University of Windsor

School of Computer Science
Faculty of Science

COMP-2650: Computer Architecture I: Digital Design
Winter 2021

Title	Date	Time	Duration	Grade Release Date
Midterm Exam	Feb. 23, 2021	10:00 AM	180 minutes	March 09, 2021

Questions

You must show your work and all steps for every question!

Question 1: [10 marks: 2.5 marks each]
Explain the following terms in two or three sentences.

a. Number System
b. Switching Algebra
c. Duality
d. Inverse Postulate

Question 2: [10 marks: 2.5 marks each]
Assuming an unsigned number system (all numbers are positive), show the maximum number and the smallest unit of increment given 4 integer and 3 fraction positions in the octal number system and their equal decimal values.

a) (Max ?)$_8$ = (?)$_{10}$
b) (Smallest Unit ?)$_8$ = (?)$_{10}$

Question 4: [10 marks]
Show the minimum possible error when converting $(16.4)_{10}$ to base-4 if only 5 positions are given in total for both integer and fraction parts. Report the error in base-10.

Question 5: [10 marks: 2.5 marks each]
Show the negative and positive numbers for $(86)_{10}$ in base-5 using the signed-magnitude and signed-radix-complement number systems, given 10 positions for integer part with no fraction part:

a) Positive signed-magnitude
b) Negative signed-magnitude
c) Positive signed-radix-complement
d) Negative signed-radix-complement

Question 6: [10 marks: 5 marks each]
Perform the following arithmetics in singed-2's-complement base-2 for the following decimal numbers using the least number of bits and check whether an overflow happens.

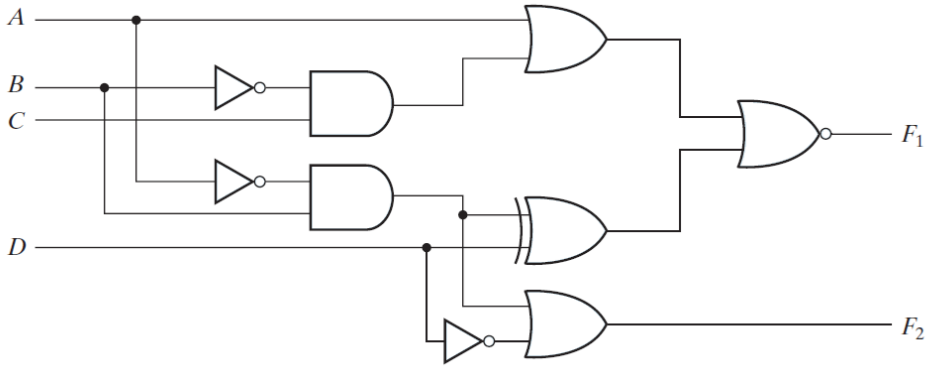
a. (+31) – (–1)
b. (+31) + (–32)

Question 7: [10 marks: 5 marks each]
Show that the binary operator XNOR satisfies the following postulates:

a) Identity
b) Inverse

Question 9: [15 marks]
Analyze the logic circuit shown below:

a) Show the truth table.
b) F2 = ∏ (?).



Question 10: [25 marks]
Design a 3-bit incrementor, that is, the output generates the next number after the input number (e.g., 3 → 4. Also, 7 → 0):

a) Show the truth table.
b) Show the Boolean expression(s) for the output(s) in sum-of-minterms.
c) Algebraically, simplify the Boolean expression(s).
d) Design the circuit using NAND gates only.