數位積體電路

Lab3

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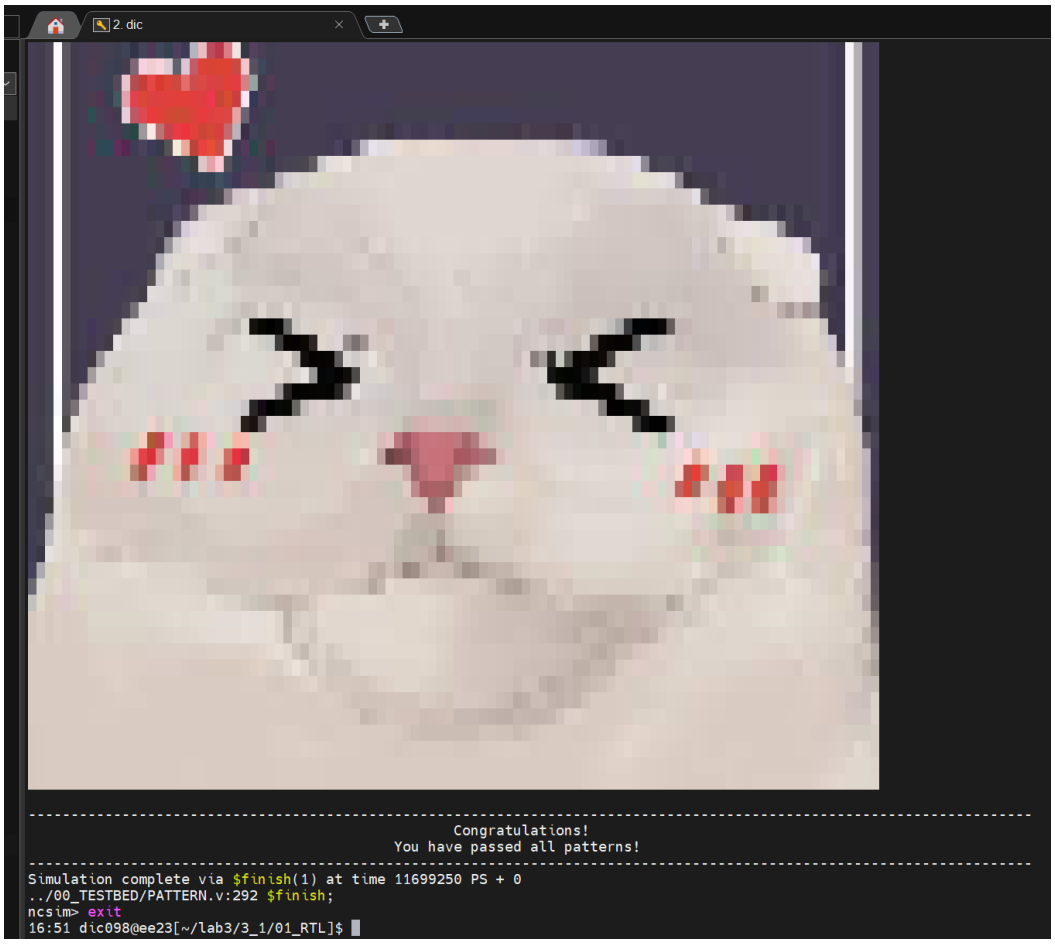
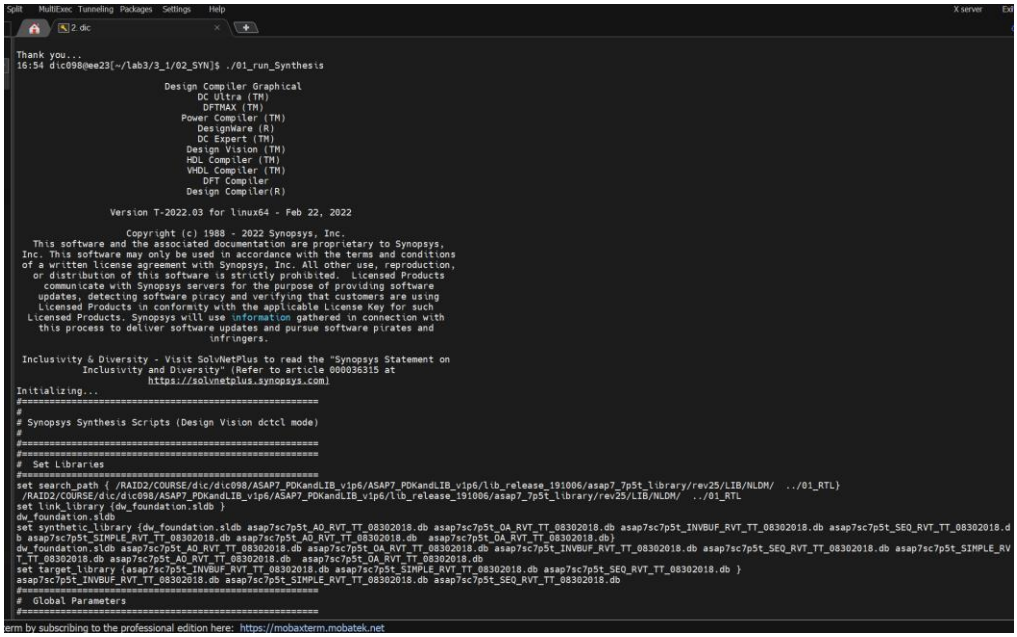
3-1 Implement the kernels **without** pipeline techniques.

```
16:45 dic098@ee23[~]$ cd /RAID2/COURSE/dic/dic098/lab3/3_1/01_RTL/
16:45 dic098@ee23[~/lab3/3_1/01_RTL]$ ./01_run
```

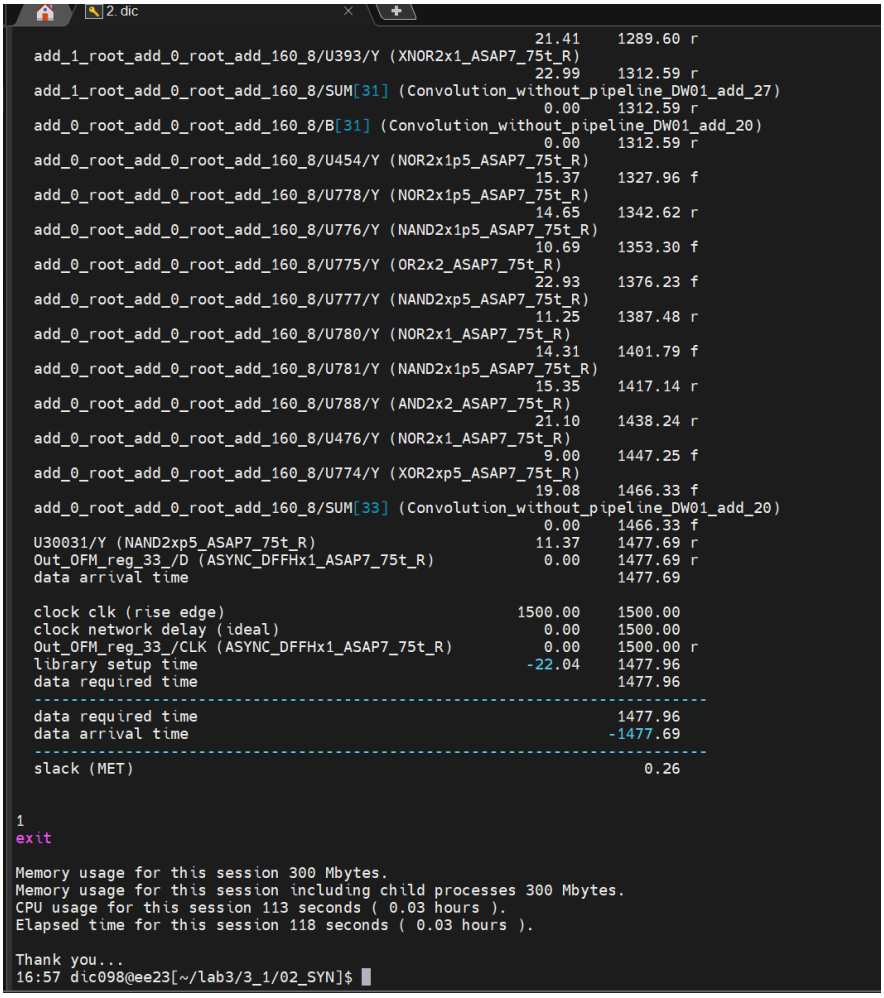
驗證指令



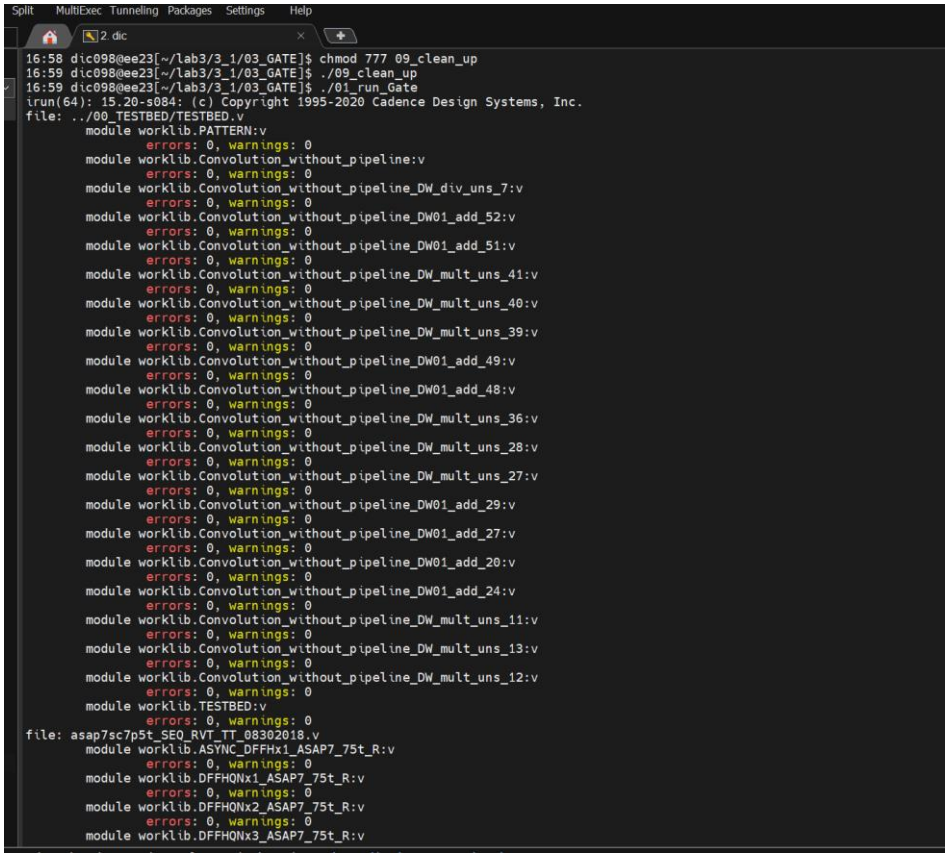
確認功能正確



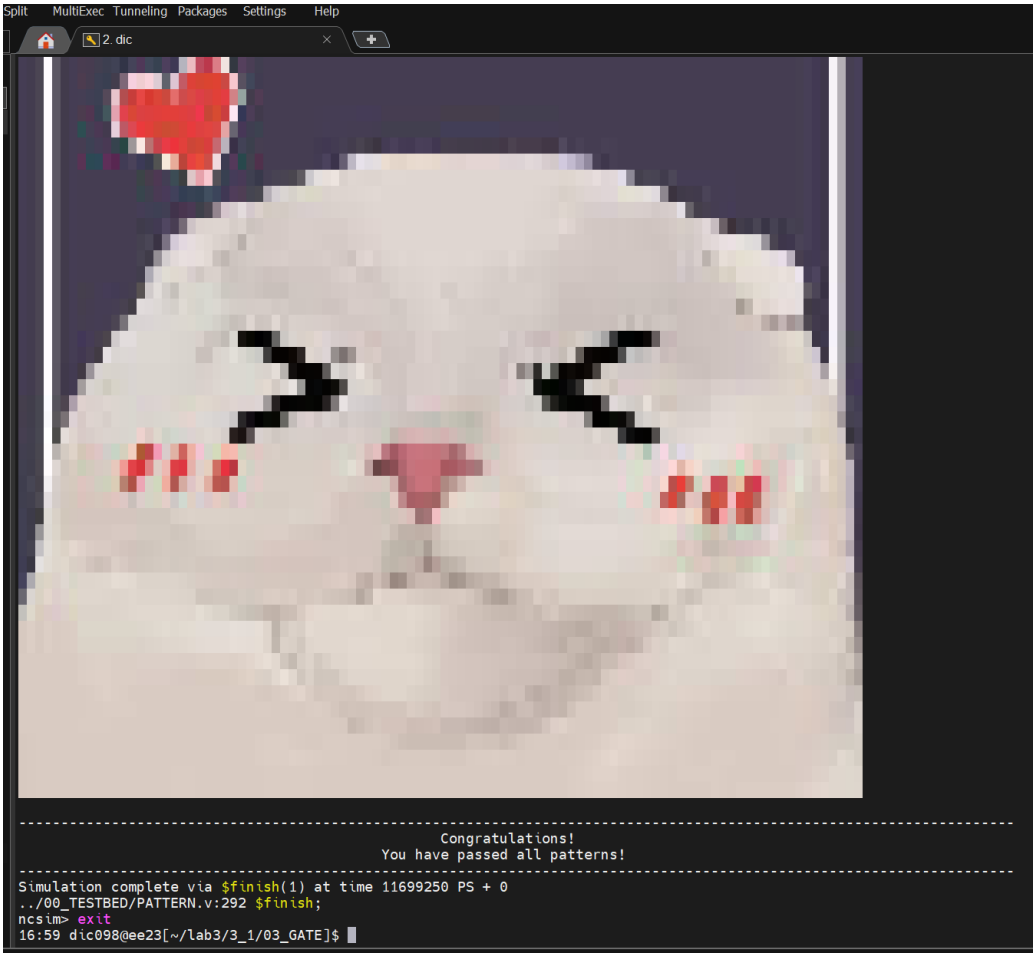
進行合成



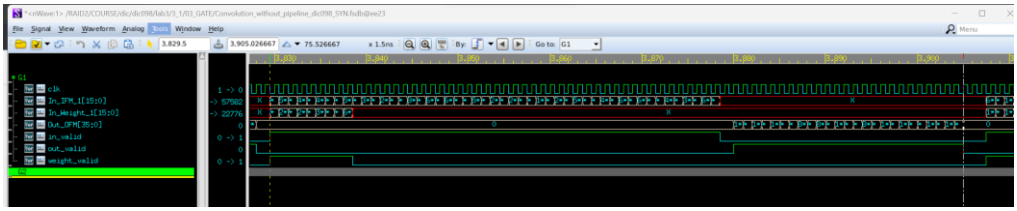
確認合成結果是否正確



Gate level 驗證



確認 Gate level 功能正確



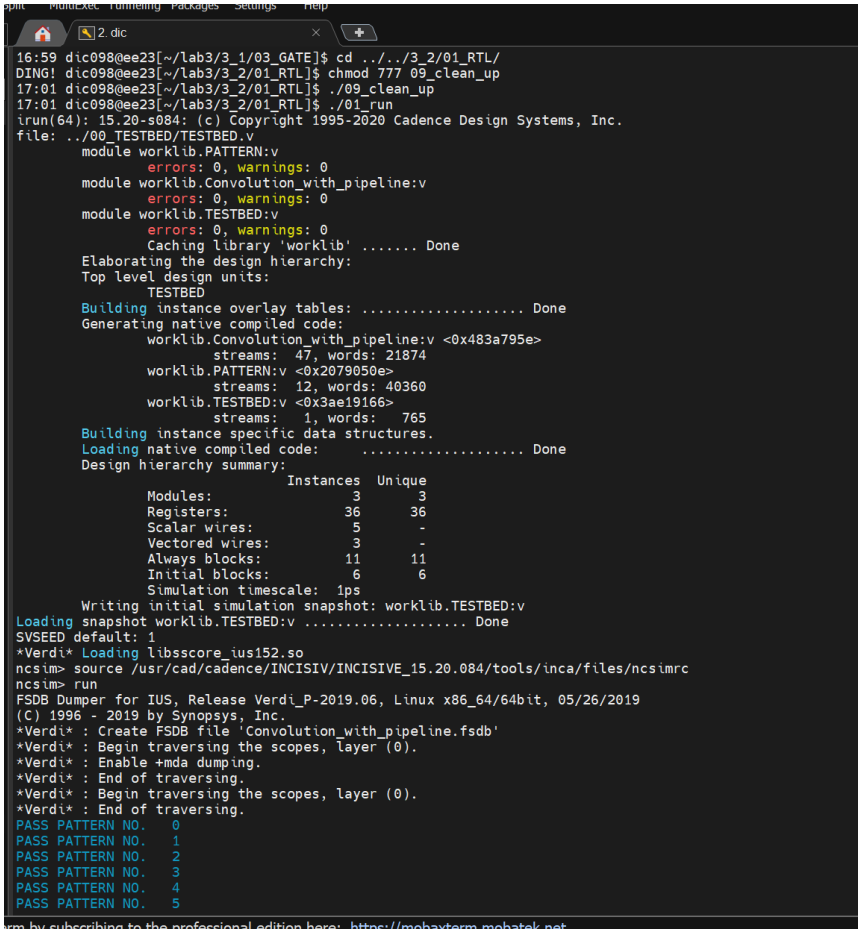
Measure Operation time

```
檔案    編輯    檢視

    asap7sc7p5t_INVBUF_RVT_TT_08302018 (File: /RAID2/COURSE/dic/dic098/ASAP7_PDKandLIB_v1p6/ASAP7
_PDKandLIB_v1p6/lib_release_191006/asap7_7p5t_library/rev25/LIB/NLDM/asap7sc7p5t_INVBUF_RVT_TT_
08302018.db)
    asap7sc7p5t_SIMPLE_RVT_TT_08302018 (File: /RAID2/COURSE/dic/dic098/ASAP7_PDKandLIB_v1p6/ASAP7
_PDKandLIB_v1p6/lib_release_191006/asap7_7p5t_library/rev25/LIB/NLDM/asap7sc7p5t_SIMPLE_RVT_TT_
08302018.db)
    asap7sc7p5t_SEQ_RVT_TT_08302018 (File: /RAID2/COURSE/dic/dic098/ASAP7_PDKandLIB_v1p6/ASAP7
_PDKandLIB_v1p6/lib_release_191006/asap7_7p5t_library/rev25/LIB/NLDM/asap7sc7p5t_SEQ_RVT_TT_
08302018.db)

Number of ports:                         1539
Number of nets:                         30738
Number of cells:                        28170
Number of combinational cells:          27125
Number of sequential cells:              1027
Number of macros/black boxes:               0
Number of buf/inv:                       2674
Number of references:                      57

Combinational area:              32807.332846
Buf/Inv area:                     1996.643542
Noncombinational area:            6229.042520
Macro/Black Box area:                0.000000
Net Interconnect area:      undefined  (No wire load specified)

Total cell area:                 39036.375366
Total area:                 undefined
1
```

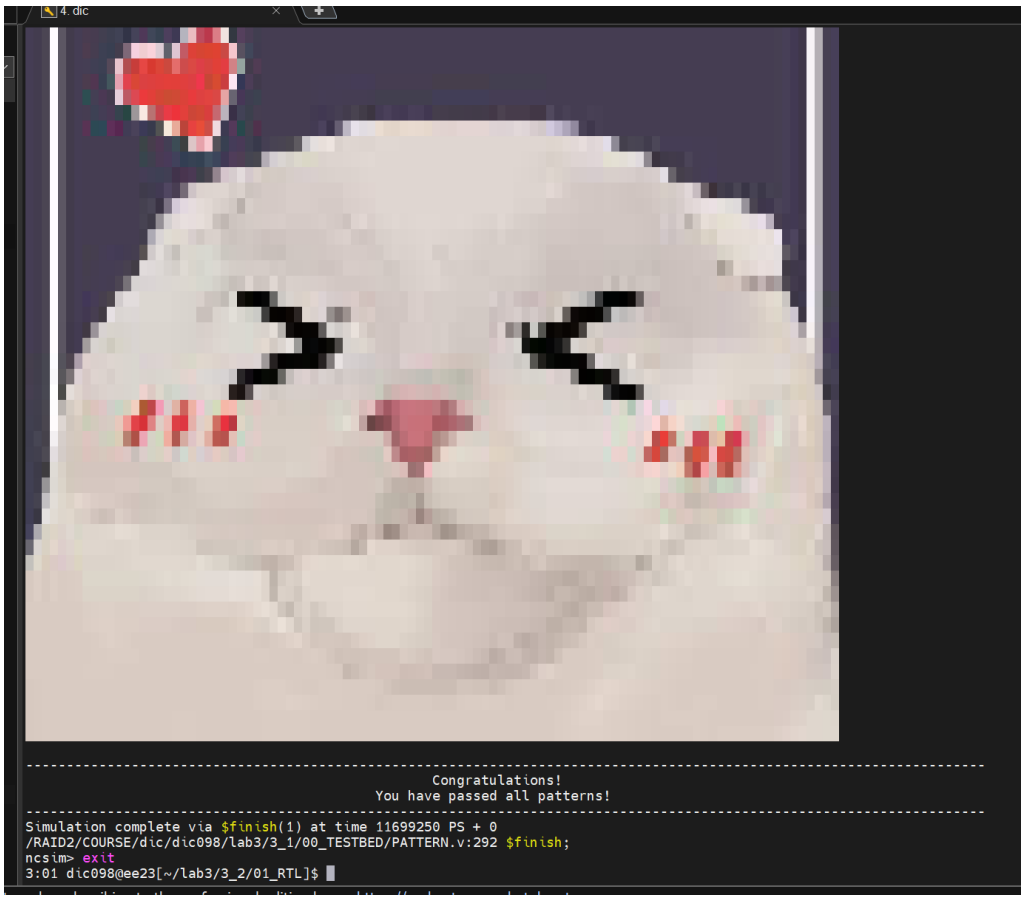
Area

$$\text{Throughput(OPS)} = \text{Operations} / \text{operating time} = \frac{450}{(3905.02-3829.5)*1.5*10^{-9}} = 3.972457627\ (\text{GOPS})$$

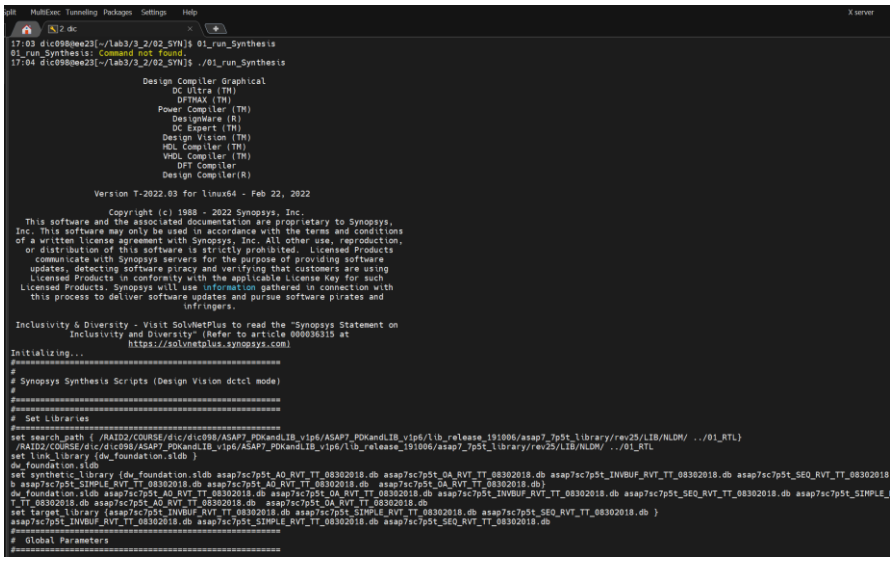
3-2 Implement the kernels **with** pipeline techniques.



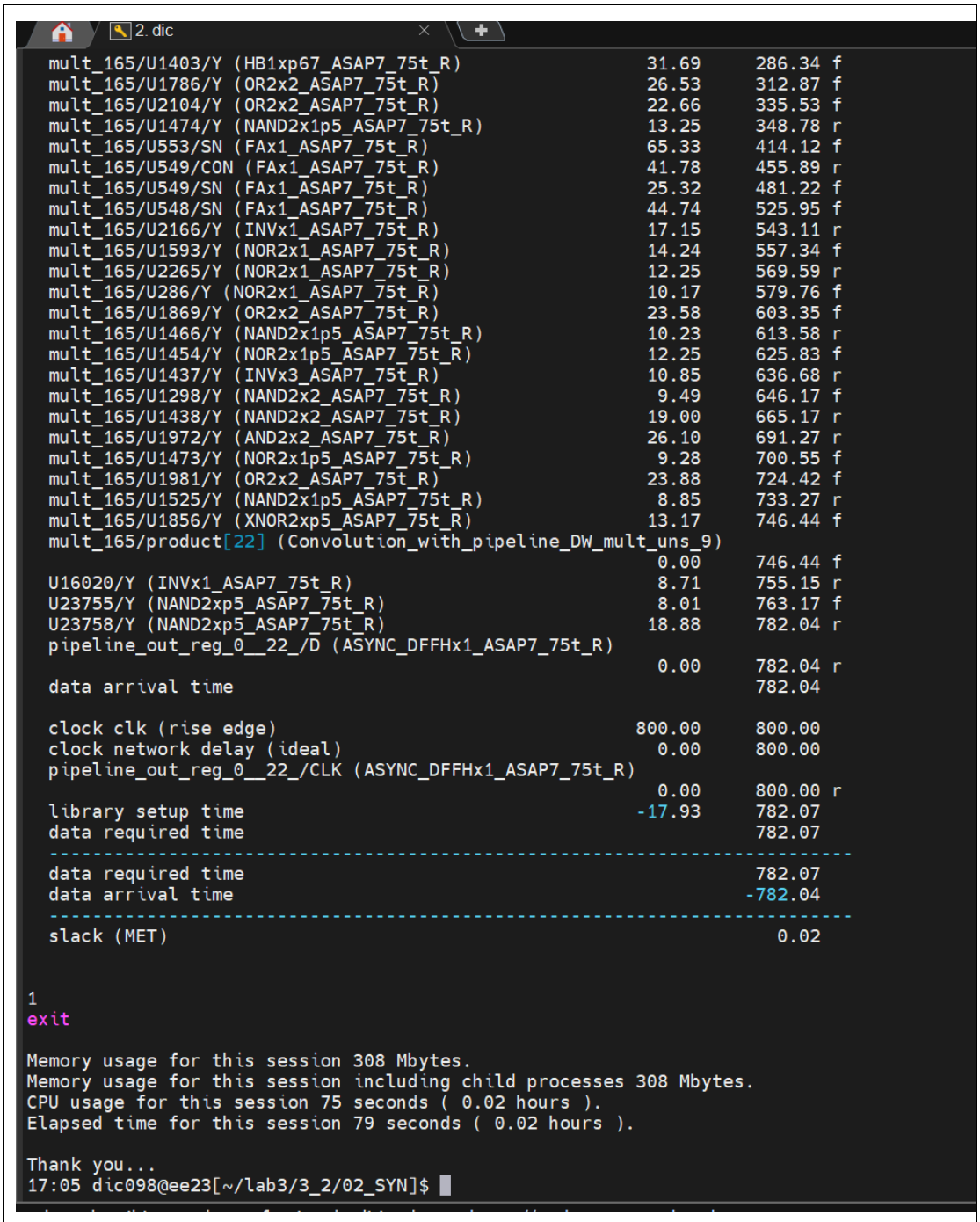
驗證指令



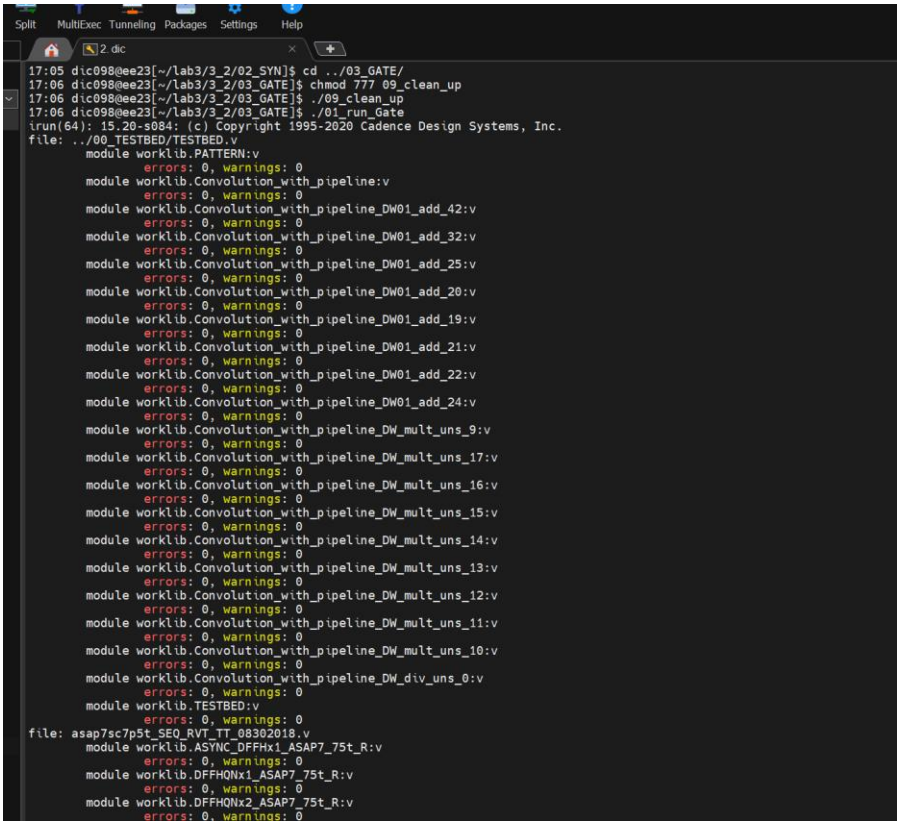
確認功能是否正確



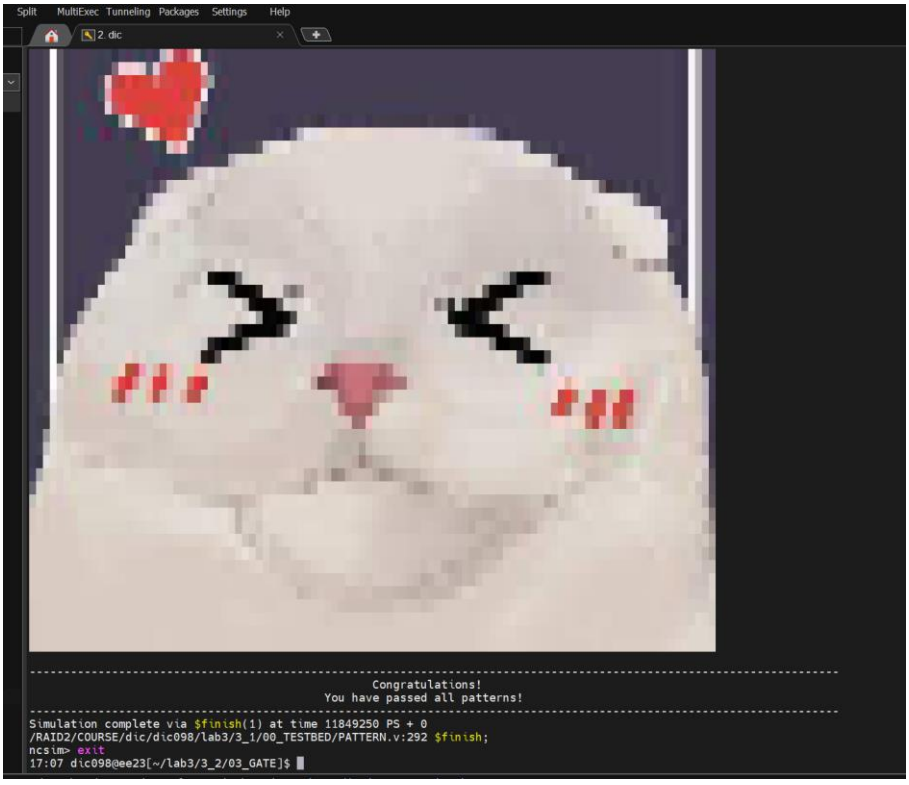
進行合成


2. dic
mult_165/U1403/Y (HB1xp67_ASAP7_75t_R) 31.69 286.34 f
mult_165/U1786/Y (OR2x2_ASAP7_75t_R) 26.53 312.87 f
mult_165/U2104/Y (OR2x2_ASAP7_75t_R) 22.66 335.53 f
mult_165/U1474/Y (NAND2x1p5_ASAP7_75t_R) 13.25 348.78 r
mult_165/U553/SN (FAx1_ASAP7_75t_R) 65.33 414.12 f
mult_165/U549/CON (FAx1_ASAP7_75t_R) 41.78 455.89 r
mult_165/U549/SN (FAx1_ASAP7_75t_R) 25.32 481.22 f
mult_165/U548/SN (FAx1_ASAP7_75t_R) 44.74 525.95 f
mult_165/U2166/Y (INVx1_ASAP7_75t_R) 17.15 543.11 r
mult_165/U1593/Y (NOR2x1_ASAP7_75t_R) 14.24 557.34 f
mult_165/U2265/Y (NOR2x1_ASAP7_75t_R) 12.25 569.59 r
mult_165/U286/Y (NOR2x1_ASAP7_75t_R) 10.17 579.76 f
mult_165/U1869/Y (OR2x2_ASAP7_75t_R) 23.58 603.35 f
mult_165/U1466/Y (NAND2x1p5_ASAP7_75t_R) 10.23 613.58 r
mult_165/U1454/Y (NOR2x1p5_ASAP7_75t_R) 12.25 625.83 f
mult_165/U1437/Y (INVx3_ASAP7_75t_R) 10.85 636.68 r
mult_165/U1298/Y (NAND2x2_ASAP7_75t_R) 9.49 646.17 f
mult_165/U1438/Y (NAND2x2_ASAP7_75t_R) 19.00 665.17 r
mult_165/U1972/Y (AND2x2_ASAP7_75t_R) 26.10 691.27 r
mult_165/U1473/Y (NOR2x1p5_ASAP7_75t_R) 9.28 700.55 f
mult_165/U1981/Y (OR2x2_ASAP7_75t_R) 23.88 724.42 f
mult_165/U1525/Y (NAND2x1p5_ASAP7_75t_R) 8.85 733.27 r
mult_165/U1856/Y (XNOR2xp5_ASAP7_75t_R) 13.17 746.44 f
mult_165/product[22] (Convolution_with_pipeline_DW_mult_uns_9)
0.00 746.44 f
U16020/Y (INVx1_ASAP7_75t_R) 8.71 755.15 r
U23755/Y (NAND2xp5_ASAP7_75t_R) 8.01 763.17 f
U23758/Y (NAND2xp5_ASAP7_75t_R) 18.88 782.04 r
pipeline_out_reg_0__22_/D (ASYNC_DFFHx1_ASAP7_75t_R)
0.00 782.04 r
data arrival time 782.04
clock clk (rise edge) 800.00 800.00
clock network delay (ideal) 0.00 800.00
pipeline_out_reg_0__22_/CLK (ASYNC_DFFHx1_ASAP7_75t_R)
0.00 800.00 r
library setup time -17.93 782.07
data required time 782.07
data required time 782.07
data arrival time -782.04
slack (MET) 0.02
1
exit
Memory usage for this session 308 Mbytes.
Memory usage for this session including child processes 308 Mbytes.
CPU usage for this session 75 seconds (0.02 hours).
Elapsed time for this session 79 seconds (0.02 hours).
Thank you...
17:05 dic098@ee23[~/lab3/3_2/02_SYN]$

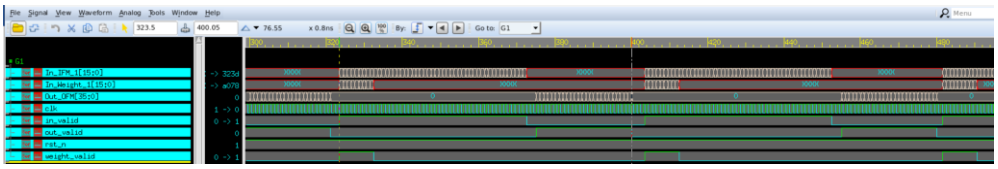
確認合成結果是否正確



Gate level 驗證



確認Gate level 功能正確



Measure Operation time

```
檔案    編輯    檢視

    asap7sc7p5t_INVBUF_RVT_TT_08302018 (File: /RAID2/COURSE/dic/dic098/ASAP7_PDKandLIB_v1p6/ASAP7
_PDKandLIB_v1p6/lib_release_191006/asap7_7p5t_library/rev25/LIB/NLDM/asap7sc7p5t_INVBUF_RVT_TT_
08302018.db)
    asap7sc7p5t_SIMPLE_RVT_TT_08302018 (File: /RAID2/COURSE/dic/dic098/ASAP7_PDKandLIB_v1p6/ASAP7
_PDKandLIB_v1p6/lib_release_191006/asap7_7p5t_library/rev25/LIB/NLDM/asap7sc7p5t_SIMPLE_RVT_TT_
08302018.db)
    asap7sc7p5t_SEQ_RVT_TT_08302018 (File: /RAID2/COURSE/dic/dic098/ASAP7_PDKandLIB_v1p6/ASAP7
_PDKandLIB_v1p6/lib_release_191006/asap7_7p5t_library/rev25/LIB/NLDM/asap7sc7p5t_SEQ_RVT_TT_
08302018.db)

Number of ports:                         1539
Number of nets:                         34189
Number of cells:                        31789
Number of combinational cells:          30456
Number of sequential cells:              1315
Number of macros/black boxes:               0
Number of buf/inv:                       3441
Number of references:                      64

Combinational area:              35346.818982
Buf/Inv area:                     2552.316509
Noncombinational area:            7975.843148
Macro/Black Box area:                0.000000
Net Interconnect area:      undefined  (No wire load specified)

Total cell area:                 43322.662130
Total area:                 undefined
1
```

AREA

Throughput(OPS) = Operations / operating time =

$$\frac{450}{(400.05-323.05)*0.8*10^{-9}} = 7.30519481\ (GOPS)$$