國立高雄科技大學

電子工程系(第一校區)

# 硬體描述語言

Lab. 7: Fork/Join

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# Lab. 7: Fork/Join (Chap. 7-C)

!!! 題說明位於作答區前面 !!!

1. Design an 8-bit *counter* by using a **forever** loop, *named block*, and *disabling of named block*.

- The counter starts counting at count = 5 and finishes at count = 67.
- The count is incremented at positive edge of clock.
- The clock has a time period of 10.
- The counter counts through the loop only once and then is disabled. (Hint: Use the disable statement.)
- Please perform the behavioral simulation, and show the correct waveform.
- Total simulation time is 650ns.

2. Below is a block with nested sequential and parallel blocks.

- When does the block finish and what is the order of execution of events?
- At what simulation times does each statement finish execution?

```
initial
begin
        x = 1'b0; $display ("Line1");
        #5 y = 1'b1;
        fork
                # 20 a = x;
                #15 b = y;
        join
        #40 x = 1'b1;
        fork
                # 10 p = x;
                begin
                        #10 a = y;
                        #30 b = x;
                end
                #5 m = y;
        join
end
```

# 作答方式

本次作業全部都是寫測試程式來模擬電路的動作順序，故於建立檔案時要記得是在 View = Simulation 的欄位下右鍵點選 xc3c200a-4dt256 之後建立一個 Verilog Test Fixture 再開始撰寫程式，需要使用的 PIN 要自行宣告。

# 作業學習目標

!!!本次作業在練習如何撰寫測試程式，是非常重要的練習!!!

第一題：學習如何透過特定條件觸發測試訊號改變。

第二題：學習 fork…join 語法，並觀察其動作方式與 begin…end 有何不同。

Table 1 begin...and & fork....join 比較

| HINT | begin…end | fork…join |
|---|---|---|
| 執行方式 | 循序執行 | 並列執行 |
| 執行開始時間 | 第一列程式開始執行 | 進入語法區況的時間 |
| 執行結束時間 | 最後一列程式執行結束 | 區塊內延遲最長的時間 |

# 作業作答格式

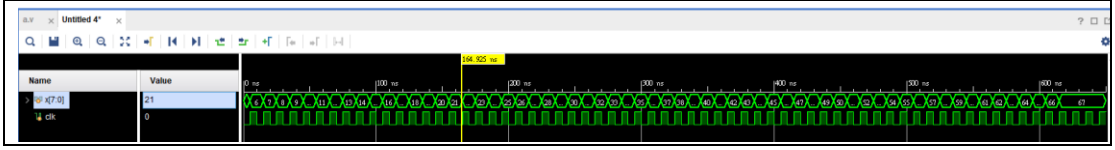
檢附項目：測試程式、Behavioral Simulation Waveform(含 $monitor)

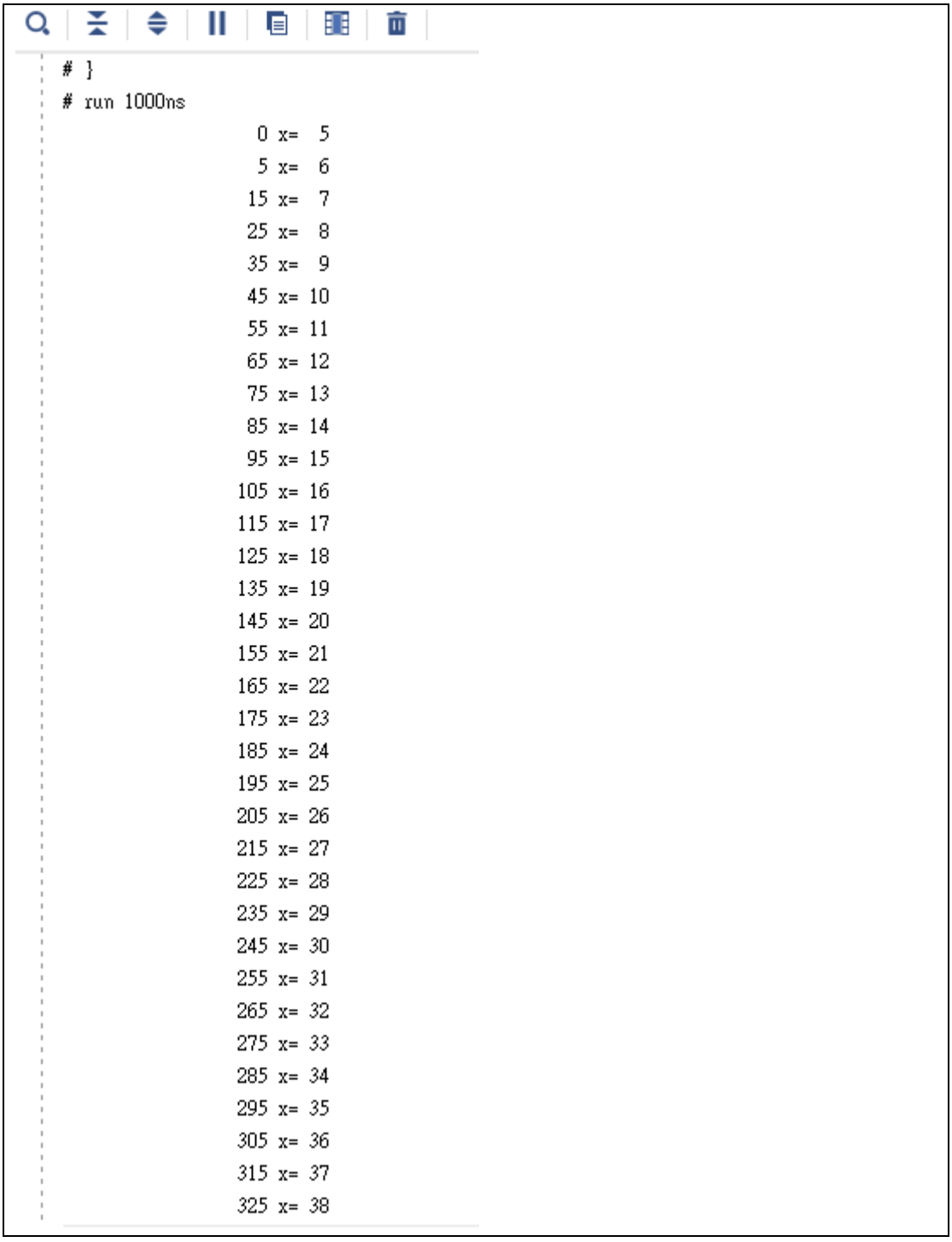
----------第一題作答區----------

測試程式

```
module count;
reg [7:0] x;
reg clk;
initial
begin
	clk = 1'b0;
	forever #5 clk = ~clk;
end
initial
begin
	x =8'b00000101;
begin: block1
	forever
		begin
			@(posedge clk) x = x+1;
			if (x==8'b01000011)
			disable block1;
		end
	end
end
initial #650 $finish;
initial
	$monitor($time," x=%d ",x);
endmodule
```

Behavioral Simulation Waveform(含 $monitor)





```
# }
# run 1000ns
                   0 x=  5
                   5 x=  6
                  15 x=  7
                  25 x=  8
                  35 x=  9
                  45 x= 10
                  55 x= 11
                  65 x= 12
                  75 x= 13
                  85 x= 14
                  95 x= 15
                 105 x= 16
                 115 x= 17
                 125 x= 18
                 135 x= 19
                 145 x= 20
                 155 x= 21
                 165 x= 22
                 175 x= 23
                 185 x= 24
                 195 x= 25
                 205 x= 26
                 215 x= 27
                 225 x= 28
                 235 x= 29
                 245 x= 30
                 255 x= 31
                 265 x= 32
                 275 x= 33
                 285 x= 34
                 295 x= 35
                 305 x= 36
                 315 x= 37
                 325 x= 38
```

```
                335 x= 39
                345 x= 40
                355 x= 41
                365 x= 42
                375 x= 43
                385 x= 44
                395 x= 45
                405 x= 46
                415 x= 47
                425 x= 48
                435 x= 49
                445 x= 50
                455 x= 51
                465 x= 52
                475 x= 53
                485 x= 54
                495 x= 55
                505 x= 56
                515 x= 57
                525 x= 58
                535 x= 59
                545 x= 60
                555 x= 61
                565 x= 62
                575 x= 63
                585 x= 64
                595 x= 65
                605 x= 66
                615 x= 67
$finish called at time : 650 ns : File "C:/Users/User/project_2/project_2.srcs/sim_1/new/a.v" Line 21
INFO: [USF-XSim-96] XSim completed. Design snapshot 'acount_behav' loaded.
```

----------作答區結束----------

----------第二題作答區----------

測試程式

```
module stimulus;
reg a,b,x,y,p,m;
initial
begin
        x = 1'b0;                $display ("Line1");
      #5 y = 1'b1;               $display ("Line2");
      fork
            # 20 a = x;          $display ("Line3");
            #15 b = y;           $display ("Line4");
      join
      #40 x = 1'b1;              $display ("Line5");
      fork
            # 10 p = x;          $display ("Line6");
            begin
                #10 a = y;       $display ("Line7");
                #30 b = x;       $display ("Line8");
            end
            #5 m = y;            $display ("Line9");
      join
end
initial
begin
      $monitor($time,"\t a=%b , b=%b , x=%b , y=%b , p=%b , m=%b",a,b,x,y,p,m);
end
initial
begin
      #200 $finish;
end
endmodule
```

Behavioral Simulation Waveform(含 $monitor)

```
# run 1000ns
Line1
                   0     a=x , b=x , x=0 , y=x , p=x , m=x
Line2
Line3
Line4
                   5     a=x , b=x , x=0 , y=1 , p=x , m=x
                  20     a=x , b=1 , x=0 , y=1 , p=x , m=x
                  25     a=0 , b=1 , x=0 , y=1 , p=x , m=x
Line5
Line6
Line9
                  65     a=0 , b=1 , x=1 , y=1 , p=x , m=x
                  70     a=0 , b=1 , x=1 , y=1 , p=x , m=1
Line7
                  75     a=1 , b=1 , x=1 , y=1 , p=1 , m=1
Line8
$finish called at time : 200 ns : File "C:/Users/User/project_1/project_1.srcs/sim_1/new/a.v" Line 27
```

1. line1 → line2 → line3 → line4 → line5 → line6 → line9 → line7 → line8

x = 1'b0; => Line1
#5 y = 1'b1; => Line2
# 20 a = x; => Line3
#15 b = y; => Line4
#40 x = 1'b1; => Line5
# 10 p = x; => Line6
#10 a = y; => Line7
#30 b = x; => Line8
#5 m = y; => Line9

2.
x = 1'b0; 在時間 0 時做完 1
#5 y = 1'b1; 在時間 5 時做完 2
# 20 a = x; 在時間 5+15=20 時做完 3
#15 b = y; 在時間 5+15+5=25 時做完 4
#40 x = 1'b1; 在時間 65 時做完 5
# 10 p = x; 在時間時 65 做完
#10 a = y; 在時間 65+5=70 時做完 7
#30 b = x; 在時間 70+5=75 時做完 8
#5 m = y; 在時間 65 時做完

----------作答區結束----------