

2008 Paper 11 Question 2

Digital Electronics

(a) With the aid of relevant diagrams, show the effect on the output of a combinational logic circuit of a:

(i) static hazard;

(ii) dynamic hazard. [3 marks]

(b) Simplify the following expressions using Boolean algebra:

(i) $X = (A + \bar{B} + \bar{A} \cdot B) \cdot (A + \bar{B}) \cdot \bar{A} \cdot B$

(ii) $Y = (A + \bar{B} + \bar{A} \cdot B) \cdot \bar{C}$ [4 marks]

(c) Given:

$$F = A \cdot B \cdot \bar{C} \cdot D + A \cdot C + B \cdot \bar{C} \cdot \bar{D} + \bar{B} \cdot C + \bar{A} \cdot \bar{C} \cdot \bar{D} + \bar{A} \cdot \bar{B} \cdot \bar{C} \cdot D$$

(i) Show using a Karnaugh map that F can be simplified to

$$F_1 = A \cdot B + \bar{A} \cdot \bar{B} + A \cdot C + B \cdot \bar{C} \cdot \bar{D}$$
 [2 marks]

(ii) Show that there are a total of four possible expressions for F . [3 marks]

(iii) Show how F_1 can be implemented using NAND gates and draw the circuit diagram. Assume that complemented input variables are available. [2 marks]

(iv) Show how the static 1 hazard in F_1 can be eliminated using a Karnaugh-map-based approach. [2 marks]

(v) Now implement F_1 assuming that only 2-input NAND gates are available. [4 marks]