

CPEN 211 Introduction to Microcomputers, 2017
Lab Proficiency Test #1

Question 1 [1.5 marks]: Create a file named “q1.v” and inside it write **synthesizable** Verilog that implements a combinational logic module matching the specification below. Your top-level module **must** be called “detect_full” and have inputs “ain” and output “f” declared as:

```
module detect_full(ain, f);
    input [11:0] ain;
    output [2:0] f;
```

The input “ain” is 12-bits wide. The output “f” is 3-bits wide. Your q1.v file **must** include definitions for **any** modules instantiated inside detect_full (even code provided in slides, labs or textbook). You are permitted to include testbench modules in q1.v. **Submit your q1.v via “Lab Proficiency Test #1” on Connect.** Your q1.v will get zero if any of the following are true:

1. Your **last** “Lab Proficiency Test #1” attempt on Connect does not include a file “q1.v”,
2. Your q1.v file does not compile using ModelSim (e.g., due to syntax errors),
3. Your q1.v does not contain a module named detect_full with inputs/outputs as above,
4. Your detect_full cannot be simulated (e.g., due to missing module definitions in q1.v),
5. The Verilog used by your detect_full is not synthesizable by Quartus,
6. The Verilog used by your detect_full has inferred latches, or
7. Your detect_full output “f” does not match the “Specification” given below.

Specification: Each bit of “ain” corresponds to one square in a 4×3 grid. A one in position *n* of “ain” indicates an “X” was played in the corresponding square as shown in **Figure 1(a)**. The output “f” uses a one-hot code to identify the closest row to the top of the board that is fully occupied with X’s, as specified on input “ain”. The bit f[0] should be one if the top row of the board is fully occupied with X’s as specified by ain. The bit f[1] should be one if the middle row of the board is fully occupied with X’s as specified by ain, but the top row is not fully occupied with X’s. The bit f[2] should be one if the bottom row of the board is fully occupied with X’s as specified by ain, but neither the top or middle rows are fully occupied with X’s. If *no* rows of the board as specified by ain are fully occupied by X’s, then f should be 3'b000. *Examples* of input ain and corresponding f are shown in **Figure 1(b)-(f)** below. **Your solution must work correctly for any value input “ain” (i.e., not only for these five examples).**

<table><tr><td>0</td><td>1</td><td>2</td><td>3</td></tr><tr><td>4</td><td>5</td><td>6</td><td>7</td></tr><tr><td>8</td><td>9</td><td>10</td><td>11</td></tr></table> <p>(a) Numbers indicate bit positon of input ain set to one for each board position played by X.</p>	0	1	2	3	4	5	6	7	8	9	10	11	<table><tr><td>X</td><td>X</td><td>X</td><td>X</td></tr><tr><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td></tr></table> <p>(b) <i>Example #1:</i> If ain==12'b000000001111 then f should output 3'b001</p>	X	X	X	X									<table><tr><td></td><td></td><td></td><td></td></tr><tr><td>X</td><td>X</td><td>X</td><td>X</td></tr><tr><td>X</td><td>X</td><td>X</td><td>X</td></tr></table> <p>(c) <i>Example #2:</i> If ain==12'b111111110000 then f should output 3'b010</p>					X	X	X	X	X	X	X	X
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Figure 1