

Digital Electronics

Tutorial Sheet 5

- 1.* What is important about the ordering of the rows and columns in a Karnaugh map?
- 2.** Using a Karnaugh map, show that $A\bar{C} + A\bar{B} + ABC + \bar{A}\bar{B}\bar{C} = A + \bar{B}\bar{C}$.
- 3.** Read the relevant parts of the notes and text book to review “Product of Sums” and “Sum of Products” forms. Minimise the following expression for f using SOP and POS forms. State which form is minimal in terms of the number of gates, not counting inverters.

$$f = \sum 0,1,5,7,8,14,15 \text{ with don't cares at 2 and 10.}$$

- 4.** Use a Karnaugh map to reduce each expression to a minimum SOP form:

a) $X = A + \bar{B}C + CD$

b) $X = \bar{A}\bar{B}CD + \bar{A}\bar{B}\bar{C}D + ABCD + ABC\bar{D}$

c) $X = \bar{A}B(\bar{C}\bar{D} + \bar{C}D) + AB(\bar{C}\bar{D} + \bar{C}D) + A\bar{B}\bar{C}D$

d) $X = (\bar{A}\bar{B} + A\bar{B})(CD + C\bar{D})$

e) $X = \bar{A}\bar{B} + A\bar{B} + \bar{C}\bar{D} + C\bar{D}$

- 5.*** A washing machine control circuit has 4 inputs: WASH, THERMOSTAT, FULL, EMPTY and 4 outputs: HOT, COLD, MOTOR and PUMP. When they are high, the outputs turn on the hot and cold taps, the main motor and the draining pump respectively. THERMOSTAT goes high when the water in the machine is above the required temperature; FULL and EMPTY indicate (when high) that the machine is completely full or completely empty of water respectively; they are both low when it is half full.

Draw a Karnaugh map for each output and hence write down the Boolean equations which describe the operation of the washing machine control circuit.

- 6.*** Design a logic circuit to produce a high output only if the input, represented by a 4-bit binary number, is greater than twelve or less than three. Implement a minimized circuit using only NAND gates.