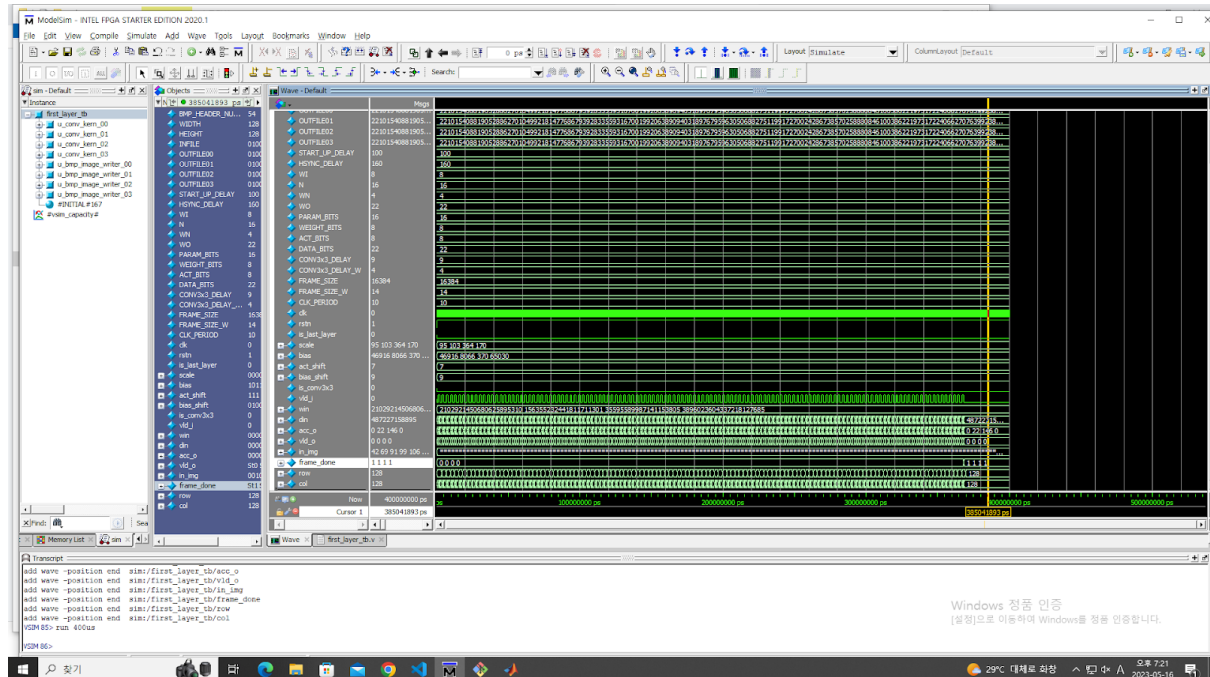**Homework 10: Sliding window, CNN Accelerator top file**
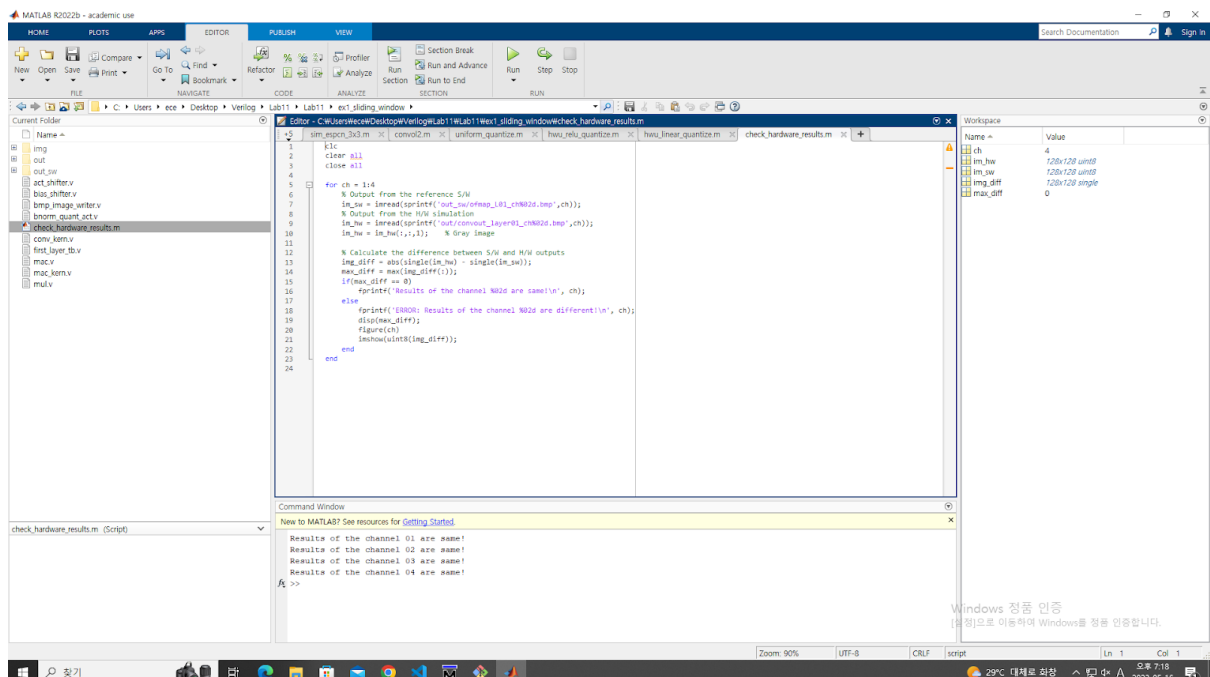
Name: Satyam (2023-81784)

Problem 1 (10p): Sliding window
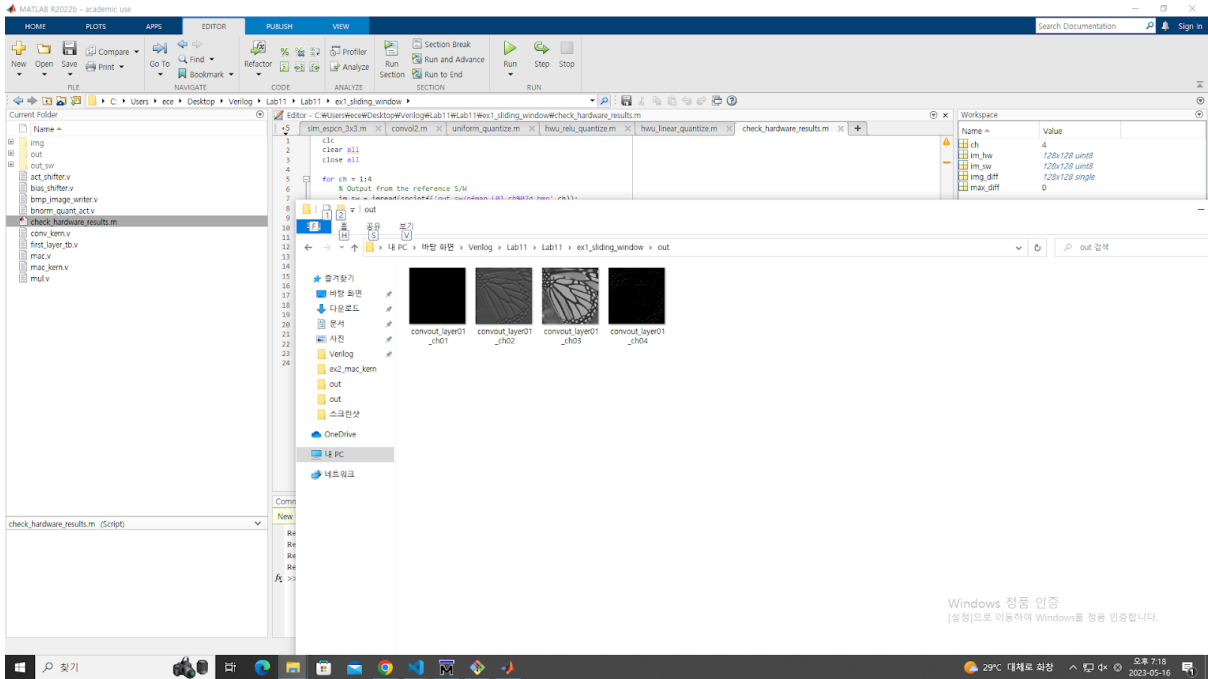
    a.   Waveform

    b.   Screenshots of check_hardware_results.m and output images generated by the H/W simulation.
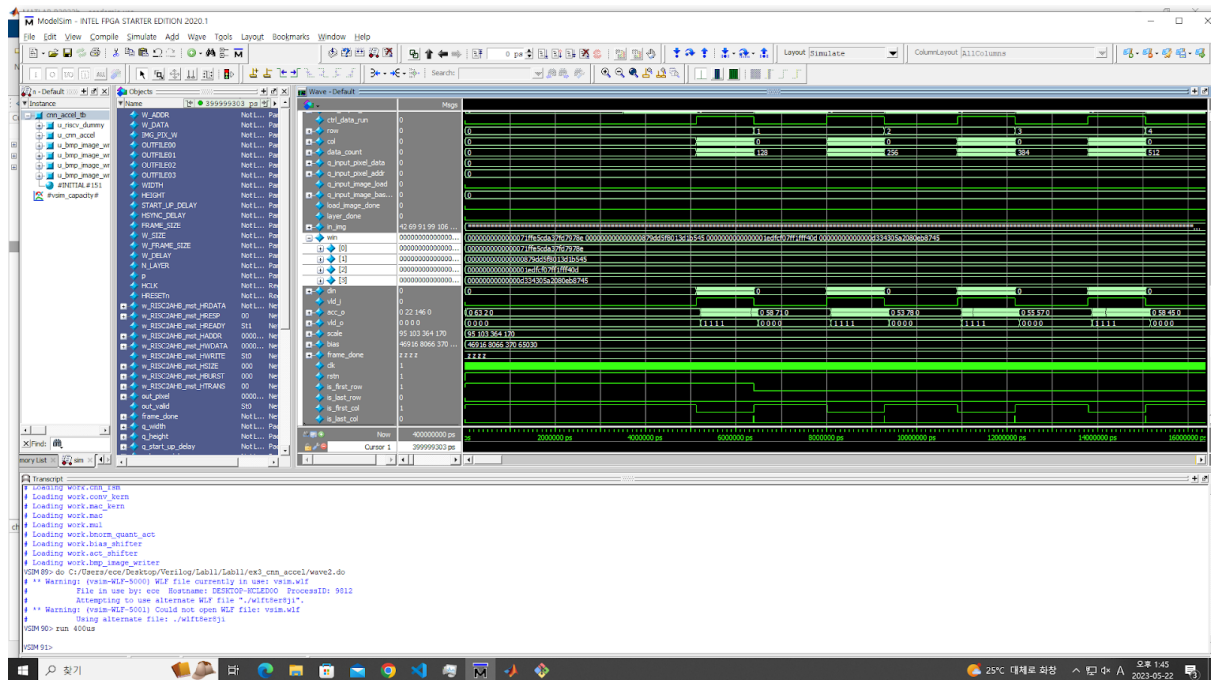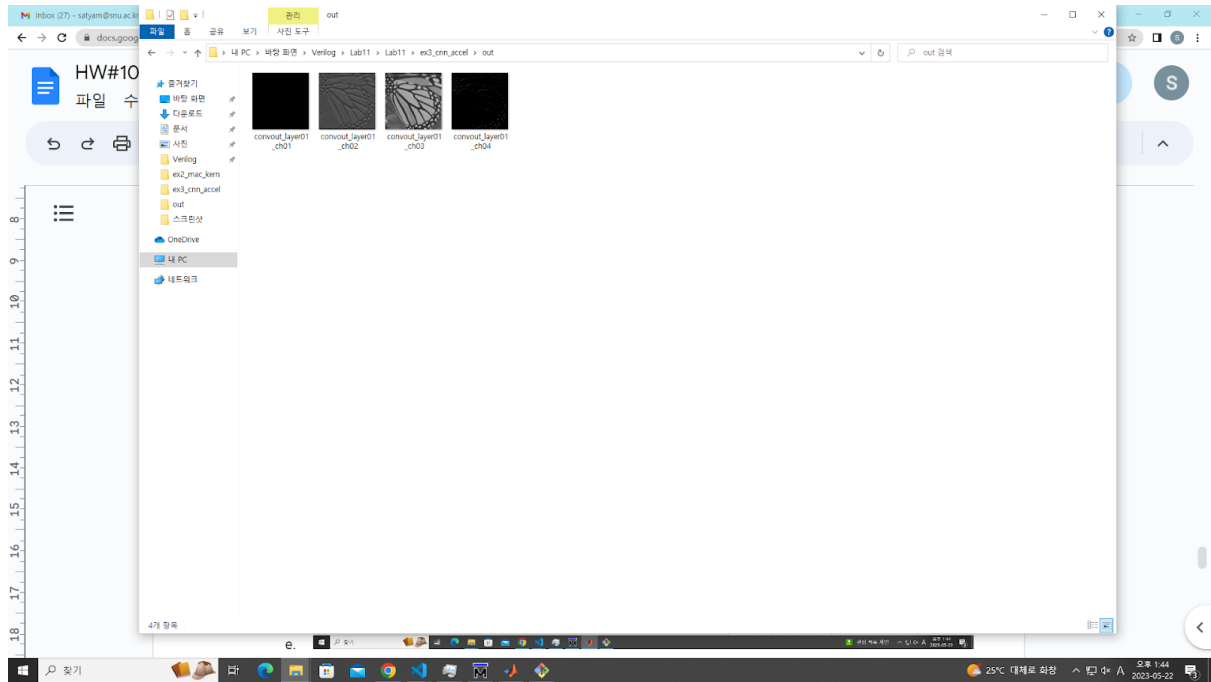
Problem 2 (10p): AHB interface, CNN Controller

a. Waveforms

Problem 3 (10p): Simplified CNN Accelerator IP

a. Waveform

b. Screenshots of check_hardware_results.m and the output images generated by the H/W simulation.

Problem 4: (Optional)

1. (1p) Briefly explain FSM's states in the CNN accelerator in Problem 3. (Hint: You can change START_UP_DELAY and HSYNC_DELAY in the testbench (cnn_accel_tb.v), do simulation, and check how the result is changed).

- Vsync: Syncing one frame till all data is received.

  - START_UP_DELAY: Helps to create a delay so all data is transformed and no data leaks happen to next frame

- Hsync: Syncing one horizontal row inside one frame till all data is received.

  - HSYNC_DELAY: Helps to create a delay so all data is transformed and no data leaks happen to next row

- Idle: When one frame is end, it is set to Idle for some time.

2. (1p) In Problems 1 and 3, it is costly to use multiplication for indexes in a sliding window (Fig.4-1). Modify the code to remove all multiplication operations for indexes here.

```
for(row = 0; row < HEIGHT*WIDTH; row = row + WIDTH) begin

    for(col = 0; col < WIDTH; col = col + 1) begin

        if (row == 0) begin

          if(col == 0) begin

            @(posedge clk)     vld_i = 1'b1;

            /* Insert your code*/

            din[0*WI+:WI] = 0          ;

            din[1*WI+:WI] = 0          ;

            din[2*WI+:WI] = 0         ;

            din[3*WI+:WI] = 0         ;

            din[4*WI+:WI] = in_img[(row  ) + col  ]      ;

            din[5*WI+:WI] = in_img[(row  ) + col+1]       ;

            din[6*WI+:WI] = 0         ;

            din[7*WI+:WI] = in_img[(row+1) + col  ]       ;

            din[8*WI+:WI] = in_img[(row+1) + col+1]       ;
```

Then so on…

We can loop row for a value of WIDTH*HEIGHT.