STUDENT NAME and NUMBER: _____

(PLEASE PRINT CLEARLY)

Georgia Institute of Technology
Department of Electrical and Computer Engineering

Test #1

ECE2030: Introduction to Computer Engineering

Marks:		
	Q1	/25
	Q2	/36
	Q3	/37
	Q4	/12
Total:		/100+10

DATE: September 21, 2000 **TIME:** 4:35 p.m. - 5:55 p.m.

REMARKS: 1. All questions should be answered (in the space provided).
2. Books and notes may NOT be used, with the exception of one 8.5”x11” sheet of paper.

1. SWITCH NETWORKS *(MAX MARK: 25)*

a) Explain why a CMOS switch network contains both nMOS and pMOS transistors.

b) Draw a transmission gate (pass gate) and explain how it works for its various inputs.

c) For each expression below, create a switch level implementation using CMOS technology with nMOS and pMOS transistors. Assume both inputs and their complements are available. Your design should contain no shorts or floats. Use as few transistors as possible, but do not simplify the expressions.

$$\mathbf{out} = \overline{\mathbf{A}} + \overline{\mathbf{C}}\mathbf{B}\overline{\mathbf{D}}$$

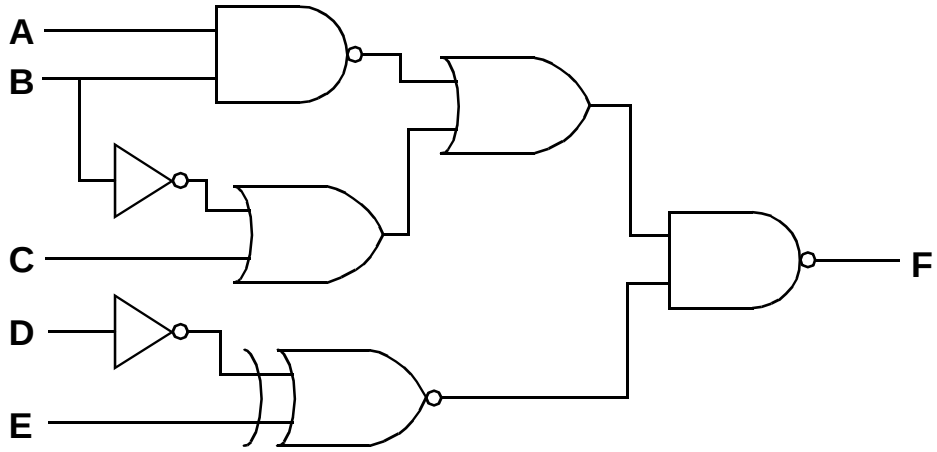
$$\mathbf{out} = (\mathbf{A} + \mathbf{B}\overline{\mathbf{C}})(\mathbf{E}\mathbf{D} + \overline{\mathbf{F}}) + \mathbf{G}$$

2. GATE DESIGN *(MAX MARK: 36)*

a) Draw a logic gate implementation of the following Boolean function.

$$\mathbf{F} = \mathbf{A}(\mathbf{B}\overline{\mathbf{C}}\mathbf{D} + \overline{\mathbf{E}})(\overline{\mathbf{B}} + \overline{\mathbf{D}}\mathbf{C})$$

b) Extract the Boolean function from the follow logic diagram.



F = _____

c) For the previous question, mark the number of transistors required to implement this logic diagram using CMOS technology.

What is the total number of transistors required? _____

d) Take the following Boolean function and use the mixed logic procedure discussed in class to implement the function using only NAND gates and inverters.

$$\mathbf{F} = \overline{\overline{(\mathbf{A} + \mathbf{B})}\mathbf{C} + \bar{\mathbf{B}}\mathbf{D}}$$

e) What is the Boolean function implemented by the previous mixed logic implementation with NAND gates and inverters?

F = _____

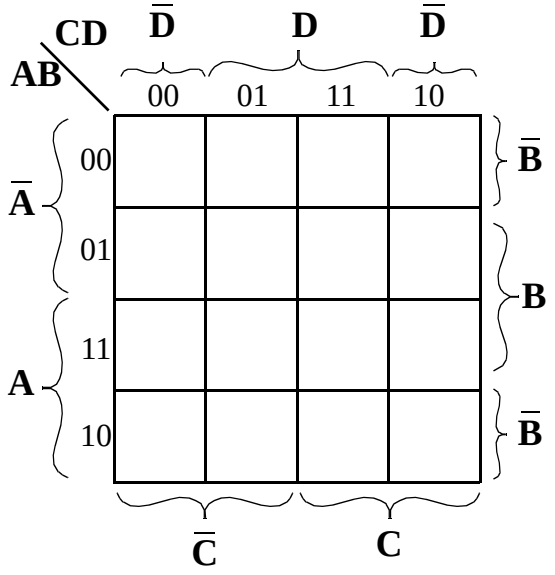
f) How many transistors are need for the mixed logic implementation? _____

3. BOOLEAN ALGEGRA AND SIMPLIFICATION *(MAX MARK: 37)*

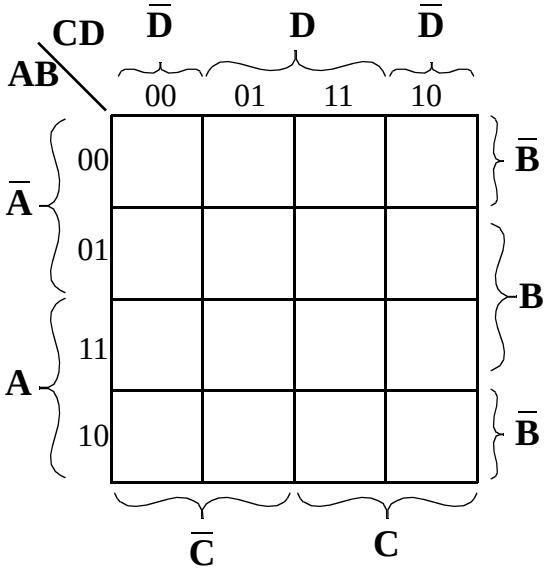
a) Simplify the following Boolean function into a sum-of-products (SOP) as well as a product-of-sums (POS) using a Karnaugh map (use one K-map for SOP and one for POS).

$$\mathbf{F}(\mathbf{A}, \mathbf{B}, \mathbf{C}, \mathbf{D}) = \overline{\mathbf{A}}(\overline{\mathbf{B}}\,\overline{\mathbf{C}}\,\overline{\mathbf{D}} + \overline{\mathbf{C}}\mathbf{D}) + \mathbf{A}(\overline{\mathbf{C}}\mathbf{D} + \mathbf{C}\mathbf{D} + \overline{\mathbf{B}}\mathbf{D})$$

SOP



POS



(SOP) $\mathbf{F}(\mathbf{A}, \mathbf{B}, \mathbf{C}, \mathbf{D}) =$ _____

(POS) $\mathbf{F}(\mathbf{A}, \mathbf{B}, \mathbf{C}, \mathbf{D}) =$ _____

b) For the Boolean function in a), what is the sum-of-minterms in m-notation.

$\mathbf{F}(\mathbf{A}, \mathbf{B}, \mathbf{C}, \mathbf{D}) =$ _____

c) For the Boolean function in a), what is the product-of-maxterms representation in M-notation.

$\mathbf{F}(\mathbf{A}, \mathbf{B}, \mathbf{C}, \mathbf{D}) =$ _____

d) Write the Boolean function corresponding to the following sum-of-minterms.

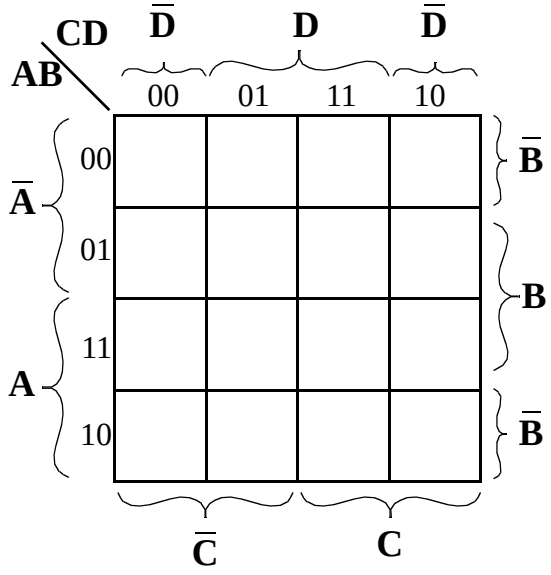
$$\mathbf{F}(\mathbf{A}, \mathbf{B}, \mathbf{C}) = \sum m(1, 4, 6)$$

$\mathbf{F}(\mathbf{A}, \mathbf{B}, \mathbf{C}) =$ _____

e) Given the following sum-of-minterms and don't-cares set, find the simplified Boolean function using the provided empty Karnaugh map. Also identify the prime implicants, and indicate whether they are essential or non-essential.

$\mathbf{F}(\mathbf{A}, \mathbf{B}, \mathbf{C}, \mathbf{D}) = \sum m(5, 6, 7, 8, 12, 14)$

$\mathbf{dc}(\mathbf{A}, \mathbf{B}, \mathbf{C}, \mathbf{D}) = \sum m(0, 9, 10)$



prime implicants	essential? yes	no
_____	☐	☐
_____	☐	☐
_____	☐	☐
_____	☐	☐
_____	☐	☐
_____	☐	☐
_____	☐	☐
_____	☐	☐

F(**A**, **B**, **C**, **D**) = _____

4. NUMBER SYSTEMS *(MAX MARK: 12)*

a) Convert the following radix-2 number (binary number) to hexadecimal and octal.

1110101101001.1011011_2 -> _____ hexadecimal

_____ octal

b) Expand the following numbers in radix-r form to decimal?

$A42B.32_{16}$ -> _____

21341.3_5 -> _____