Name _____

# Digital Logic I

# EE 2720-2

# Midterm Examination 1

3 October 2011, 14:40–15:30 CDT

Exam Rules

Use only a pencil or pen. No calculators of any kind are allowed. Texting is out of the question.

| | | |
|---|---|---|
| Problem 1 | _____ | (15 pts) |
| Problem 2 | _____ | (9 pts) |
| Problem 3 | _____ | (9 pts) |
| Problem 4 | _____ | (24 pts) |
| Problem 5 | _____ | (9 pts) |
| Problem 6 | _____ | (9 pts) |
| Problem 7 | _____ | (16 pts) |
| Problem 8 | _____ | (9 pts) |
| Exam Total | _____ | (100 pts) |

Alias _____

*Good Luck!*

Problem 1: (15 pts) Perform the conversions indicated below. For conversions to decimal all you need to show is the arithmetic that needs to be done to compute the value, there's no need to perform the computation. For example, a decimal value can be written as $\boxed{12 + 3 \times \frac{4}{5+6} + 7 \times \pi^{-9}}$. This only applies to answers in decimal.

☐ Convert $257_{10}$ to hexadecimal.

*Hint:* $16^2 = 256$.

☐ Convert $2f7_{16}$ to decimal.

☐ Convert $2.f7_{16}$ to decimal. (Don't overlook the radix point.)

☐ Convert $257_9$ to decimal.

☐ Convert $1011\,0100_2$ to decimal.

Problem 2: (9 pts) Perform the conversions below, taking advantage of the fact that all radices are powers of 2.

☐ Convert $abc_{16}$ to binary.

☐ Convert $abc_{16}$ to octal.

☐ Convert $abc_{16}$ to radix 4.

Problem 3: (9 pts) For each pair below briefly indicate an advantage (in some situations) of the first coding over the second coding.

☐ Advantage of Gray code over binary code.

☐ Advantage of BCD over binary.

☐ Advantage of binary over BCD.

Problem 4: (24 pts) Perform the conversions indicated below. The number representations in this problem have specific sizes (*e.g.*, 8 bits).

☐ Convert the following 8-bit binary unsigned to decimal: `1100 0101`

☐ Convert the following 8-bit binary signed magnitude to decimal: `1100 0101`

☐ Convert the following 8-bit binary 2's complement to decimal: `1100 0101`

☐ Convert the following 8-bit binary 1's complement to decimal: `1100 0101`

☐ Convert the following 8-bit binary 2's complement to 12-bit binary 2's complement: `1100 0101`

☐ Convert the following 12-bit (yes 12 bit even though 8 bits are shown) binary 2's complement to decimal: `1100 0101`

☐ Convert the following 8-bit binary unsigned to 12-bit BCD: `1100 0101`

☐ Convert the following 8-bit excess-3 code to decimal: `1100 0101`

☐ Double-check that minus signs were included where necessary in the answers above.

Problem 5: (9 pts) Find the minimum number of bits to encode one thousand in each of the representations below. For example, the number of bits needed for $10^3$ in unsigned binary would be 10 because $1000_{10} = 3e8_{16}$ and each hex digit spans four bits. *Hint: The solution does not require a tedious conversion.*

☐ Number of bits needed to encode one thousand in BCD:

☐ Number of bits needed to encode one thousand in decimal using ASCII:

☐ Number of bits needed to encode one thousand in English using ASCII:

Problem 6: (9 pts) Solve the following arithmetic problems. Show the result (sum) in the same representation as the operands. To avoid confusion, box your answer and show your work.

☐ Add the following 8-bit unsigned numbers.

☐ Indicate whether there is overflow:

$$\begin{array}{rr} & 1100\,0101 \\ + & 0101\,0011 \\ \hline \end{array}$$

☐ Add the following 8-bit 2's complement numbers.

☐ Indicate whether there is overflow:

$$\begin{array}{rr} & 1100\,0101 \\ + & 0101\,0011 \\ \hline \end{array}$$

☐ Add the following 8-bit 1's complement numbers.

☐ Indicate whether there is overflow:

$$\begin{array}{rr} & 1100\,0101 \\ + & 0101\,0011 \\ \hline \end{array}$$

Problem 7: (16 pts) Transform the following Boolean expressions as indicated.

☐ Simplify.

$$x \cdot y + x \cdot y \cdot z' + y \cdot w \cdot x$$

☐ Simplify by eliminating one term.

$$x \cdot (a + b) + (a + b)' \cdot (c + e) + (c + e) \cdot x$$

☐ Simplify.

*Those who recognize something from Homework 2 can solve this quickly.*

$$(a + b + c) \cdot (a + b + e) \cdot (a + b + f)$$

☐ Write the following as a sum of products.

$$[a + b + (c + e)']' + f$$

☐ Write the following as a product of sums.

$$a + b \cdot (c + e)$$

Problem 8: (9 pts) Convert the Boolean expressions as indicated.

(*a*) Show logic gates corresponding to the expression below as written. (That is, don't simplify or otherwise transform it.)

$$[a + b + (c + e)']' + f$$

☐ Show logic gates.

(*b*) Show the dual of the Boolean equation below:

$$x + x' \cdot y = x + y$$

☐ Dual of equation above.

(*c*) Prove that the following equality is valid by constructing a truth table.

$$x + x' \cdot y = x + y$$

☐ Truth table to prove equality.