

Your Name:

ECE 152A–Fall 2002
Prof. K. Banerjee

University of California, Santa Barbara
Department of Electrical and Computer Engineering

Midterm Examination

Room 1104 Eng. I, November 12, 5:00-6:15PM

(One sheet of 8.5"x11" paper allowed with handwritten notes, Calculators OK)

Include all your answers in locations specified on these pages. Show ALL WORKING used to arrive at answers. Use space provided for all working. Use the back sides if necessary. There are 8 pages. Be sure to write Your NAME on EVERY PAGE.

1. **(30 points)** This question has four different parts.

(a) **(5pts)** Simplify the following algebraic expression:

$$a + a'b + a'b'c + a'b'c'd + a'b'c'd'e + \dots$$

(b) **(5pts=3+2)** Represent the following sentences by a Boolean equation and then realize the equation using a minimum number of 2-input AND and 2-input OR gates. Assume complemented variables are available.

"The tape drive motor for a computer tape drive should be running iff:

(i) the tape is properly threaded,

(ii) an end-of-tape signal is not present, and

(iii) the tape drive is in the manual mode and the motor start button has been pressed, or it is in the automatic mode and the "tape on" signal from the computer is present."

Definition of terms: R: Run motor

T: Tape properly threaded

E: End-of-tape signal

M: Manual (automatic = not manual)

S: Motor start button

O: Tape ON signal

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(c) **(10pts = 4+2+4)** Consider the four variable function $F(a, b, c, d)$. If $F = 1$ only if exactly two of the variables equal to 1, list all the prime implicants. How many are essential? If F was an n variable function and $F = 1$ iff exactly k of the variables were equal to 1, how many prime implicants and essential prime implicants will this function have?

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(d) (10pts=4+4+2) A three-input gate BOMB, whose characteristics are shown below, has been mass produced by an unfortunate company. Experimental evidence shows that the input combinations 101 and 010 causes the gate to “explode”. Is this gate completely useless? If not, how can you externally modify it so that it may be used to implement any switching function without causing explosions? List all the possible switching functions. Can this gate be considered functionally complete?

		AB			
		00	01	11	10
C	0	1	1	0	1
	1	0	1	0	0

BOMB (A, B, C)

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2. (35 points) The table shown below is a prime implicant table for $f(a, b, c, d)$, in which some of the row and column headings are unknown. It is known, however, that the table has a row for each prime implicant of f and has a column for each minterm for which f has a value 1.

	0	7	8	10	15	?	?
A = b' d'	X		X	X			
B = ?	X					X	
C = bcd		X			X		
D = ?					X		X
E = ?			X				
F = ?							X

- (a) (15pts) Find all the minterms and the prime implicants that correspond, respectively, to the columns and rows with unknown headings.

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(b) **(6pts)** Is your solution to (a) unique? Justify your answer.

(c) **(8pts)** Find the minimal expression for f .

(d) **(6pts)** Write the minterms for which f must be equal to 0.

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3. (35 points) Consider the logic function shown below in Karnaugh Map form. In all parts to this question, assume input complements are not available. (i.e., an inverter counts as a gate)

		AB			
CD		00	01	11	10
00		1	0	1	0
01		0	1	0	1
11		1	1	1	0
10		0	0	0	1

(a) (8 pts) Derive an implementation of this function using a single 8-input, 3-control line multiplexer and a minimum number of logic gates.

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(b) **(8 pts)** Derive an implementation of the function using a single 4-input, 2-control-line multiplexer and a minimum number of two-input XOR gates and inverters only.

(c) **(6 pts)** Implement the function using a minimum number of simple logic gates (AND, OR, NAND, NOR, XOR, XNOR, and inverters only).

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(d) **(8 pts)** Construct the PLA-format table representation for the function in AND-OR form. How many product terms would an AND-OR PLA implementation require?

(e) **(5 pts)** If the function were implemented using ROM, how many ROM storage locations would be required? How many address inputs would the ROM have?