: saveDerived(geomGetNon45(glass) "Non-Manhattan shape - glass")
executing: offGrid(gwell gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(nwell gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(pwell gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(active gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(gselect gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(nselect gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(pselect gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(poly gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(metal1 gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(ca gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(cp gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(metal2 gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(via gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(glass gridRes "(SCMOS Inst) Edge not on grid")
executing: dubiousData(("metal3" "drawing") "Improperly formed shape - metal3")
executing: dubiousData(("via2" "drawing") "Improperly formed shape - via2")
executing: saveDerived(geomGetNon45(metal3) "Non-Manhattan shape - metal3")
executing: saveDerived(geomGetNon45(via2) "Non-Manhattan shape - via2")
executing: offGrid(metal3 gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(via2 gridRes "(SCMOS Inst) Edge not on grid")
executing: dubiousData(("elec" "drawing") "Improperly formed shape - elec")
executing: dubiousData(("ce" "drawing") "Improperly formed shape - ce")
executing: saveDerived(geomGetNon45(elec) "Non-Manhattan shape - elec")
executing: saveDerived(geomGetNon45(ce) "Non-Manhattan shape - ce")
executing: offGrid(elec gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(ce gridRes "(SCMOS Inst) Edge not on grid")
executing: nwellEdge = geomGetEdge(nwell)
executing: pwellEdge = geomGetEdge(pwell)
executing: activeEdge = geomGetEdge(active)
executing: nselectEdge = geomGetEdge(nselect)
executing: pselectEdge = geomGetEdge(pselect)
executing: polyEdge = geomGetEdge(poly)
executing: metal1Edge = geomGetEdge(metal1)
executing: caEdge = geomGetEdge(ca)
executing: cpEdge = geomGetEdge(cp)
executing: metal2Edge = geomGetEdge(metal2)
executing: viaEdge = geomGetEdge(via)
executing: glassEdge = geomGetEdge(glass)
executing: highresEdge = geomGetEdge(highres)
executing: ceEdge = geomGetEdge(ce)
executing: metal3Edge = geomGetEdge(metal3)
executing: via2Edge = geomGetEdge(via2)
```

```
executing: nBulkEdge = geomGetEdge(nBulk)
executing: pBulkEdge = geomGetEdge(pBulk)
executing: nOhmicEdge = geomGetEdge(nOhmic)
executing: pOhmicEdge = geomGetEdge(pOhmic)
executing: nNotOhmicEdge = geomGetEdge(nNotOhmic)
executing: pNotOhmicEdge = geomGetEdge(pNotOhmic)
executing: GateEdge = geomGetEdge(Gate)
executing: fieldPolyEdge = geomGetEdge(fieldPoly)
executing: CapacitorElecEdge = geomGetEdge(CapacitorElec)
executing: TransistorElecEdge = geomGetEdge(TransistorElec)
executing: elecHighresEdge = geomGetEdge(elecRes coincident elec)
executing: saveDerived(geomAndNot(active geomOr(nselect pselect)) "(DBM Rule 1.1) Active must b...
executing: saveDerived(geomAnd(poly nOhmic) "(DBM Rule 2.0) Poly cannot overlap ohmic diffusion")
executing: saveDerived(geomAnd(poly pOhmic) "(DBM Rule 2.0) Poly cannot overlap ohmic diffusion")
executing: saveDerived(geomAnd(elec nOhmic) "(DBM Rule 2.1) Elec cannot overlap ohmic diffusion")
executing: saveDerived(geomAnd(elec pOhmic) "(DBM Rule 2.1) Elec cannot overlap ohmic diffusion")
executing: saveDerived(geomAnd(pactive nselect) "(DBM Rule 3.1) Pactive and Nselect may not ove...
executing: saveDerived(geomAnd(nactive pselect) "(DBM Rule 3.2) Nactive and Pselect may not ove...
executing: saveDerived(geomAnd(active elec) "(DBM Rule 4.0, AMI 0.6um) Elec and active may not ...
executing: drc(nwellEdge (width < (lambda * 12.0)) errMesg)
        drc(nwellEdge (notch < (lambda * 6.0)) errMesg)
executing: drc(pwellEdge (width < (lambda * 12.0)) errMesg)
        drc(pwellEdge (notch < (lambda * 6.0)) errMesg)
executing: drc(nwell (sep < (lambda * 18.0)) diffNet errMesg)
        drc(nwell (sep < (lambda * 6.0)) sameNet errMesg)
executing: drc(pwell (sep < (lambda * 18.0)) diffNet errMesg)
        drc(pwell (sep < (lambda * 6.0)) sameNet errMesg)
executing: saveDerived(geomAnd(nwell pwell) "(SCMOS Rule 1 note) n-wells and p-wells may not ov...
executing: drc(activeEdge (width < (lambda * 3.0)) errMesg)
        drc(activeEdge (sep < (lambda * 3.0)) errMesg)
        drc(activeEdge (notch < (lambda * 3.0)) errMesg)
executing: drc(nNotOhmicEdge nBulkEdge (sep < (lambda * 6.0)) errMesg)
executing: drc(pNotOhmicEdge pBulkEdge (sep < (lambda * 6.0)) errMesg)
executing: drc(pBulkEdge nNotOhmicEdge (enc < (lambda * 6.0)) errMesg)
executing: drc(nBulkEdge pNotOhmicEdge (enc < (lambda * 6.0)) errMesg)
executing: drc(nBulkEdge nOhmicEdge (enc < (lambda * 3.0)) errMesg)
executing: drc(nOhmicEdge pBulkEdge (sep < (lambda * 3.0)) errMesg)
executing: drc(pOhmicEdge nBulkEdge (sep < (lambda * 3.0)) errMesg)
executing: drc(pBulkEdge pOhmicEdge (enc < (lambda * 3.0)) errMesg)
executing: drc(nNotOhmicEdge pOhmicEdge ((0 < sep) < (lambda * 4.0)) errMesg)
executing: drc(pNotOhmicEdge nOhmicEdge ((0 < sep) < (lambda * 4.0)) errMesg)
executing: drc(polyEdge (width < (lambda * 2.0)) errMesg)
        drc(polyEdge (sep < (lambda * 3.0)) errMesg)
        drc(polyEdge (notch < (lambda * 3.0)) errMesg)
executing: drc(polyEdge activeEdge (enc < (lambda * 2.0)) errMesg)
        drc(activeEdge polyEdge (enc < (lambda * 3.0)) errMesg)
        drc(polyEdge activeEdge (sep < (lambda * 1.0)) errMesg)
executing: drc(nselectEdge geomGetEdge(polyEdge inside pNotOhmic) (sep < (lambda * 3.0)) (app >...
executing: drc(nselectEdge geomGetEdge(polyEdge inside nNotOhmic) (enc < (lambda * 3.0)) (app >...
executing: drc(pselectEdge geomGetEdge(polyEdge inside nNotOhmic) (sep < (lambda * 3.0)) (app >...
executing: drc(pselectEdge geomGetEdge(polyEdge inside pNotOhmic) (enc < (lambda * 3.0)) (app >...
executing: drc(geomOr(nselectEdge pselectEdge) activeEdge (sep < (lambda * 2.0)) errMesg)
        drc(geomOr(nselectEdge pselectEdge) activeEdge (enc < (lambda * 2.0)) errMesg)
executing: drc(nselectEdge caEdge (sep < (lambda * 1.0)) errMesg)
        drc(nselectEdge caEdge (enc < (lambda * 1.0)) errMesg)
executing: drc(pselectEdge caEdge (sep < (lambda * 1.0)) errMesg)
        drc(pselectEdge caEdge (enc < (lambda * 1.0)) errMesg)
executing: saveDerived(geomButting(geomAnd(ca nselect) geomAnd(ca pselect)) errMesg)
executing: drc(nselectEdge (width < (lambda * 2.0)) errMesg)
        drc(nselectEdge (sep < (lambda * 2.0)) errMesg)
        drc(nselectEdge (notch < (lambda * 2.0)) errMesg)
executing: drc(pselectEdge (width < (lambda * 2.0)) errMesg)
        drc(pselectEdge (sep < (lambda * 2.0)) errMesg)
        drc(pselectEdge (notch < (lambda * 2.0)) errMesg)
executing: saveDerived(geomAnd(nselect pselect) errMesg)
executing: drc(cpEdge (width < (lambda * 2.0)) errMesg)
        drc(cpEdge (sep < (lambda * 3.0)) errMesg)
        drc(cpEdge (notch < (lambda * 3.0)) errMesg)
executing: drc(cp (area > ((lambda * 2.0 * (lambda * 2.0)) + (lambda * 0.1 * (lambda * 0.1)))) ...
executing: drc(polyEdge cpEdge (enc < (lambda * 1.0)) errMesg)
```

```
        drc(cpEdge polyEdge (sep < (lambda * 5.0)) errMesg)
executing: saveDerived(geomAndNot(cp poly) errMesg)
executing: saveDerived(geomAndNot(cc geomOr(poly elec active)) errMesg)
executing: drc(cpEdge GateEdge (sep < (lambda * 2.0)) errMesg)
executing: drc(cpEdge activeEdge (sep < (lambda * 2.0)) errMesg)
executing: saveDerived(geomAnd(cp active) errMesg)
executing: saveDerived(geomGetLength(drc(cpEdge activeEdge (sep < (lambda * 3.0))) (length > (l...
executing: drc(caEdge (width < (lambda * 2.0)) errMesg)
        drc(caEdge (sep < (lambda * 3.0)) errMesg)
        drc(caEdge (notch < (lambda * 3.0)) errMesg)
executing: drc(ca (area > ((lambda * 2.0 * (lambda * 2.0)) + (lambda * 0.1 * (lambda * 0.1)))) ...
executing: drc(activeEdge caEdge (enc < (lambda * 1.0)) errMesg)
        drc(caEdge activeEdge (sep < (lambda * 5.0)) errMesg)
executing: saveDerived(geomAndNot(ca active) errMesg)
executing: drc(caEdge GateEdge (sep < (lambda * 2.0)) errMesg)
executing: saveDerived(geomAnd(ca Gate) errMesg)
executing: drc(caEdge fieldPolyEdge (sep < (lambda * 2.0)) errMesg)
executing: saveDerived(geomAnd(ca fieldPoly) errMesg)
executing: saveDerived(geomGetLength(drc(caEdge fieldPolyEdge (sep < (lambda * 3.0))) (length >...
executing: drc(caEdge cpEdge (sep < (lambda * 4.0)) errMesg)
executing: saveDerived(geomAnd(ca cp) errMesg)
executing: drc(metal1Edge (width < (lambda * 3.0)) errMesg)
        drc(metal1Edge (sep < (lambda * 3.0)) errMesg)
        drc(metal1Edge (notch < (lambda * 3.0)) errMesg)
executing: drc(metal1Edge cpEdge (enc < (lambda * 1.0)) errMesg)
executing: drc(metal1Edge caEdge (enc < (lambda * 1.0)) errMesg)
executing: saveDerived(geomAndNot(cp metal1) errMesg)
executing: saveDerived(geomAndNot(ca metal1) errMesg)
executing: drc(viaEdge (width < (lambda * 2.0)) errMesg)
        drc(viaEdge (sep < (lambda * 3.0)) errMesg)
executing: drc(via (area > ((lambda * 2.0 * (lambda * 2.0)) + (lambda * 0.1 * (lambda * 0.1))))...
executing: drc(metal1Edge viaEdge (enc < (lambda * 1.0)) errMesg)
executing: saveDerived(geomAndNot(via metal1) errMesg)
executing: drc(metal2Edge (width < (lambda * 3.0)) errMesg)
        drc(metal2Edge (sep < (lambda * 3.0)) errMesg)
        drc(metal2Edge (notch < (lambda * 3.0)) errMesg)
executing: drc(metal2Edge viaEdge (enc < (lambda * 1.0)) errMesg)
executing: saveDerived(geomAndNot(via metal2) errMesg)
executing: BondingGlass = geomInside(glass pad)
        ProbeGlass = geomOutside(glass pad)
executing: saveDerived(geomStraddle(glass pad))
executing: BondingPad = geomAndNot(geomSize(BondingGlass 6.0) geomHoles(BondingGlass))
executing: ProbePad = geomAndNot(geomSize(ProbeGlass 6.0) geomHoles(ProbeGlass))
executing: Pad = geomOr(BondingPad ProbePad)
executing: BondingPadEdge = geomGetEdge(BondingPad not_over "nodrc")
executing: ProbePadEdge = geomGetEdge(ProbePad not_over "nodrc")
executing: PadEdge = geomGetEdge(Pad not_over "nodrc")
executing: Metal3EdgeNearPad = geomGetEdge(geomOr(geomGetByLayer("metal3" "glass" 36.0)) not_ov...
executing: Metal2EdgeNearPad = geomGetEdge(geomOr(geomGetByLayer("metal2" "glass" 36.0)) not_ov...
executing: Metal1EdgeNearPad = geomGetEdge(geomOr(geomGetByLayer("metal1" "glass" 21.0)) not_ov...
executing: PolyEdgeNearPad = geomGetEdge(geomOr(geomGetByLayer("poly" "glass" 21.0)) not_over "...
executing: ActiveEdgeNearPad = geomGetEdge(geomOr(geomGetByLayer("active" "glass" 21.0)) not_ov...
executing: ElecEdgeNearPad = geomGetEdge(geomOr(geomGetByLayer("elec" "glass" 21.0)) not_over "...
executing: drc(BondingPadEdge (width < 60.0) "(SCMOS Rule 10.1) bonding pad width: 60 um")
executing: drc(ProbePadEdge (width < 20.0) "(SCMOS Rule 10.2) probe pad width: 20 um")
executing: drc(Metal3EdgeNearPad glassEdge (enc < 6.0) "(SCMOS Rule 10.3) pad enclosure of glas...
executing: saveDerived(geomAndNot(glass metal3) "(SCMOS Rule 10.3) pad enclosure of glass: 6 um")
executing: drc(PadEdge Metal3EdgeNearPad (sep < 30.0) "(SCMOS Rule 10.4) pad to unrelated metal...
executing: drc(PadEdge Metal2EdgeNearPad (sep < 30.0) "(SCMOS Rule 10.4) pad to unrelated metal...
executing: drc(PadEdge Metal1EdgeNearPad (sep < 15.0) "(SCMOS Rule 10.5) pad to unrelated metal...
executing: drc(PadEdge PolyEdgeNearPad (sep < 15.0) "(SCMOS Rule 10.5) pad to unrelated poly sp...
executing: drc(PadEdge ActiveEdgeNearPad (sep < 15.0) "(SCMOS Rule 10.5) pad to unrelated activ...
executing: drc(PadEdge ElecEdgeNearPad (sep < 15.0) "(SCMOS Rule 10.5) pad to unrelated elec sp...
executing: drc(CapacitorElecEdge (width < (lambda * 7.0)) errMesg)
        drc(CapacitorElecEdge (sep < (lambda * 3.0)) errMesg)
        drc(CapacitorElecEdge (notch < (lambda * 3.0)) errMesg)
executing: drc(polyEdge CapacitorElecEdge (enc < (lambda * 5.0)) errMesg)
executing: drc(CapacitorElecEdge nBulkEdge (sep < (lambda * 2.0)) errMesg)
        drc(nBulkEdge CapacitorElecEdge (enc < (lambda * 2.0)) errMesg)
executing: drc(CapacitorElecEdge pBulkEdge (sep < (lambda * 2.0)) errMesg)
```

```
        drc(pBulkEdge CapacitorElecEdge (enc < (lambda * 2.0)) errMesg)
executing: saveDerived(geomStraddle(CapacitorElec nBulk) errMesg)
executing: saveDerived(geomStraddle(CapacitorElec pBulk) errMesg)
executing: drc(CapacitorElecEdge activeEdge (sep < (lambda * 2.0)) errMesg)
executing: saveDerived(geomAnd(CapacitorElec active) errMesg)
executing: drc(CapacitorElecEdge cpEdge (sep < (lambda * 6.0)) errMesg)
executing: drc(geomGetEdge("elec") geomGetEdge("metal3") (sep < (lambda * 2.0)) errMesg)
executing: saveDerived(geomOverlap(metal3 elec diffNet) errMesg)
executing: drc(geomGetEdge("elec") geomGetEdge("metal2") (sep < (lambda * 2.0)) errMesg)
executing: saveDerived(geomOverlap(metal2 elec diffNet) errMesg)
executing: drc(geomGetEdge("elec") geomGetEdge("metal1") (sep < (lambda * 2.0)) errMesg)
executing: saveDerived(geomOverlap(metal1 elec diffNet) errMesg)
executing: drc(TransistorElecEdge (width < (lambda * 2.0)) errMesg)
        drc(TransistorElecEdge (sep < (lambda * 3.0)) errMesg)
        drc(TransistorElecEdge (notch < (lambda * 3.0)) errMesg)
executing: drc(TransistorElecEdge activeEdge (enc < (lambda * 2.0)) errMesg)
        drc(TransistorElecEdge activeEdge (sep < (lambda * 1.0)) errMesg)
executing: drc(TransistorElecEdge polyEdge (sep < (lambda * 2.0)) errMesg)
        drc(TransistorElecEdge polyEdge (ovlp < (lambda * 2.0)) errMesg)
executing: drc(TransistorElecEdge cpEdge (sep < (lambda * 3.0)) errMesg)
executing: saveDerived(geomAnd(TransistorElec cp) errMesg)
executing: drc(TransistorElecEdge caEdge (sep < (lambda * 3.0)) errMesg)
executing: saveDerived(geomAnd(TransistorElec ca) errMesg)
executing: drc(ceEdge (width < (lambda * 2.0)) errMesg)
        drc(ceEdge (sep < (lambda * 3.0)) errMesg)
        drc(ceEdge (notch < (lambda * 3.0)) errMesg)
executing: drc(ce (area > ((lambda * 2.0 * (lambda * 2.0)) + (lambda * 0.1 * (lambda * 0.1)))) ...
executing: drc(CapacitorElecEdge ceEdge (enc < (lambda * 3.0)) errMesg)
executing: drc(TransistorElecEdge ceEdge (enc < (lambda * 2.0)) errMesg)
executing: saveDerived(geomAndNot(ce elec) "(SCMOS Rules 13.3,13.4) electrode enclosure of cont...
executing: drc(ceEdge polyEdge (sep < (lambda * 3.0)) errMesg)
executing: saveDerived(geomOutside(geomAnd(ce poly) CapacitorElec) errMesg)
executing: drc(ceEdge activeEdge (sep < (lambda * 3.0)) errMesg)
executing: saveDerived(geomAnd(ce active) errMesg)
executing: drc(via2Edge (width < (lambda * 2.0)) errMesg)
        drc(via2Edge (sep < (lambda * 3.0)) errMesg)
executing: drc(via2 (area > ((lambda * 2.0 * (lambda * 2.0)) + (lambda * 0.1 * (lambda * 0.1)))...
executing: drc(metal2Edge via2Edge (enc < (lambda * 1.0)) errMesg)
executing: saveDerived(geomAndNot(via2 metal2) errMesg)
executing: drc(metal3Edge (width < (lambda * 5.0)) errMesg)
        drc(metal3Edge (sep < (lambda * 3.0)) errMesg)
        drc(metal3Edge (notch < (lambda * 3.0)) errMesg)
executing: drc(metal3Edge via2Edge (enc < (lambda * 2.0)) errMesg)
executing: saveDerived(geomAndNot(via2 metal3) errMesg)
executing: drc(highresEdge (width < (lambda * 4.0)) errMesg)
        drc(highresEdge (sep < (lambda * 4.0)) errMesg)
        drc(highresEdge (notch < (lambda * 4.0)) errMesg)
executing: drc(highresEdge caEdge (sep < (lambda * 2.0)) errMesg)
executing: drc(highresEdge cpEdge (sep < (lambda * 2.0)) errMesg)
executing: saveDerived(geomAnd(highres ca) errMesg)
executing: saveDerived(geomAnd(highres cp) errMesg)
executing: drc(highresEdge activeEdge (sep < (lambda * 2.0)) errMesg)
executing: drc(highresEdge geomGetEdge(geomAndNot(elec geomButting(elec elecHighres))) (sep < (...
executing: saveDerived(geomButting(elecHighres geomAndNot(elec elecHighres) (ignore == 2)) errM...
executing: saveDerived(geomAnd(elecHighres nwell) "(SCMOS Rule 27.6) resistor must be outside w...
executing: saveDerived(geomAnd(elecHighres active) "(SCMOS Rule 27.6) resistor must be outside ...
executing: drc(elecHighresEdge (width < (lambda * 5.0)) errMesg)
        drc(elecHighresEdge (sep < (lambda * 7.0)) errMesg)
        drc(elecHighresEdge (notch < (lambda * 7.0)) errMesg)
executing: drc(highresEdge elecHighresEdge (enc < (lambda * 2.0)) errMesg)
DRC started.......Mon Mar 13 23:32:29 2023
  completed ....Mon Mar 13 23:32:29 2023
  CPU TIME = 00:00:00  TOTAL TIME = 00:00:00
*********  Summary of rule violations for cell "inv_homework41_nor layout"  *********
  Total errors found: 0
```

# + LVS check result

@(#)$CDS: LVS version 6.1.8-64b 08/09/2022 19:10 (sjfhw317) $

Command line: /project/engineering/cadence21/IC618/tools.lnx86/dfII/bin/64bit/LVS -dir /home/warehouse/b.gwak/cadence/LVS -l -s -t /home/warehouse/b.gwak/cadence/LVS/layout /home/warehouse/b.gwak/cadence/LVS/schematic
Like matching is enabled.
Net swapping is enabled.
Using terminal names as correspondence points.

   Net-list summary for /home/warehouse/b.gwak/cadence/LVS/layout/netlist
    count
    6       nets
    5       terminals
    2       pmos
    2       nmos

   Net-list summary for /home/warehouse/b.gwak/cadence/LVS/schematic/netlist
    count
    6       nets
    5       terminals
    2       pmos
    2       nmos

   Terminal correspondence points

| | | |
|---|---|---|
| N4 | N6 | A |
| N3 | N4 | B |
| N2 | N5 | OUT |
| N1 | N1 | gnd! |
| N5 | N0 | vdd! |

Devices in the netlist but not in the rules:
    pcapacitor pmos nmos

The net-lists match.

| | layout | schematic |
|---|---|---|
| **instances** | | |
| un-matched | 0 | 0 |
| rewired | 0 | 0 |
| size errors | 0 | 0 |
| pruned | 0 | 0 |
| active | 4 | 4 |
| total | 4 | 4 |
| **nets** | | |
| un-matched | 0 | 0 |
| merged | 0 | 0 |
| pruned | 0 | 0 |
| active | 6 | 6 |
| total | 6 | 6 |
| **terminals** | | |
| un-matched | 0 | 0 |
| matched but different type | 0 | 0 |
| total | 5 | 5 |

Probe files from /home/warehouse/b.gwak/cadence/LVS/schematic

devbad.out:

netbad.out:

mergenet.out:

termbad.out:

prunenet.out:

prunedev.out:

audit.out:


Probe files from /home/warehouse/b.gwak/cadence/LVS/layout

devbad.out:

netbad.out:

mergenet.out:

termbad.out:

prunenet.out:

prunedev.out:

audit.out:

2) NAND

a)
$$V_{th}(ND2) = \frac{V_{DD}}{2} \implies K_n = 4K_p$$
$$V_{DD} = 5\,V, V_{th}(ND2) = 2.5\,V,$$

$$\boxed{4\frac{W_p}{L_p} = \frac{W_n}{L_n}}$$

+ I'm going to set PMOS L=600n and NMOS L=600n. And I would get the result like below.

$$\boxed{\begin{aligned} W_P &= 900n, L_P = 600n \\ W_L &= 3.6u, L_L = 600n \end{aligned}}$$

+ To get the result of t_fall and t_rise, I applied equations below.

$$\tau_{fall} = \frac{C_{load}}{\frac{1}{2} \cdot k_n(V_{DD} - V_{T0n})} \left[\frac{2(V_{T0n} - 0.1V_{DD})}{V_{DD} - V_{T0n}} + \ln\left(\frac{2(V_{DD} - V_{T0n})}{0.1V_{DD}} - 1\right)\right]$$

$$\tau_{fall} = \frac{C_{load}}{\frac{1}{2} \cdot \mu_n C_{ox} \frac{W_n}{L_n}(V_{DD} - V_{T0n})} \left[\frac{2(V_{T0n} - 0.1V_{DD})}{V_{DD} - V_{T0n}} + \ln\left(\frac{2(V_{DD} - V_{T0n})}{0.1V_{DD}} - 1\right)\right]$$

$$2 \cdot 10^{-9} > \frac{100 \cdot 10^{-15}}{\frac{1}{2} \cdot 120 \cdot 10^{-6} \cdot \frac{W_n}{L_n} \cdot (5 - 0.8)} \left[\frac{2(0.8 - 0.1 \cdot 5)}{5 - 0.8} + \ln\left(\frac{2(5 - 0.8)}{0.1 \cdot 5} - 1\right)\right]$$

$$\frac{W_n}{L_n} > \frac{100}{120 \cdot (5 - 0.8)} \left[\frac{2(0.8 - 0.1 \cdot 5)}{5 - 0.8} + \ln\left(\frac{2(5 - 0.8)}{0.1 \cdot 5} - 1\right)\right]$$

$$\boxed{\frac{W_n}{L_n} > 0.5759}$$

$$\tau_{rise} = \frac{C_{load}}{2k_p(V_{DD} - |V_{T0p}|)} \left[\frac{2(|V_{T0p}| - 0.1V_{DD})}{V_{DD} - |V_{T0p}|} + \ln\left(\frac{2(V_{DD} - |V_{T0p}|)}{0.1V_{DD}} - 1\right)\right]$$

$$\tau_{rise} = \frac{C_{load}}{2 \cdot \mu_p C_{ox} \frac{W_p}{L_p}(V_{DD} - |V_{T0p}|)} \left[\frac{2(|V_{T0p}| - 0.1V_{DD})}{V_{DD} - |V_{T0p}|} + \ln\left(\frac{2(V_{DD} - |V_{T0p}|)}{0.1V_{DD}} - 1\right)\right]$$

$$2 \cdot 10^{-9} > \frac{100 \cdot 10^{-15}}{2 \cdot 40 \cdot 10^{-6} \cdot \frac{W_p}{L_p} \cdot (5 - 0.8)} \left[\frac{2(0.8 - 0.1 \cdot 5)}{5 - 0.8} + \ln\left(\frac{2(5 - 0.8)}{0.1 \cdot 5} - 1\right)\right]$$

$$\frac{W_p}{L_p} > \frac{100}{4 \cdot 40 \cdot (5 - 0.8)} \left[\frac{2(0.8 - 0.1 \cdot 5)}{5 - 0.8} + \ln\left(\frac{2(5 - 0.8)}{0.1 \cdot 5} - 1\right)\right]$$

$$\boxed{\frac{W_p}{L_p} > 0.4319}$$

+ To get the result of t_PHL and t_PLH, I applied equations below.

$$\tau_{PHL} = \frac{C_{load}}{\frac{1}{2}\mu_n C_{ox}(V_{DD} - V_{T0n})} \left(\frac{L_n}{W_n}\right)\left[\frac{2V_{T0n}}{V_{DD} - V_{T0n}} + \ln\left(\frac{4(V_{DD} - V_{T0n})}{V_{DD}} - 1\right)\right]$$

$$\tau_{PHL} = \frac{100 \cdot 10^{-15}}{\frac{1}{2} \cdot 120 \cdot 10^{-6} \cdot (5 - 0.8)} \cdot \frac{600}{3600} \cdot \left[\frac{2 \cdot 0.8}{5 - 0.8} + \ln\left(\frac{4(5 - 0.8)}{5} - 1\right)\right]$$

$$\boxed{\tau_{PHL} = 0.0819851 \, ns}$$

$$\tau_{PLH} = \frac{C_{load}}{2\mu_p C_{ox}(V_{DD} - |V_{T0p}|)} \left(\frac{L_p}{W_p}\right)\left[\frac{2|V_{T0p}|}{V_{DD} - |V_{T0p}|} + \ln\left(\frac{4(V_{DD} - |V_{T0p}|)}{V_{DD}} - 1\right)\right]$$

$$\tau_{PLH} = \frac{100 \cdot 10^{-15}}{2 \cdot 40 \cdot 10^{-6} \cdot (5 - 0.8)} \cdot \frac{600}{900} \cdot \left[\frac{2 \cdot 0.8}{5 - 0.8} + \ln\left(\frac{4(5 - 0.8)}{5} - 1\right)\right]$$

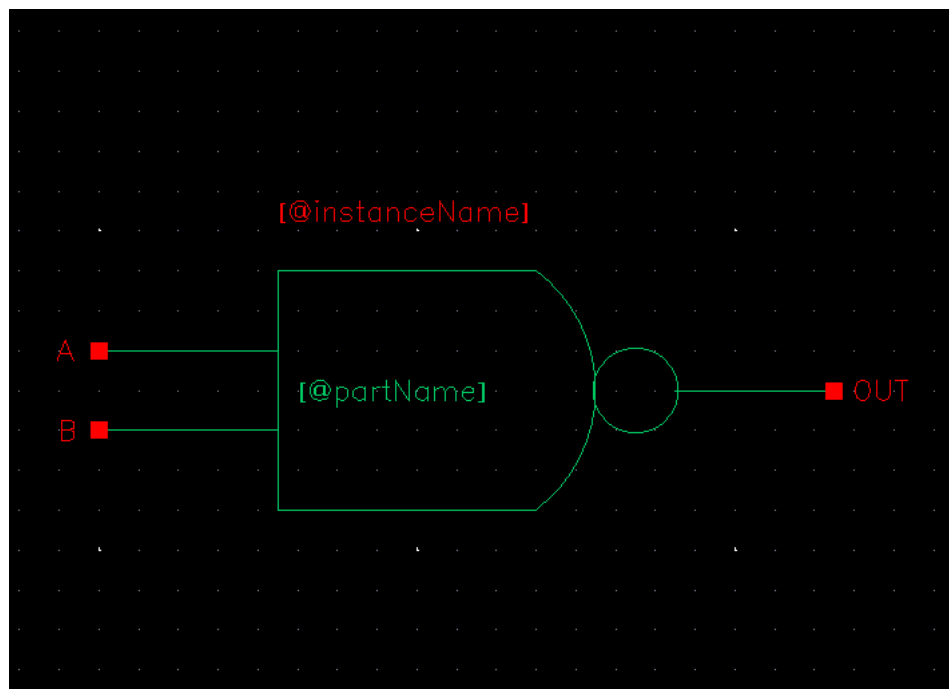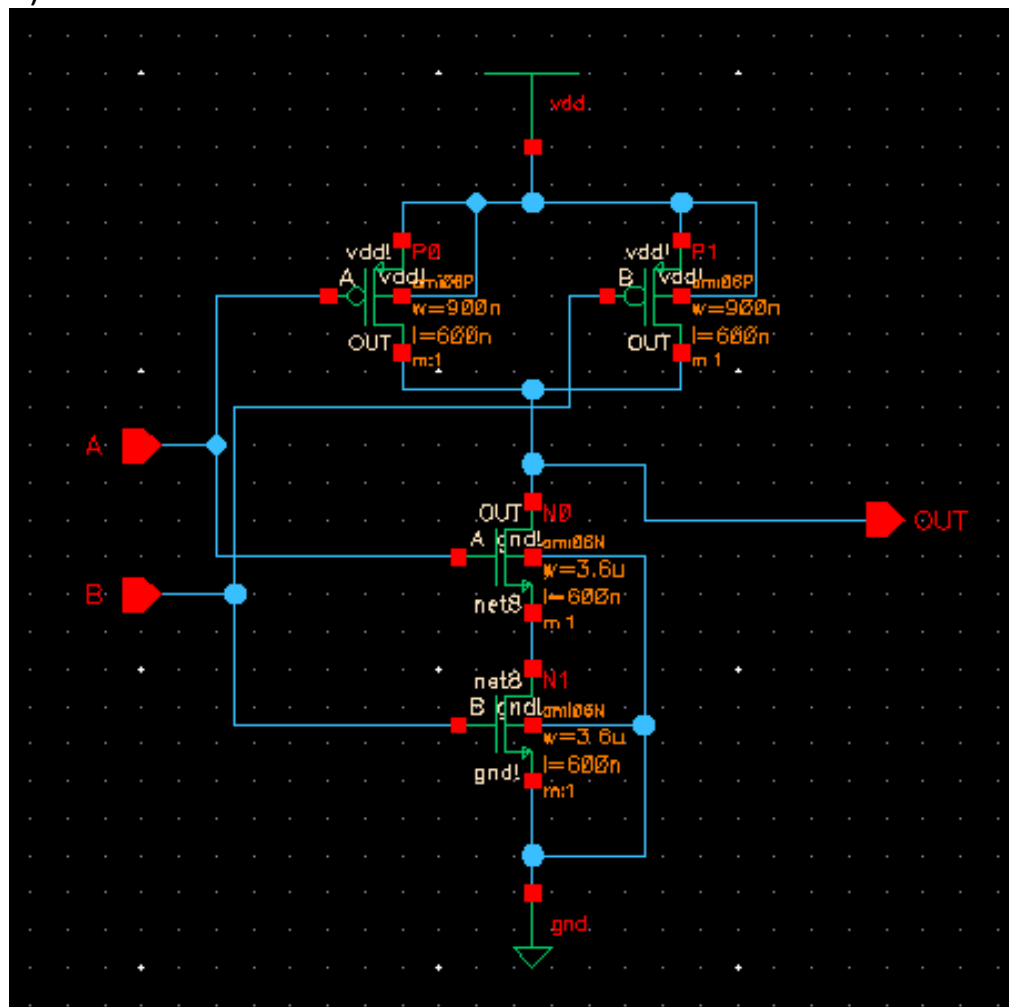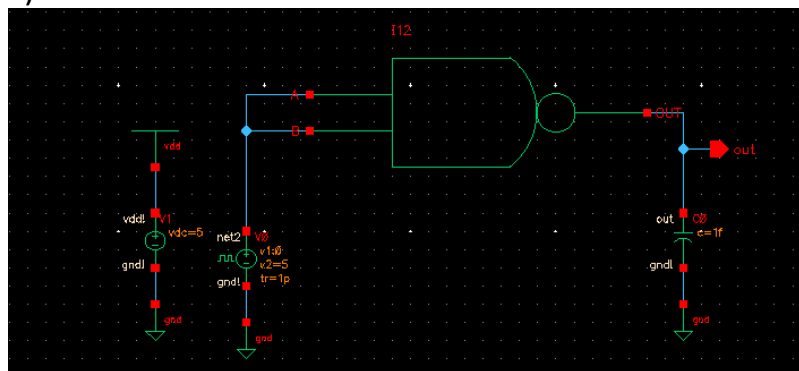$$\boxed{\tau_{PLH} = 0.245955 \, ns}$$

b)

c)



DC Response                                                    Mon Mar 13 23:26:12 2023  1
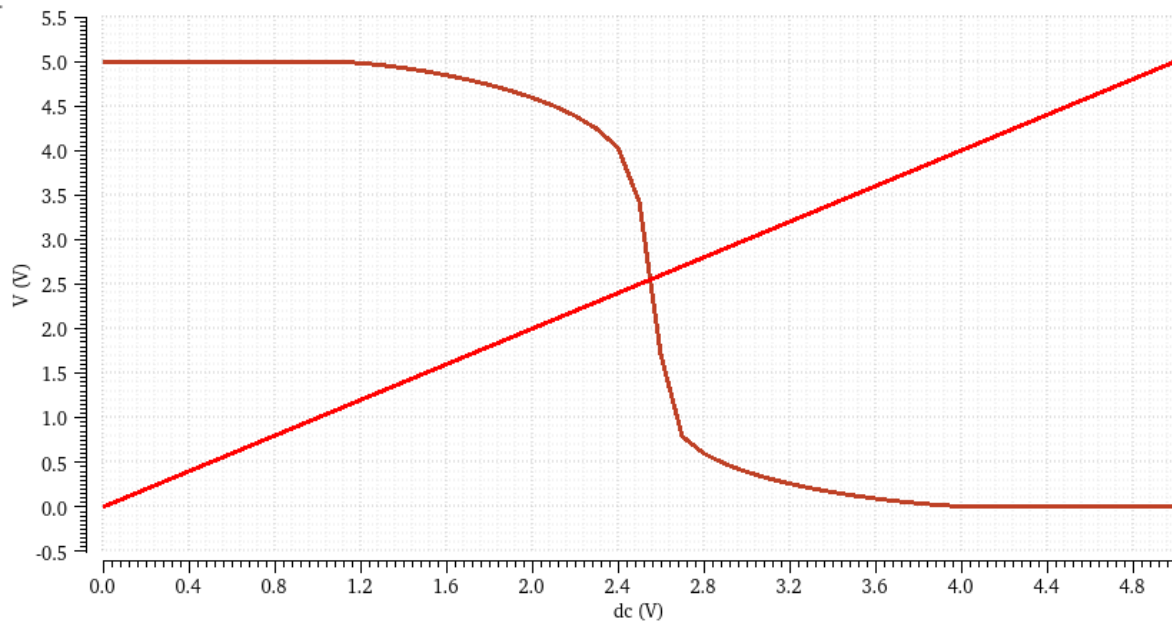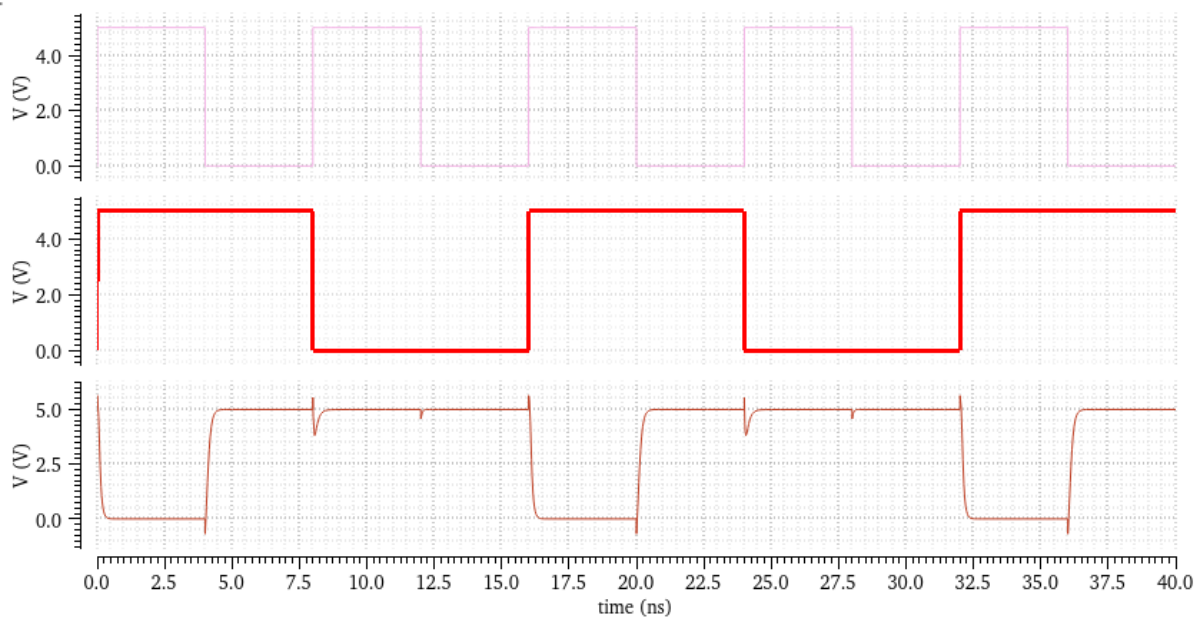
| Name | Vis |
|------|-----|
| /out | 👁 |
| /net1 | 👁 |

Transient Response                                            Tue Mar 14 09:30:03 2023  1

| Name | Vis |
|------|-----|
| /net1 | 👁 |
| /net2 | 👁 |
| /out | 👁 |

d)
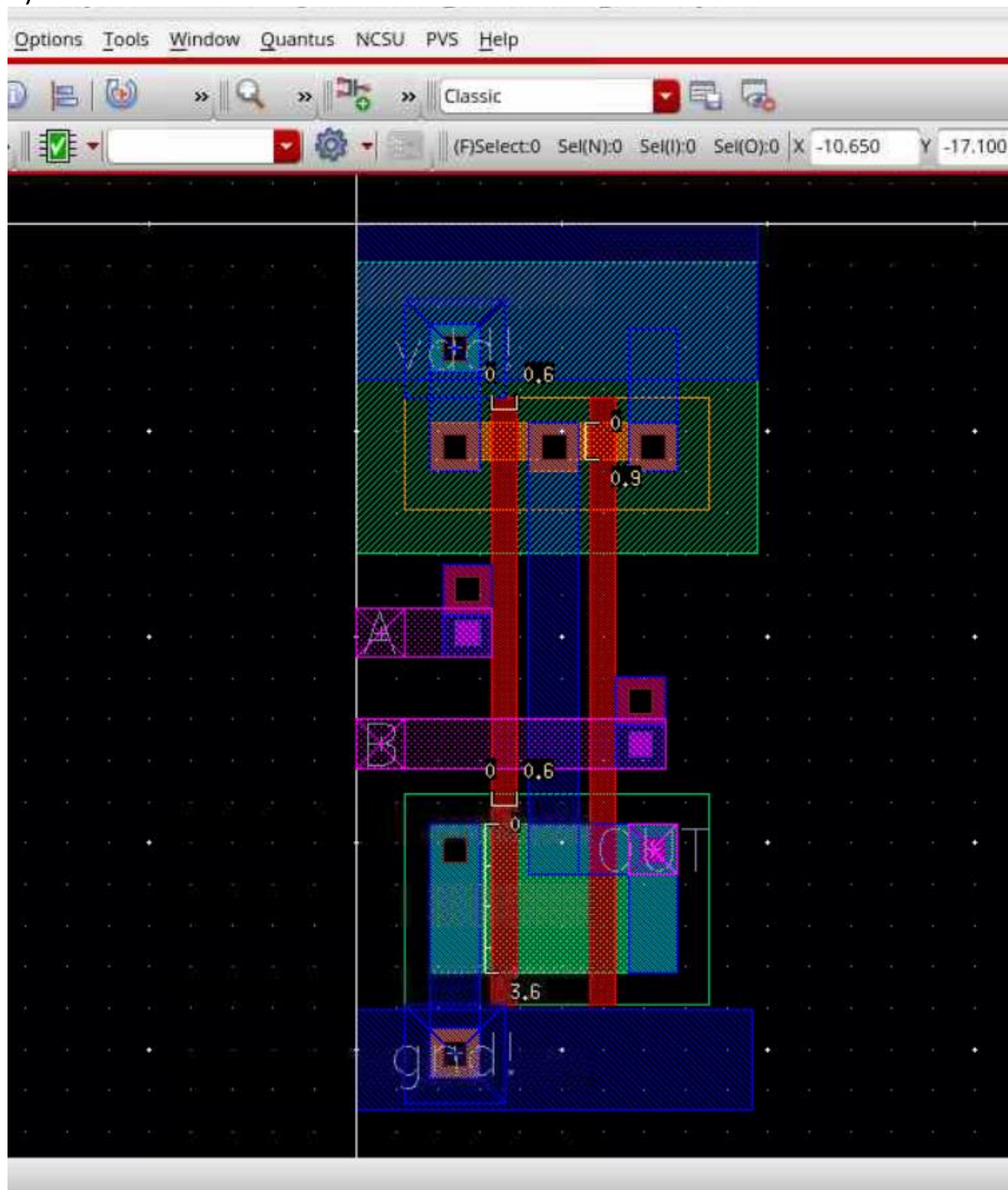
e)
+ DRC check result

DRC started at Tue Mar 14 01:25:56 2023

Validating hierarchy instantiation for:
library: cse463
cell:   inv_homework43_nand
view:   layout
Rules come from library NCSU_TechLib_ami06.
Rules path is divaDRC.rul.
Inclusion limit is set to 1000.
Running layout DRC analysis
Flat mode
Full checking.
executing: nodrc = geomOr("nodrc")
executing: gwell = geomOr(geomAndNot(("gwell" "drawing") nodrc))
executing: nwell = geomOr(geomAndNot(("nwell" "drawing") nodrc))
executing: pwell = geomOr(geomAndNot(("pwell" "drawing") nodrc))
executing: nactive = geomOr(geomAndNot(("nactive" "drawing") nodrc))
executing: pactive = geomOr(geomAndNot(("pactive" "drawing") nodrc))
executing: active = geomOr(geomAndNot(("active" "drawing") nodrc) nactive pactive)
executing: gselect = geomOr(geomAndNot(("gselect" "drawing") nodrc))
executing: nselect = geomOr(geomAndNot(("nselect" "drawing") nodrc))
executing: pselect = geomOr(geomAndNot(("pselect" "drawing") nodrc))
executing: poly = geomOr(geomAndNot(("poly" "drawing") nodrc))
executing: metal1 = geomOr(geomAndNot(("metal1" "drawing") nodrc))
executing: cc = geomOr(geomAndNot(("cc" "drawing") nodrc))
executing: metal2 = geomOr(geomAndNot(("metal2" "drawing") nodrc))
executing: via = geomOr(geomAndNot(("via" "drawing") nodrc))
executing: glass = geomOr(geomAndNot(("glass" "drawing") nodrc))
executing: pad = geomOr(geomAndNot(("pad" "drawing") nodrc))
executing: res_id = geomOr("res_id")
executing: metal3 = geomOr(geomAndNot(("metal3" "drawing") nodrc))
executing: via2 = geomOr(geomAndNot(("via2" "drawing") nodrc))
executing: highres = geomOr(geomAndNot(("highres" "drawing") nodrc))
executing: elec = geomOr(geomAndNot(("elec" "drawing") nodrc))
executing: ce = geomOr(geomOr(geomAndNot(("ce" "drawing") nodrc)) geomAnd(cc elec))
executing: cp = geomOr(geomOr(geomAndNot(("cp" "drawing") nodrc)) geomAnd(cc geomAndNot(poly ce)))
executing: ca = geomOr(geomOr(geomAndNot(("ca" "drawing") nodrc)) geomAnd(cc geomAndNot(active ...
executing: nActive = geomAnd(active nselect)
executing: pActive = geomAnd(active pselect)
executing: nBulk = geomOr(nwell)
executing: pBulk = geomOr(geomNot(nwell) geomAndNot(pwell nwell))
executing: nOhmic = geomAnd(nActive nwell)
        nNotOhmic = geomAndNot(nActive nwell)
executing: pOhmic = geomAndNot(pActive nwell)
        pNotOhmic = geomAnd(pActive nwell)
executing: nDiff = geomAndNot(nNotOhmic geomOr(poly elec))
executing: pDiff = geomAndNot(pNotOhmic geomOr(poly elec))
executing: nDiffContact = geomAnd(ca nDiff)
executing: pDiffContact = geomAnd(ca pDiff)
executing: nOhmicContact = geomAnd(ca nOhmic)
executing: pOhmicContact = geomAnd(ca pOhmic)
executing: Gate = geomAnd(geomOr(nNotOhmic pNotOhmic) poly)
executing: fieldPoly = geomAvoiding(poly Gate)
executing: elecGate = geomAnd(geomOr(nNotOhmic pNotOhmic) elec)
executing: fieldElec = geomAvoiding(elec elecGate)
executing: CapacitorElec = geomInside(elec poly)
executing: TransistorElec = geomOverlap(elec geomNot(poly))
executing: fieldPoly = geomAndNot(fieldPoly res_id)
executing: poly = geomAndNot(poly res_id)
executing: fieldElec = geomAndNot(fieldElec geomOr(res_id highres))
executing: elecRes = geomButting(geomAnd(res_id elec) fieldElec (keep == 2))
executing: elecHighres = geomButting(geomAnd(highres elec) fieldElec (keep == 2))
executing: elec = geomAndNot(elec geomOr(res_id highres))
executing: nBulk = geomAndNot(nBulk res_id)
executing: nwell = geomAndNot(nwell res_id)
executing: geomConnect((via nOhmicContact nOhmic nwell nBulk metal1) (via pOhmicContact pOhmic ...

```
executing: dubiousData(("gwell" "drawing") "Improperly formed shape - gwell")
executing: dubiousData(("nwell" "drawing") "Improperly formed shape - nwell")
executing: dubiousData(("pwell" "drawing") "Improperly formed shape - pwell")
executing: dubiousData(("active" "drawing") "Improperly formed shape - active, nactive or pacti...
executing: dubiousData(("gselect" "drawing") "Improperly formed shape - gselect")
executing: dubiousData(("nselect" "drawing") "Improperly formed shape - nselect")
executing: dubiousData(("pselect" "drawing") "Improperly formed shape - pselect")
executing: dubiousData(("poly" "drawing") "Improperly formed shape - poly")
executing: dubiousData(("metal1" "drawing") "Improperly formed shape - metal1")
executing: dubiousData(("ca" "drawing") "Improperly formed shape - ca")
executing: dubiousData(("cp" "drawing") "Improperly formed shape - cp")
executing: dubiousData(("metal2" "drawing") "Improperly formed shape - metal2")
executing: dubiousData(("via" "drawing") "Improperly formed shape - via")
executing: dubiousData(("glass" "drawing") "Improperly formed shape - glass")
executing: saveDerived(geomGetNon45(gwell) "Non-Manhattan shape - gwell")
executing: saveDerived(geomGetNon45(nwell) "Non-Manhattan shape - nwell")
executing: saveDerived(geomGetNon45(pwell) "Non-Manhattan shape - pwell")
executing: saveDerived(geomGetNon45(active) "Non-Manhattan shape - active, nactive or pactive")
executing: saveDerived(geomGetNon45(gselect) "Non-Manhattan shape - gselect")
executing: saveDerived(geomGetNon45(nselect) "Non-Manhattan shape - nselect")
executing: saveDerived(geomGetNon45(pselect) "Non-Manhattan shape - pselect")
executing: saveDerived(geomGetNon45(poly) "Non-Manhattan shape - poly")
executing: saveDerived(geomGetNon45(metal1) "Non-Manhattan shape - metal1")
executing: saveDerived(geomGetNon45(ca) "Non-Manhattan shape - ca")
executing: saveDerived(geomGetNon45(cp) "Non-Manhattan shape - cp")
executing: saveDerived(geomGetNon45(metal2) "Non-Manhattan shape - metal2")
executing: saveDerived(geomGetNon45(via) "Non-Manhattan shape - via")
executing: saveDerived(geomGetNon45(glass) "Non-Manhattan shape - glass")
executing: offGrid(gwell gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(nwell gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(pwell gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(active gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(gselect gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(nselect gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(pselect gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(poly gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(metal1 gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(ca gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(cp gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(metal2 gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(via gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(glass gridRes "(SCMOS Inst) Edge not on grid")
executing: dubiousData(("metal3" "drawing") "Improperly formed shape - metal3")
executing: dubiousData(("via2" "drawing") "Improperly formed shape - via2")
executing: saveDerived(geomGetNon45(metal3) "Non-Manhattan shape - metal3")
executing: saveDerived(geomGetNon45(via2) "Non-Manhattan shape - via2")
executing: offGrid(metal3 gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(via2 gridRes "(SCMOS Inst) Edge not on grid")
executing: dubiousData(("elec" "drawing") "Improperly formed shape - elec")
executing: dubiousData(("ce" "drawing") "Improperly formed shape - ce")
executing: saveDerived(geomGetNon45(elec) "Non-Manhattan shape - elec")
executing: saveDerived(geomGetNon45(ce) "Non-Manhattan shape - ce")
executing: offGrid(elec gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(ce gridRes "(SCMOS Inst) Edge not on grid")
executing: nwellEdge = geomGetEdge(nwell)
executing: pwellEdge = geomGetEdge(pwell)
executing: activeEdge = geomGetEdge(active)
executing: nselectEdge = geomGetEdge(nselect)
executing: pselectEdge = geomGetEdge(pselect)
executing: polyEdge = geomGetEdge(poly)
executing: metal1Edge = geomGetEdge(metal1)
executing: caEdge = geomGetEdge(ca)
executing: cpEdge = geomGetEdge(cp)
executing: metal2Edge = geomGetEdge(metal2)
executing: viaEdge = geomGetEdge(via)
executing: glassEdge = geomGetEdge(glass)
executing: highresEdge = geomGetEdge(highres)
executing: ceEdge = geomGetEdge(ce)
executing: metal3Edge = geomGetEdge(metal3)
executing: via2Edge = geomGetEdge(via2)
```

```
executing: nBulkEdge = geomGetEdge(nBulk)
executing: pBulkEdge = geomGetEdge(pBulk)
executing: nOhmicEdge = geomGetEdge(nOhmic)
executing: pOhmicEdge = geomGetEdge(pOhmic)
executing: nNotOhmicEdge = geomGetEdge(nNotOhmic)
executing: pNotOhmicEdge = geomGetEdge(pNotOhmic)
executing: GateEdge = geomGetEdge(Gate)
executing: fieldPolyEdge = geomGetEdge(fieldPoly)
executing: CapacitorElecEdge = geomGetEdge(CapacitorElec)
executing: TransistorElecEdge = geomGetEdge(TransistorElec)
executing: elecHighresEdge = geomGetEdge(elecRes coincident elec)
executing: saveDerived(geomAndNot(active geomOr(nselect pselect)) "(DBM Rule 1.1) Active must b...
executing: saveDerived(geomAnd(poly nOhmic) "(DBM Rule 2.0) Poly cannot overlap ohmic diffusion")
executing: saveDerived(geomAnd(poly pOhmic) "(DBM Rule 2.0) Poly cannot overlap ohmic diffusion")
executing: saveDerived(geomAnd(elec nOhmic) "(DBM Rule 2.1) Elec cannot overlap ohmic diffusion")
executing: saveDerived(geomAnd(elec pOhmic) "(DBM Rule 2.1) Elec cannot overlap ohmic diffusion")
executing: saveDerived(geomAnd(pactive nselect) "(DBM Rule 3.1) Pactive and Nselect may not ove...
executing: saveDerived(geomAnd(nactive pselect) "(DBM Rule 3.2) Nactive and Pselect may not ove...
executing: saveDerived(geomAnd(active elec) "(DBM Rule 4.0, AMI 0.6um) Elec and active may not ...
executing: drc(nwellEdge (width < (lambda * 12.0)) errMesg)
        drc(nwellEdge (notch < (lambda * 6.0)) errMesg)
executing: drc(pwellEdge (width < (lambda * 12.0)) errMesg)
        drc(pwellEdge (notch < (lambda * 6.0)) errMesg)
executing: drc(nwell (sep < (lambda * 18.0)) diffNet errMesg)
        drc(nwell (sep < (lambda * 6.0)) sameNet errMesg)
executing: drc(pwell (sep < (lambda * 18.0)) diffNet errMesg)
        drc(pwell (sep < (lambda * 6.0)) sameNet errMesg)
executing: saveDerived(geomAnd(nwell pwell) "(SCMOS Rule 1 note) n-wells and p-wells may not ov...
executing: drc(activeEdge (width < (lambda * 3.0)) errMesg)
        drc(activeEdge (sep < (lambda * 3.0)) errMesg)
        drc(activeEdge (notch < (lambda * 3.0)) errMesg)
executing: drc(nNotOhmicEdge nBulkEdge (sep < (lambda * 6.0)) errMesg)
executing: drc(pNotOhmicEdge pBulkEdge (sep < (lambda * 6.0)) errMesg)
executing: drc(pBulkEdge nNotOhmicEdge (enc < (lambda * 6.0)) errMesg)
executing: drc(nBulkEdge pNotOhmicEdge (enc < (lambda * 6.0)) errMesg)
executing: drc(nBulkEdge nOhmicEdge (enc < (lambda * 3.0)) errMesg)
executing: drc(nOhmicEdge pBulkEdge (sep < (lambda * 3.0)) errMesg)
executing: drc(pOhmicEdge nBulkEdge (sep < (lambda * 3.0)) errMesg)
executing: drc(pBulkEdge pOhmicEdge (enc < (lambda * 3.0)) errMesg)
executing: drc(nNotOhmicEdge pOhmicEdge ((0 < sep) < (lambda * 4.0)) errMesg)
executing: drc(pNotOhmicEdge nOhmicEdge ((0 < sep) < (lambda * 4.0)) errMesg)
executing: drc(polyEdge (width < (lambda * 2.0)) errMesg)
        drc(polyEdge (sep < (lambda * 3.0)) errMesg)
        drc(polyEdge (notch < (lambda * 3.0)) errMesg)
executing: drc(polyEdge activeEdge (enc < (lambda * 2.0)) errMesg)
        drc(activeEdge polyEdge (enc < (lambda * 3.0)) errMesg)
        drc(polyEdge activeEdge (sep < (lambda * 1.0)) errMesg)
executing: drc(nselectEdge geomGetEdge(polyEdge inside pNotOhmic) (sep < (lambda * 3.0)) (app >...
executing: drc(nselectEdge geomGetEdge(polyEdge inside nNotOhmic) (enc < (lambda * 3.0)) (app >...
executing: drc(pselectEdge geomGetEdge(polyEdge inside nNotOhmic) (sep < (lambda * 3.0)) (app >...
executing: drc(pselectEdge geomGetEdge(polyEdge inside pNotOhmic) (enc < (lambda * 3.0)) (app >...
executing: drc(geomOr(nselectEdge pselectEdge) activeEdge (sep < (lambda * 2.0)) errMesg)
        drc(geomOr(nselectEdge pselectEdge) activeEdge (enc < (lambda * 2.0)) errMesg)
executing: drc(nselectEdge caEdge (sep < (lambda * 1.0)) errMesg)
        drc(nselectEdge caEdge (enc < (lambda * 1.0)) errMesg)
executing: drc(pselectEdge caEdge (sep < (lambda * 1.0)) errMesg)
        drc(pselectEdge caEdge (enc < (lambda * 1.0)) errMesg)
executing: saveDerived(geomButting(geomAnd(ca nselect) geomAnd(ca pselect)) errMesg)
executing: drc(nselectEdge (width < (lambda * 2.0)) errMesg)
        drc(nselectEdge (sep < (lambda * 2.0)) errMesg)
        drc(nselectEdge (notch < (lambda * 2.0)) errMesg)
executing: drc(pselectEdge (width < (lambda * 2.0)) errMesg)
        drc(pselectEdge (sep < (lambda * 2.0)) errMesg)
        drc(pselectEdge (notch < (lambda * 2.0)) errMesg)
executing: saveDerived(geomAnd(nselect pselect) errMesg)
executing: drc(cpEdge (width < (lambda * 2.0)) errMesg)
        drc(cpEdge (sep < (lambda * 3.0)) errMesg)
        drc(cpEdge (notch < (lambda * 3.0)) errMesg)
executing: drc(cp (area > ((lambda * 2.0 * (lambda * 2.0)) + (lambda * 0.1 * (lambda * 0.1)))) ...
executing: drc(polyEdge cpEdge (enc < (lambda * 1.0)) errMesg)
```

```
        drc(cpEdge polyEdge (sep < (lambda * 5.0)) errMesg)
executing: saveDerived(geomAndNot(cp poly) errMesg)
executing: saveDerived(geomAndNot(cc geomOr(poly elec active)) errMesg)
executing: drc(cpEdge GateEdge (sep < (lambda * 2.0)) errMesg)
executing: drc(cpEdge activeEdge (sep < (lambda * 2.0)) errMesg)
executing: saveDerived(geomAnd(cp active) errMesg)
executing: saveDerived(geomGetLength(drc(cpEdge activeEdge (sep < (lambda * 3.0))) (length > (l...
executing: drc(caEdge (width < (lambda * 2.0)) errMesg)
        drc(caEdge (sep < (lambda * 3.0)) errMesg)
        drc(caEdge (notch < (lambda * 3.0)) errMesg)
executing: drc(ca (area > ((lambda * 2.0 * (lambda * 2.0)) + (lambda * 0.1 * (lambda * 0.1)))) ...
executing: drc(activeEdge caEdge (enc < (lambda * 1.0)) errMesg)
        drc(caEdge activeEdge (sep < (lambda * 5.0)) errMesg)
executing: saveDerived(geomAndNot(ca active) errMesg)
executing: drc(caEdge GateEdge (sep < (lambda * 2.0)) errMesg)
executing: saveDerived(geomAnd(ca Gate) errMesg)
executing: drc(caEdge fieldPolyEdge (sep < (lambda * 2.0)) errMesg)
executing: saveDerived(geomAnd(ca fieldPoly) errMesg)
executing: saveDerived(geomGetLength(drc(caEdge fieldPolyEdge (sep < (lambda * 3.0))) (length >...
executing: drc(caEdge cpEdge (sep < (lambda * 4.0)) errMesg)
executing: saveDerived(geomAnd(ca cp) errMesg)
executing: drc(metal1Edge (width < (lambda * 3.0)) errMesg)
        drc(metal1Edge (sep < (lambda * 3.0)) errMesg)
        drc(metal1Edge (notch < (lambda * 3.0)) errMesg)
executing: drc(metal1Edge cpEdge (enc < (lambda * 1.0)) errMesg)
executing: drc(metal1Edge caEdge (enc < (lambda * 1.0)) errMesg)
executing: saveDerived(geomAndNot(cp metal1) errMesg)
executing: saveDerived(geomAndNot(ca metal1) errMesg)
executing: drc(viaEdge (width < (lambda * 2.0)) errMesg)
        drc(viaEdge (sep < (lambda * 3.0)) errMesg)
executing: drc(via (area > ((lambda * 2.0 * (lambda * 2.0)) + (lambda * 0.1 * (lambda * 0.1))))...
executing: drc(metal1Edge viaEdge (enc < (lambda * 1.0)) errMesg)
executing: saveDerived(geomAndNot(via metal1) errMesg)
executing: drc(metal2Edge (width < (lambda * 3.0)) errMesg)
        drc(metal2Edge (sep < (lambda * 3.0)) errMesg)
        drc(metal2Edge (notch < (lambda * 3.0)) errMesg)
executing: drc(metal2Edge viaEdge (enc < (lambda * 1.0)) errMesg)
executing: saveDerived(geomAndNot(via metal2) errMesg)
executing: BondingGlass = geomInside(glass pad)
        ProbeGlass = geomOutside(glass pad)
executing: saveDerived(geomStraddle(glass pad))
executing: BondingPad = geomAndNot(geomSize(BondingGlass 6.0) geomHoles(BondingGlass))
executing: ProbePad = geomAndNot(geomSize(ProbeGlass 6.0) geomHoles(ProbeGlass))
executing: Pad = geomOr(BondingPad ProbePad)
executing: BondingPadEdge = geomGetEdge(BondingPad not_over "nodrc")
executing: ProbePadEdge = geomGetEdge(ProbePad not_over "nodrc")
executing: PadEdge = geomGetEdge(Pad not_over "nodrc")
executing: Metal3EdgeNearPad = geomGetEdge(geomOr(geomGetByLayer("metal3" "glass" 36.0)) not_ov...
executing: Metal2EdgeNearPad = geomGetEdge(geomOr(geomGetByLayer("metal2" "glass" 36.0)) not_ov...
executing: Metal1EdgeNearPad = geomGetEdge(geomOr(geomGetByLayer("metal1" "glass" 21.0)) not_ov...
executing: PolyEdgeNearPad = geomGetEdge(geomOr(geomGetByLayer("poly" "glass" 21.0)) not_over "...
executing: ActiveEdgeNearPad = geomGetEdge(geomOr(geomGetByLayer("active" "glass" 21.0)) not_ov...
executing: ElecEdgeNearPad = geomGetEdge(geomOr(geomGetByLayer("elec" "glass" 21.0)) not_over "...
executing: drc(BondingPadEdge (width < 60.0) "(SCMOS Rule 10.1) bonding pad width: 60 um")
executing: drc(ProbePadEdge (width < 20.0) "(SCMOS Rule 10.2) probe pad width: 20 um")
executing: drc(Metal3EdgeNearPad glassEdge (enc < 6.0) "(SCMOS Rule 10.3) pad enclosure of glas...
executing: saveDerived(geomAndNot(glass metal3) "(SCMOS Rule 10.3) pad enclosure of glass: 6 um")
executing: drc(PadEdge Metal3EdgeNearPad (sep < 30.0) "(SCMOS Rule 10.4) pad to unrelated metal...
executing: drc(PadEdge Metal2EdgeNearPad (sep < 30.0) "(SCMOS Rule 10.4) pad to unrelated metal...
executing: drc(PadEdge Metal1EdgeNearPad (sep < 15.0) "(SCMOS Rule 10.5) pad to unrelated metal...
executing: drc(PadEdge PolyEdgeNearPad (sep < 15.0) "(SCMOS Rule 10.5) pad to unrelated poly sp...
executing: drc(PadEdge ActiveEdgeNearPad (sep < 15.0) "(SCMOS Rule 10.5) pad to unrelated activ...
executing: drc(PadEdge ElecEdgeNearPad (sep < 15.0) "(SCMOS Rule 10.5) pad to unrelated elec sp...
executing: drc(CapacitorElecEdge (width < (lambda * 7.0)) errMesg)
        drc(CapacitorElecEdge (sep < (lambda * 3.0)) errMesg)
        drc(CapacitorElecEdge (notch < (lambda * 3.0)) errMesg)
executing: drc(polyEdge CapacitorElecEdge (enc < (lambda * 5.0)) errMesg)
executing: drc(CapacitorElecEdge nBulkEdge (sep < (lambda * 2.0)) errMesg)
        drc(nBulkEdge CapacitorElecEdge (enc < (lambda * 2.0)) errMesg)
executing: drc(CapacitorElecEdge pBulkEdge (sep < (lambda * 2.0)) errMesg)
```

```
        drc(pBulkEdge CapacitorElecEdge (enc < (lambda * 2.0)) errMesg)
executing: saveDerived(geomStraddle(CapacitorElec nBulk) errMesg)
executing: saveDerived(geomStraddle(CapacitorElec pBulk) errMesg)
executing: drc(CapacitorElecEdge activeEdge (sep < (lambda * 2.0)) errMesg)
executing: saveDerived(geomAnd(CapacitorElec active) errMesg)
executing: drc(CapacitorElecEdge cpEdge (sep < (lambda * 6.0)) errMesg)
executing: drc(geomGetEdge("elec") geomGetEdge("metal3") (sep < (lambda * 2.0)) errMesg)
executing: saveDerived(geomOverlap(metal3 elec diffNet) errMesg)
executing: drc(geomGetEdge("elec") geomGetEdge("metal2") (sep < (lambda * 2.0)) errMesg)
executing: saveDerived(geomOverlap(metal2 elec diffNet) errMesg)
executing: drc(geomGetEdge("elec") geomGetEdge("metal1") (sep < (lambda * 2.0)) errMesg)
executing: saveDerived(geomOverlap(metal1 elec diffNet) errMesg)
executing: drc(TransistorElecEdge (width < (lambda * 2.0)) errMesg)
        drc(TransistorElecEdge (sep < (lambda * 3.0)) errMesg)
        drc(TransistorElecEdge (notch < (lambda * 3.0)) errMesg)
executing: drc(TransistorElecEdge activeEdge (enc < (lambda * 2.0)) errMesg)
        drc(TransistorElecEdge activeEdge (sep < (lambda * 1.0)) errMesg)
executing: drc(TransistorElecEdge polyEdge (sep < (lambda * 2.0)) errMesg)
        drc(TransistorElecEdge polyEdge (ovlp < (lambda * 2.0)) errMesg)
executing: drc(TransistorElecEdge cpEdge (sep < (lambda * 3.0)) errMesg)
executing: saveDerived(geomAnd(TransistorElec cp) errMesg)
executing: drc(TransistorElecEdge caEdge (sep < (lambda * 3.0)) errMesg)
executing: saveDerived(geomAnd(TransistorElec ca) errMesg)
executing: drc(ceEdge (width < (lambda * 2.0)) errMesg)
        drc(ceEdge (sep < (lambda * 3.0)) errMesg)
        drc(ceEdge (notch < (lambda * 3.0)) errMesg)
executing: drc(ce (area > ((lambda * 2.0 * (lambda * 2.0)) + (lambda * 0.1 * (lambda * 0.1)))) ...
executing: drc(CapacitorElecEdge ceEdge (enc < (lambda * 3.0)) errMesg)
executing: drc(TransistorElecEdge ceEdge (enc < (lambda * 2.0)) errMesg)
executing: saveDerived(geomAndNot(ce elec) "(SCMOS Rules 13.3,13.4) electrode enclosure of cont...
executing: drc(ceEdge polyEdge (sep < (lambda * 3.0)) errMesg)
executing: saveDerived(geomOutside(geomAnd(ce poly) CapacitorElec) errMesg)
executing: drc(ceEdge activeEdge (sep < (lambda * 3.0)) errMesg)
executing: saveDerived(geomAnd(ce active) errMesg)
executing: drc(via2Edge (width < (lambda * 2.0)) errMesg)
        drc(via2Edge (sep < (lambda * 3.0)) errMesg)
executing: drc(via2 (area > ((lambda * 2.0 * (lambda * 2.0)) + (lambda * 0.1 * (lambda * 0.1)))...
executing: drc(metal2Edge via2Edge (enc < (lambda * 1.0)) errMesg)
executing: saveDerived(geomAndNot(via2 metal2) errMesg)
executing: drc(metal3Edge (width < (lambda * 5.0)) errMesg)
        drc(metal3Edge (sep < (lambda * 3.0)) errMesg)
        drc(metal3Edge (notch < (lambda * 3.0)) errMesg)
executing: drc(metal3Edge via2Edge (enc < (lambda * 2.0)) errMesg)
executing: saveDerived(geomAndNot(via2 metal3) errMesg)
executing: drc(highresEdge (width < (lambda * 4.0)) errMesg)
        drc(highresEdge (sep < (lambda * 4.0)) errMesg)
        drc(highresEdge (notch < (lambda * 4.0)) errMesg)
executing: drc(highresEdge caEdge (sep < (lambda * 2.0)) errMesg)
executing: drc(highresEdge cpEdge (sep < (lambda * 2.0)) errMesg)
executing: saveDerived(geomAnd(highres ca) errMesg)
executing: saveDerived(geomAnd(highres cp) errMesg)
executing: drc(highresEdge activeEdge (sep < (lambda * 2.0)) errMesg)
executing: drc(highresEdge geomGetEdge(geomAndNot(elec geomButting(elec elecHighres))) (sep < (...
executing: saveDerived(geomButting(elecHighres geomAndNot(elec elecHighres) (ignore == 2)) errM...
executing: saveDerived(geomAnd(elecHighres nwell) "(SCMOS Rule 27.6) resistor must be outside w...
executing: saveDerived(geomAnd(elecHighres active) "(SCMOS Rule 27.6) resistor must be outside ...
executing: drc(elecHighresEdge (width < (lambda * 5.0)) errMesg)
        drc(elecHighresEdge (sep < (lambda * 7.0)) errMesg)
        drc(elecHighresEdge (notch < (lambda * 7.0)) errMesg)
executing: drc(highresEdge elecHighresEdge (enc < (lambda * 2.0)) errMesg)
DRC started.......Tue Mar 14 01:25:56 2023
  completed ....Tue Mar 14 01:25:56 2023
  CPU TIME = 00:00:00  TOTAL TIME = 00:00:00
*********  Summary of rule violations for cell "inv_homework43_nand layout"  *********
  Total errors found: 0
```

# + LVS check result

```
@(#)$CDS: LVS version 6.1.8-64b 08/09/2022 19:10 (sjfhw317) $

Command     line:     /project/engineering/cadence21/IC618/tools.lnx86/dfII/bin/64bit/LVS     -dir     /home/warehouse/b.gwak/cadence/LVS     -l     -s     -t
/home/warehouse/b.gwak/cadence/LVS/layout /home/warehouse/b.gwak/cadence/LVS/schematic
Like matching is enabled.
Net swapping is enabled.
Using terminal names as correspondence points.

    Net-list summary for /home/warehouse/b.gwak/cadence/LVS/layout/netlist
      count
      6        nets
      5        terminals
      2        pmos
      2        nmos

    Net-list summary for /home/warehouse/b.gwak/cadence/LVS/schematic/netlist
      count
      6        nets
      5        terminals
      2        pmos
      2        nmos


    Terminal correspondence points
    N4    N6    A
    N3    N5    B
    N2    N4    OUT
    N1    N1    gnd!
    N5    N0    vdd!

Devices in the netlist but not in the rules:
    pcapacitor
Devices in the rules but not in the netlist:
    cap nfet pfet nmos4 pmos4

The net-lists match.

                layout  schematic
                    instances
    un-matched        0    0
    rewired           0    0
    size errors       0    0
    pruned            0    0
    active            4    4
    total             4    4

                    nets
    un-matched        0    0
    merged            0    0
    pruned            0    0
    active            6    6
    total             6    6

                    terminals
    un-matched        0    0
    matched but
    different type    0    0
    total             5    5


Probe files from /home/warehouse/b.gwak/cadence/LVS/schematic

devbad.out:

netbad.out:

mergenet.out:

termbad.out:

prunenet.out:

prunedev.out:

audit.out:


Probe files from /home/warehouse/b.gwak/cadence/LVS/layout
```

devbad.out:

netbad.out:

mergenet.out:

termbad.out:

prunenet.out:

prunedev.out:

audit.out: