

2001 Paper 2 Question 3

Digital Electronics

Consider two numbers X and Y , each represented by n boolean variables $x_{n-1}x_{n-2}\dots x_0$ and $y_{n-1}y_{n-2}\dots y_0$ in the usual way so that for example $X = \sum_{i=0}^{n-1} 2^i x_i$.

- (a) Design a full adder to find $Z = X + Y$ in the case where $n = 2$. If each gate has a delay τ , how quickly is the result of the addition available after the inputs are presented? [5 marks]
- (b) Estimate a rough upper bound on the number of gates required to build a full adder in combinational logic when $n = 4$. [3 marks]
- (c) Describe *two* techniques for building adders which reduce gate count. [7 marks]
- (d) Design a full multiplier to find $W = X \times Y$ for the case where $n = 2$. [5 marks]