COMPUTER SCIENCE TRIPOS Part IA – 2017 – Paper 2

1 Digital Electronics (IJW)

(*a*) Briefly describe the main feature of a combinational logic block. [2 marks]

(*b*) Use Boolean algebra to simplify the following expression

$$W = A.\overline{B}.C.\overline{D}.E + A.C.D + A.C.\overline{F}.G.\overline{H} + A.B.C.\overline{D}.E + A.C.D.\overline{E} + \overline{E}.\overline{H}$$

in sum of products form.

Hint: $X.Y + \overline{X}.Z = X.Y + \overline{X}.Z + Y.Z$ [4 marks]

(*c*) A 2-bit binary adder sums two numbers, A_1A_0 and B_1B_0 to yield the unsigned result $Y_2Y_1Y_0$, where the zero subscript indicates the least significant bit (LSB).

(*i*) Write down the truth table for the required outputs Y_2, Y_1 and Y_0.

(*ii*) Using a Karnaugh map (K map) or otherwise, give the simplified sum of products expression for Y_2.

(*iii*) Using a K map or otherwise, determine a simplified product of sums expression for Y_2 and show how the circuit can be implemented using only NOR gates (of any number of inputs).

[7 marks]

(*d*) Simplify the following four variable function $F(A, B, C, D)$ using the Quine-McCluskey (Q-M) method:

Minterms: $\overline{A}.\overline{B}.\overline{C}.\overline{D}$, $\overline{A}.\overline{B}.C.D$, $\overline{A}.B.\overline{C}.D$, $\overline{A}.B.C.D$, $A.\overline{B}.\overline{C}.\overline{D}$, $A.\overline{B}.C.\overline{D}$

Don't cares: $\overline{A}.\overline{B}.\overline{C}.D$, $A.\overline{B}.\overline{C}.D$, $A.B.C.D$ [7 marks]