(additional space for working)

(additional space for working)

(6) Make a race-free state assignment for the following table.

(a) Show your assignment map and

(b) List the state codes.

Do *not* attempt to reduce the table any further.

	X1X2 = 00	01	11	10
A	1	7	2	10
B	5	3	9	4
C	5	6	8	10
D	1	7	8	4
E	1	3	9	10

next state

6(a) (10pts) Assignment Map:

6(b) (5pts) State codes:

A = B = C = D = E =

(additional space for working, Problem 6)

(additional space for working, Problem 5)

5(c) (6pts) Merger Diagram:

5(d) (7pts) Minimum-Row Merged Flow Table:

(additional space for working, Problem 5)

(5) One type of clocked D flip-flop works as follows:

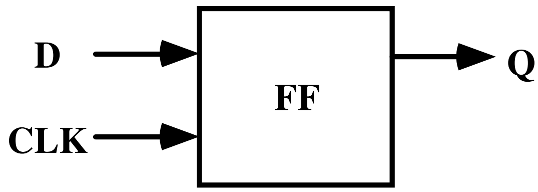
> "On the trailing edge of the clock (CLK) pulse (1→0 transition) the output Q assumes the same state which the input D had on the leading edge of the clock pulse (0→1 transition). The output does not change at any other time. D may change at any time with respect to the clock. When D changes simultaneously with the leading edge of the clock, the value D had immediately before the change determines the output after the clock pulse."

(a) Show a primitive flow table for the flip-flop.

(b) Reduce the flow table by removing redundant states. Indicate specifically which states, if any, are redundant.

(c) Show a merger diagram for the reduced table. Indicate the optimal merging of rows on the diagram.

(d) Show the final, minimum-row merged flow table for the flip-flop.



5(a) (6pts) Primitive Flow Table:

5(b) (6pts) Redundant States:

(additional space for working, Problem 4)

Your Name: ___________________________________

(4) For the following state table, where X_1 and X_2 are inputs and Z_1 and Z_2 are outputs:

(a) Use the three guidelines for state assignment to determine which of the three possible non-equivalent state assignments should give the best solution. Show all steps and explain your choice. Do *not* attempt to reduce the state table.

(b) Using your answer to (a) above, derive T flip-flop input equations and the output equations. All equations stated should contain the minimum number of literals. Show all steps.

	next state X1X2 = 00	01	11	10	output Z_1Z_2 X1X2= 00	01	11	10
A	A	C	B	D	00	00	00	00
B	B	B	D	D	00	00	10	10
C	C	A	C	A	01	01	01	01
D	B	B	C	A	01	01	10	10

4(a) (8pts) State codes:

A = B = C = D =

4(b) (10pts) Equations:

T1 =

T2 =

Z1 =

Z2 =

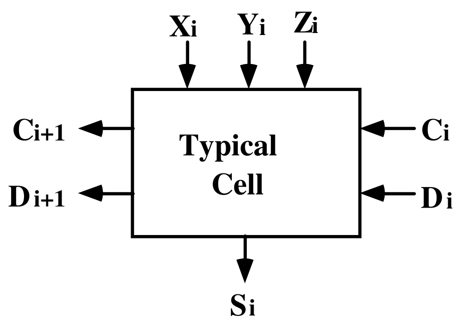
(additional space for working, Problem 3)

Your Name: ___________________________________

(3) This problem concerns the design of a parallel adder for adding *three* positive binary numbers. These numbers are designated $X_n \ldots X_3X_2X_1$, $Y_n \ldots Y_3Y_2Y_1$ and $Z_n \ldots Z_3Z_2Z_1$. A typical cell used in the adder is shown below. Note that there are two carry signals, C and D, propagating between cells. Two carry signals are required because when three binary digits are added to the carry coming into the cell, the carry to the next cell may be either 0, 1, or 2 (coded as $C_{i+1}D_{i+1}$= 00, 01, and 10 respectively).

(a) Derive a truth table which specifies the complete operation of a typical cell (your table should contain some "don't cares").

(b) Derive a Boolean equation for S_i in minimum form (Equations for C_{i+1} and D_{i+1} are *not* required.).

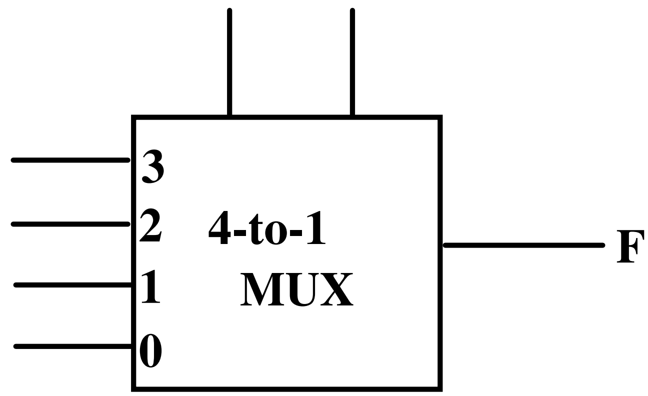


3(a) (6pts) Truth Table:

3(b) (6pts)

S_i =

2(b) (9pts)



(additional space for working, Problem 2)

Your Name: ________________________________

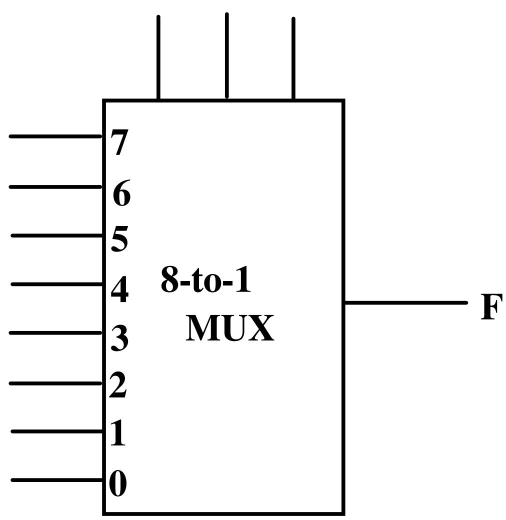
(2) (a) Implement the function, F, shown on the Karnaugh map below using *only* an 8-to-1 MUX and using A, C, and D as control inputs. Assume complements are available.

(b) Repeat (a) above using a 4-to-1 MUX and logic gates (INV, AND, OR, NAND, NOR, XOR or XNOR). Select the control inputs so as to minimize the number of additional gates needed. Assume complements are available.

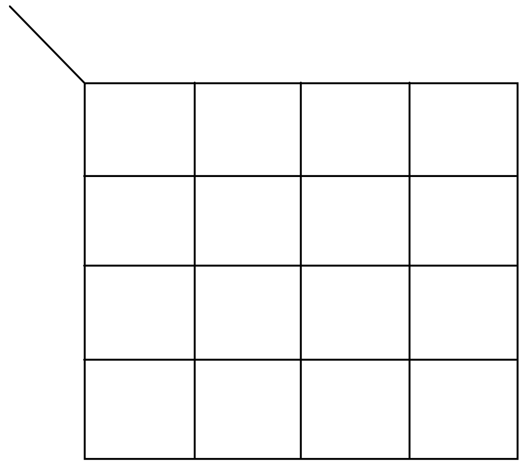
CD \ AB	00	01	11	10
00	1 $_{0}$	1 $_{4}$	0 $_{12}$	0 $_{8}$
01	1 $_{1}$	1 $_{5}$	0 $_{13}$	0 $_{9}$
11	0 $_{3}$	1 $_{7}$	1 $_{15}$	1 $_{11}$
10	1 $_{2}$	0 $_{6}$	0 $_{14}$	0 $_{10}$

A (columns 11, 10); B (columns 01, 11); C (rows 11, 10); D (rows 01, 11)

2(a) (6pts)



(additional space for working, Problem 1)



Your Name: ________________________________

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Department of Electrical Engineering
and Computer Sciences

CS 150 - Spring 1990
Prof. A. R. Newton

Final Examination

Thursday 5/17

(Open Wakerly, Calculators OK, 3 hrs)

Include all final answers in locations indicated by boxes on these pages. Use reverse side of sheets for all working. SHOW ALL WORKING USED TO ARRIVE AT ANSWERS. If necessary, attach additional sheets by staple at the end. BE SURE TO WRITE YOUR NAME ON EVERY SHEET. There are 6 questions and 100 points, as indicated.

(1) (a) Represent the following sentences by a single Boolean equation:

"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 signal from the computer is present."

1(a) (6pts) Definition of terms:
Boolean Equation:

(b) Given that $F = \overline{A}\,\overline{B} + \overline{A}\,\overline{C} + \overline{C}\,\overline{D} + \overline{B}\,C\,D$

(i) Use a Karnaugh map to find the maxterm representation of F. Express your answer in standard decimal notation.

(ii) Use the K-map to find the minimum sum-of-products form for $\overline{F}$. Express in algebraic form.

(iii) Find the minimum product-of-sums for F. Express in algebraic form.

1(b) (9pts)		
(i)	**Maxterm representation:**	F =
(ii)	**Minimum S-of-P form:**	$\overline{F}$ =
(iii)	**Minimum P-of-S form:**	F =