

National Exams – December 2002

98-Elec-A4, Digital Systems and Computers

3 Hours Duration

NOTES

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper a clear statement of any assumptions made;
2. Candidates may use one of two calculators, the Casio or Sharp approved models. This is a Closed Book exam.
3. Any five questions constitute a complete paper. Only the first five questions as they appear in your answer book will be marked.
4. All questions are of equal value

1. Simplify the following Boolean function using a five variable K-map

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$$F = \overline{A}B\overline{C}\overline{E} + \overline{A}BCD + \overline{BDE} + \overline{B}\overline{C}\overline{D} + C\overline{D}\overline{E} + B\overline{D}\overline{E}$$

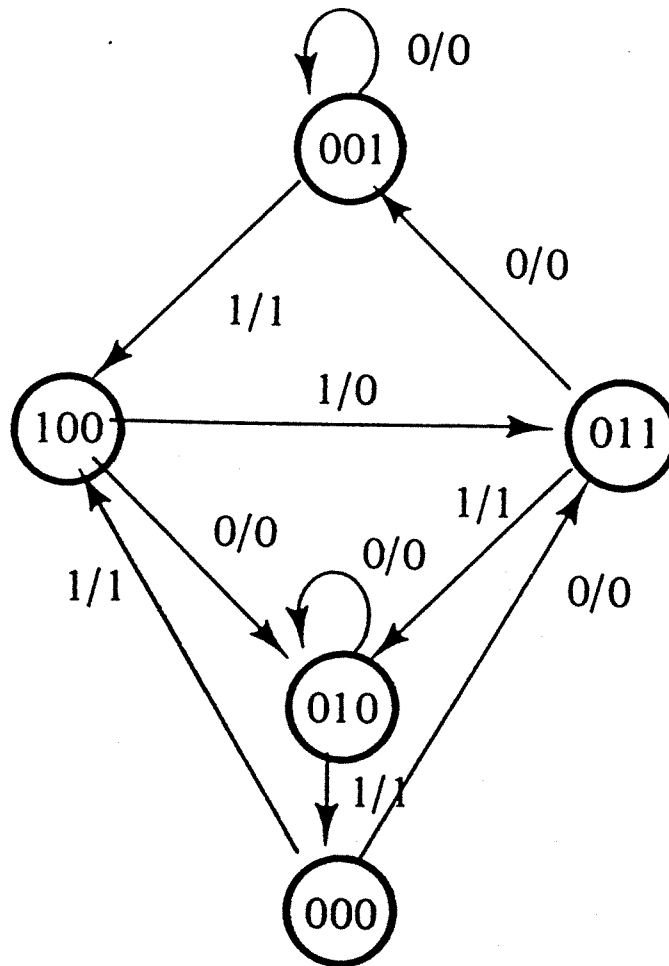
The box numbering for a five variable K-map is on an attached sheet.

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2. Design a sequential circuit with two JK flip-flops, A and B, and two inputs, E and x. If $E = 0$, the circuit remains in the same state regardless of the value of x. When $E = 1$ and $x = 1$, the circuit goes through the state transitions from 00 to 01 to 10 to 11 back to 00, and repeats. When $E = 1$ and $x = 0$, the circuit goes through state transitions from 00 to 11 to 10 to 01 back to 00, and repeats.

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3. A sequential circuit has three flip-flops, A, B, C; one input, x ; and one output, y . The state diagram is shown in the figure below. The circuit is to be designed by treating the unused states as don't-care conditions. The final circuit must be analyzed to ensure that it is self-correcting. Use D flip-flops in the design.



4. Write short paragraphs (approximately 200 words) on the operation of each of the following kinds of MOS memories

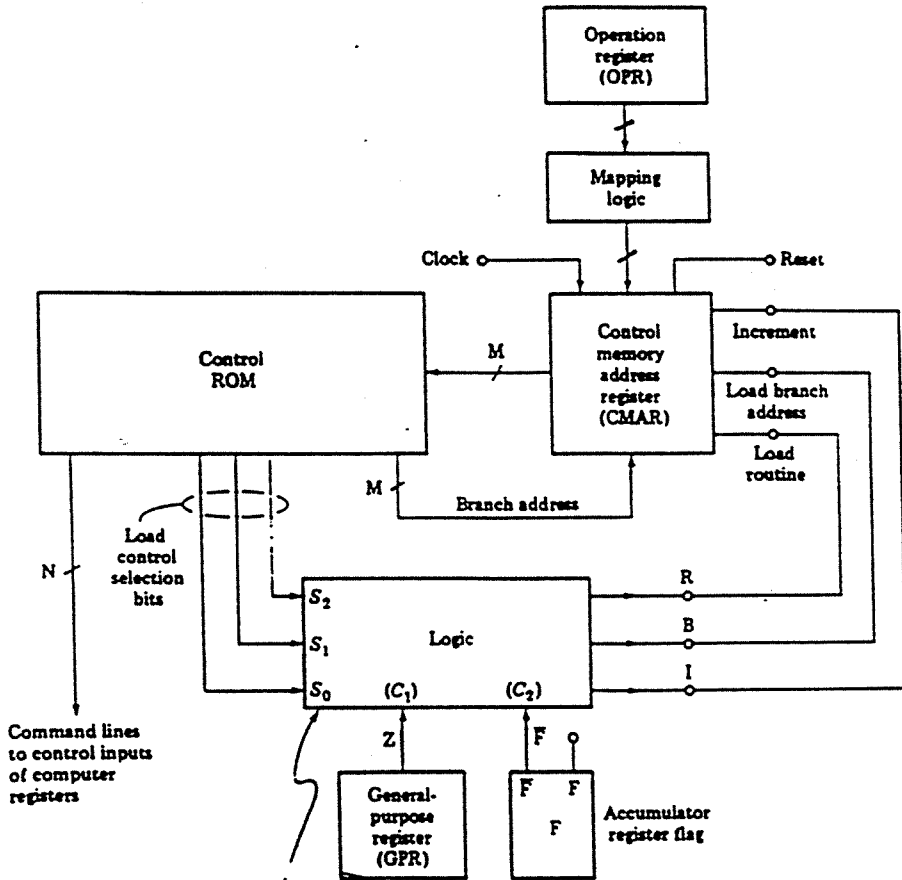
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- a) Sequentially accessed (FILO and FIFO)
- b) Random access (RAM) and
- c) Read only (ROM), including EEPROM

Illustrate your description with logic circuits as well as with integrated circuits. Comment on addressing, programming, and erasing times, memory capacity, and cost. Describe the difference between static and dynamic memory and also indicate when and how one would use the three types of memories listed above.

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5. The following architecture represents a ROM controller for a microcomputer. The logic box in the controller with inputs $S_2, S_1,$ and S_0 (load control section bits) and C_1, C_2 (status bits), has to be designed using combinational logic gates. Considering that the truth table for this logic box is given at the bottom of the circuit, draw the minimum circuit necessary to implement the truth table.



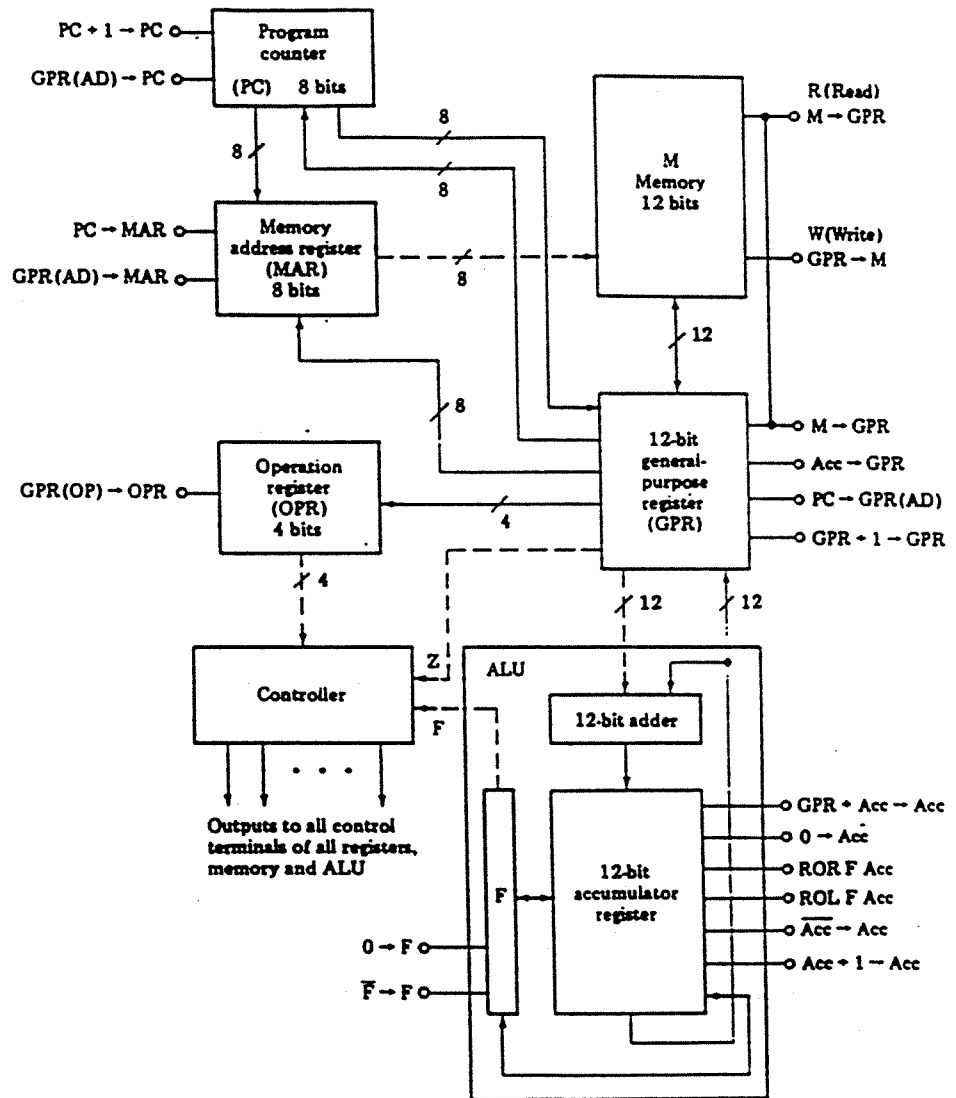
Command lines to control inputs of computer registers

S_2	S_1	S_0	C_1	C_2	I	B	R
0	0	0	x	x	0	1	0
0	0	1	x	x	1	0	0
0	1	0	0	x	1	0	0
0	1	0	1	x	0	1	0
0	1	1	x	0	0	1	0
0	1	1	x	1	1	0	0
1	x	x	x	x	0	0	1

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6. Considering that the architecture of a microcomputer is as shown below, write the microoperations necessary to carry out the following instructions. Assume that the fetch part of the cycle has been completed.

- a) STA - store
- b) ADD - add
- c) CSR - call
- d) JMPI - indirect jump



Note: In answering this question, explain first what each instruction is intended to do, and also indicate how much time it takes to execute each instruction assuming that the clock rate is 1.25MHz.

A = 0

		D			
		DE	D		
		00	01	11	10
BC	00	0	1	3	2
	01	4	5	7	6
	11	12	13	15	14
	10	8	9	11	10

E

A = 1

		D			
		DE	D		
		00	01	11	10
BC	00	16	17	19	18
	01	20	21	23	22
	11	28	29	31	30
	10	24	25	27	26

E