

King Fahd University of Petroleum and Minerals
College of Computer Science and Engineering
Computer Engineering Department

COE 202: Digital Logic Design (3-0-3)
Term 102 (Spring 2011)
Major Exam 1
Thursday March 17, 2011

Time: 90 minutes, Total Pages: 9

Name: _____ **ID:** _____ **Section:** _____

Notes:

- Do not open the exam book until instructed
- **Calculators are not allowed** (*basic, advanced, cell phones, etc.*)
- Answer all questions
- All steps must be shown
- Any assumptions made must be clearly stated

Question	Maximum Points	Your Points
1	25	
2	20	
3	10	
4	20	
Total	75	

Question 1.

(25 points)

Fill in the Spaces: (Show all work needed to obtain your answer)

- a. The expressions $A(B + CD) + \overline{B}C$ and _____ are duals
- b. For the logic function $F(W, X, Y, Z)$, minterm $m_5 = X\overline{Y}Z$. _____ (True/False)
- c. Counting the number of hours in one day in BCD requires a minimum of _____ (how many) bits.
- d. The Boolean function $F(x, y) = \sum m(1, 3)$ simplifies to one literal as _____.
- e. $F(A, B, C, D) = \overline{A}\overline{B}\overline{C}\overline{D} + A\overline{B}\overline{C}D + \overline{A}\overline{B}CD$ is represented in the canonical shorthand form as $F(A, B, C, D) = \sum m(\underline{\hspace{2cm}})$.
The complement $\overline{F}(A, B, C, D) = \prod M(\underline{\hspace{2cm}})$
- f. Assume some computer hardware that performs integer arithmetic in 5 bits. The largest decimal number that can be added to 12 without causing an incorrect result is _____.
- g. The decimal value of the largest 3-bit binary fraction is _____.
- h. One factor that may limit gate fan out is _____.
- i. The largest 2-digit octal number has the decimal value _____.
- j. Using gates having propagation delay of 5 ns each, the input-to-output delay for a logic circuit that directly implements the logic function $XYZ + WV$ will be _____ ns.

k. To implement the function $F(V, W, X, Y, Z) = \Pi(2, 14, 29)$ as a product of maxterms, we need _____ (how many) OR gates, each having _____ (how many) inputs.

l. To represent any integer greater than 1, the binary system requires the largest number of digits among all number systems _____ (True/False)

m. The Hi-Z logic state becomes relevant when connecting: _____ (select one)

- i) Inputs of logic gates together
- ii) An output of a logic gate to inputs of other logic gates
- iii) Outputs of logic gates together

Question 2.

(20 Points)

- a. Using up to 4-bit fractional accuracy, convert $(103.4375)_{10}$ to: **(8 Points)**
- i. Binary
 - ii. Octal
 - iii. Hexadecimal

b. Find the result of the following operations:

(9 Points)

- i. $(37.4)_{16} + (59.7)_{16}$
- ii. $(37.4)_8 + (59.7)_{16}$
- iii. $(101)_2 \times (110)_2$
- iv. $(111100)_2 - (100011)_2$

c. Determine the radix r for the following case: $(6A)_r = (86)_{14}$

(3 Points)

Question 3.**(10 Points)**

Prove the identity of each of the following Boolean functions using algebraic manipulation. Start with the left-hand side expression and derive from it the right-hand side expression.

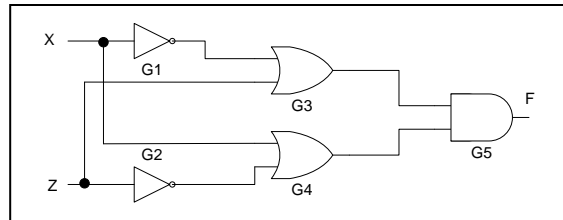
(i) $\bar{a}\bar{c} + ad + b\bar{c}d = \bar{a}\bar{c} + ad$

(ii) $\overline{(\bar{a}[\bar{c} + d] + c[\bar{b} + \bar{d}] + \bar{c}\bar{d})} = ad(b + \bar{c})$

Question 4.**(20 Points)**

- a. For the circuit shown, the propagation delay (in nano-seconds) for each gate is listed in the table below. **(5 Points)**

Gate	Propagation Delay (in Nano ¹ -Seconds)
G1	1 ns
G2	1.5 ns
G3	4 ns
G4	2.5 ns
G5	2 ns



- (i) What is the Boolean expression of the output function F

- (ii) What is the worst case path delay for this circuit

- b. Express the following function in the sum of minterms form $\{\Sigma(m_i)\}$ and the product of Maxterms form $\{\Pi(M_i)\}$ **(6 Points)**

$$F(A, B, C, D) = A' C (B' + D)$$

¹ Nano = 10^{-9}

