2001 Paper 10 Question 1

Digital Electronics

(*a*) Give the truth table for the exclusive or (XOR) of two boolean variables.

[2 marks]

(*b*) Express XOR in disjunctive normal form. [3 marks]

(*c*) XOR gates are sometimes called *half-adders*. Show how two XOR gates can be used to find the low-order bit of the sum of three one-bit numbers. [3 marks]

(*d*) If the XOR gates in part (*c*) were composed of gates corresponding to the expression in part (*b*), what would the delay of the circuit be? (Assume that inverters, OR gates and AND gates have a delay τ.) [4 marks]

(*e*) Give the transistor level circuit diagram for a CMOS NOR gate and explain its operation. [4 marks]

(*f*) Give a transistor level circuit diagram for a CMOS XOR gate. [4 marks]