1.4 DATA TYPES & STRUCTURES · 1.4.3

Adders & D-type flip-flops

Original practice questions · 30 marks · about 40 minutes · spec 1.4.3(e)

Instructions. Answer all questions. Marks are shown in brackets [ ]. Notation: `·` = AND, `+` = OR, `⊕` = XOR.

1

Total: 6 marks

A half adder adds two binary digits A and B, producing a sum S and a carry C.

(a) Write a Boolean expression for S in terms of A and B. _____ **[1]**

(b) Write a Boolean expression for C in terms of A and B. _____ **[1]**

(c) Draw a logic gate diagram for the half adder. **[2]**

(d) Explain why it is called a *half* adder. _____ **[1]**

(e) When the half adder computes 1 + 1, state the values of S and C. _____ **[1]**

2 **Total: 6 marks**

A full adder adds A, B and a carry-in (Cin).

(a) State the number of inputs a full adder has. _____ **[1]**

(b) Complete the truth table for the full adder. **[4]**

A	B	Cin	S	Cout
0	0	0		
0	0	1		
0	1	0		
0	1	1		
1	0	0		
1	0	1		
1	1	0		
1	1	1		

(c) Describe how full adders are used to add two multi-bit binary numbers. **[1]**

3 **Total: 6 marks**

(a) State the purpose of a D-type flip-flop. **[2]**

(b) Name the inputs and the outputs of a D-type flip-flop. **[2]**

(c) Describe how a D-type flip-flop stores a bit, referring to the clock. **[2]**

4 Total: 6 marks

(a) Write the Boolean expression for the sum S of a full adder, in terms of A, B and Cin. **[1]**

(b) Write the Boolean expression for the carry-out Cout of a full adder. **[2]**

(c) State what flip-flops are used to build. **[1]**

(d) Explain the role of the clock when many flip-flops are used together. **[2]**

5 Total: 6 marks

(a) For a full adder with A = 1, B = 1, Cin = 1, state the outputs S and Cout. **[2]**

(b) Explain how these outputs correspond to the binary addition 1 + 1 + 1. **[2]**

(c) State how many full adders would be needed to add two 8-bit numbers. **[1]**

(d) State the type of gate that produces the sum output in a half adder. **[1]**

END OF QUESTIONS