

**University of Waterloo**  
**Department of Electrical and Computer Engineering**  
**ECE 223 Digital Circuits and Systems**

Midterm Examination

Instructor: M. Sachdev/J. Hamel

Date Feb 10, 2001

Total Marks = 100

Name:..... Student id:.....								
1.		2.	3.	4.		5.		Total:

Attempt all problems. If information appears to be missing make a reasonable assumption, state it and proceed. Calculators are not needed and are not allowed

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**Problem 1**

**(A):** Convert following number from one radix to another [8]

(i)  $(10.11111)_2$  to radix 8 to five significant decimal places

(ii)  $(157)_{BCD}$  to radix 12

Name:.....

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**(B):**

(i) Given  $A = (0111\ 0001)_2$  and  $B = (0101\ 0101)_2$ ; Perform  $B - A$  operation using 1's complement arithmetic. Show all steps. [6]

(ii) Assuming that a computer uses 8 bits to represent numbers, show how the numbers  $(-21)_{10}$  and  $(-33)_{10}$  would be represented in the computer using the signed 2's complement binary number system. Perform the operation  $\{ (-21)_{10} - (33)_{10} \}$  as it would occur in this computer using 8-bit signed 2's complement binary arithmetic, converting the answer to signed magnitude binary and decimal numbers. [6]

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**Problem 2**

Simplify the following functions using the K-map method expressing them in product of sums form. Implement them with two-level NOR gate circuits (assume that complement versions of all input variables are already available to the circuit). [20]

(i)  $F = W \bar{X} + \bar{Y} \bar{Z} + \bar{W} Y \bar{Z}$

(ii)  $F(W,X,Y,Z) = \sum m(5,6,9,10)$

Name:.....

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**Problem 3**

Given the function  $F(w, x, y, z) = \sum m(0, 3, 4, 5, 6, 7, 9, 10, 12, 13, 14, 15)$  [20]

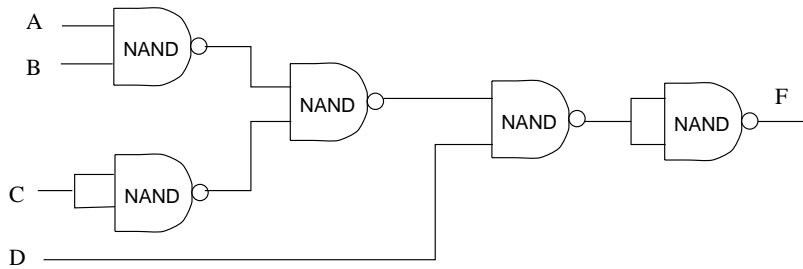
- (i) Derive the Truth Table for the function F
- (ii) Simplify the function using 4 variable K-map
- (iii) List all the essential prime implicants
- (iv) Express the simplified function in the “Sum of products form”

Name:.....

Student id:.....

**Problem 4**

**(A):** Verify algebraically that the circuit shown below implements the following Boolean function,  $F = \overline{C} (\overline{A} + \overline{B}) + \overline{D}$  [10]



**(B):** Implement the above function F using **only** 2-input NOR gates [10]

Name:.....

Student id:.....

**Problem 5**

Derive the truth table of the circuit shown below [20]

