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12EC029

M.Tech. Degree Examination, June/July 2013
Digital Circuits and Logic Design

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions.***

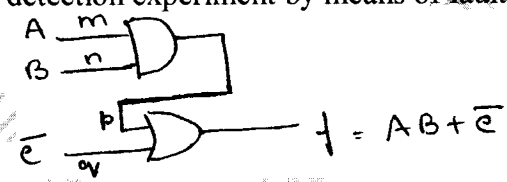
1 a. Define unate function with an example. **(04 Marks)**

b. Determine whether the following function is a threshold function by examining the linear inequalities and if yes, find the weight threshold vector $f(x_1, x_2, x_3) = \Sigma(0, 2, 4, 5, 6)$. **(06 Marks)**

c. Determine whether the following function is unate or not. If yes, find a two-element cascade realization: $f(x_1, x_2, x_3, x_4) = \Sigma(2, 3, 6, 7, 8, 9, 13, 15)$. **(10 Marks)**

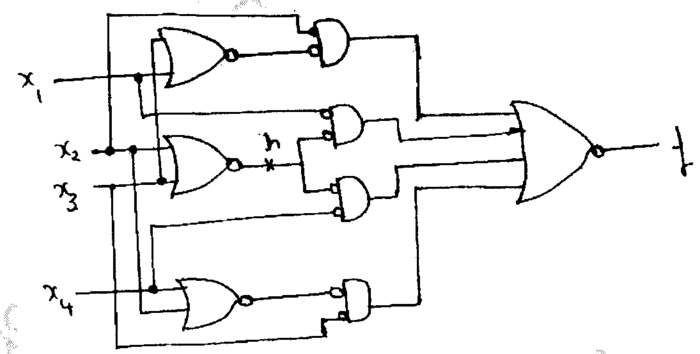
2 a. For the circuit shown in Fig.Q.2(a), wires m, n, p and q may become either s-a-o or s-a-1. Determine a minimal fault-detection experiment by means of fault table. **(10 Marks)**

Fig.Q.2(a)



b. Apply Boolean difference method to test wire 'h' in the circuit shown in Fig.Q.2(b). **(10 Marks)**

Fig.Q.2(b)



3 a. Show that the circuit $F = A\overline{B} + BD$ is having static hazard. Also make it hazard free. **(04 Marks)**

b. Write a note on fault-detection by path sensitizing. **(08 Marks)**

c. Explain the basic structure of quadded network with the help of diagram. **(08 Marks)**

4 a. For the machine given Table Q.4(a) find the equivalence partition and a corresponding reduced machine in standard form. **(10 Marks)**

Table Q.4(a)

PS	NS	Z
	x = 0	x = 1
A	D, 0	H, 1
B	F, 1	C, 1
C	D, 0	F, 1
D	C, 0	E, 1
E	C, 1	D, 1
F	D, 1	D, 1
G	D, 1	C, 1
H	B, 1	A, 1

b. The direct sum $M_1 + M_2$ of 2 machines $M_1 + M_2$ is obtained by combining the tables of individual machines as shown in Table Q.4(b).
   i) Use the direct sum to determine whether state A of machine M_1 is equivalent to state H of machine M_2.
   ii) Prove that machine M_1 is contained in machine M_2.
   iii) Under what starting conditions are machines M_1 and M_2 equivalent.

PS	NS, Z	
	x = 0	x = 1
A	B, 0	C, 1
B	D, 1	C, 0
C	A, 1	C, 0
D	B, 1	C, 0

Machine M_1
Table Q.4(b)(i)

PS	NS, Z	
	x = 0	x = 1
E	H, 1	E, 0
F	F, 1	E, 0
G	E, 0	G, 1
H	F, 0	E, 1

Machine M_2
Table Q.4(b)(ii)

PS	NS, Z	
	x = 0	x = 1
A	B, 0	C, 1
B	D, 1	C, 0
C	A, 1	C, 0
D	B, 1	C, 0
E	H, 1	E, 0
F	F, 1	E, 0
G	E, 0	G, 1
H	F, 0	E, 1

Machine $M_1 + M_2$
Table Q.4(b)(iii) **(10 Marks)**

5 a. i) Find all the state containments present in the machine shown in Table Q.5(a).
   ii) Find two minimum-state machines that contain the given machine. **(10 Marks)**

Table Q.5(a)

PS	NS, Z	
	x = 0	x = 1
A	B, 0	C, 1
B	D, 0	C, 1
C	A, 0	E, 0
D	-	F, 1
E	G, 1	F, 0
F	B, 0	-
G	D, 0	E, 0

b. For the incompletely specified machine shown in Table Q.5(b) find a minimum state reduced machine containing the original one. **(10 Marks)**

Table Q.5(b)

PS	NS, Z		
	I_1	I_2	I_3
A	C, 0	E, 1	-
B	C, 0	E, -	-
C	B, -	C, 0	A, -
D	B, 0	C, -	E, -
E	-	E, 0	A, -

6 a. i) For the machine shown in Table Q.6(a), find λ_1 and λ_0 and construct the π-lattice.
   ii) Choose as a basis for your state assignment three partitions, τ_1, τ_2 and τ_3, such that the following functional dependencies result:

$y_1 = f_1 (y_1)$,
$y_2 = f_2 (x, y_2, y_3)$,
$y_3 = f_3 (x_1, y_2, y_3)$,
$z = f_0 (y_1, y_2)$.

Specify the desired relationship between the chosen τ's and λ_o and λ_i, and show a schematic diagram of the resulting structure.

iii) From the chosen τ's, obtain a state assignment and derive the corresponding logic equations. **(12 Marks)**

PS	NS x = 0	NS x = 1	Z
A	F	D	0
B	D	E	0
C	E	F	0
D	A	B	0
E	B	C	0
F	C	A	1

b. In the following set of partitions, π_1 and π_2 designate closed partitions while λ_0 and λ_1 designate output-consistent and input-consistent partitions respectively. Construct the corresponding π-lattice by obtaining all the necessary sums and products. Show schematic diagram demonstrating the possible machine decompositions that yield minimal interdependencies of the state variables, as well as the outputs.

$\pi_1 = \{\overline{A,B,E,F}; \overline{C,D,G,H}\}$; $\pi_2 = \{\overline{A,F,C,H}; \overline{B,D,E,G}\}$

$\lambda_0 = \{\overline{A,B,G,H}; \overline{C,D,E,F}\}$; $\lambda_i = \{\overline{A,C}; \overline{B,D}; \overline{E,G}; \overline{F,H}\}$. **(08 Marks)**

7 a. For the machine shown in Table Q.7(a):
i) Find the shortest homing sequence.
ii) Determine whether or not synchronizing sequences exist, and if any do exist, find the shortest ones. **(10 Marks)**

Table Q.7(a)

PS	NS, Z x = 0	NS, Z x = 1
A	B, 0	A, 0
B	B, 1	C, 1
C	A, 1	D, 0
D	C, 0	A, 1

b. i) Find a preset distinguishing experiment that determines the initial state of the machine shown in Table Q.7(b), given that it cannot be initially in state E.
ii) Can you identify the initial state when the initial uncertainty is (ABCDE)? **(10 Marks)**

PS	NS, Z x = 0	NS, Z x = 1
A	B, 1	A, 1
B	E, 0	A, 1
C	A, 0	E, 1
D	C, 1	D, 1
E	E, 0	D, 1

Table Q.7(b)

PS	NS, Z x = 0	NS, Z x = 1
A	A, 1	B, 0
B	C, 0	A, 0
C	B, 0	C, 1

Table Q.8(a)

8 a. The machine shown in Table Q.8(a) is initially provided with an input sequence 01 to which it responds by producing an output sequence 10. It is next provided with the sequence 10101010100100110100001. Assuming that no malfunction increases the number of states, show that this sequence is a fault-detection experiment for this machine and find the correct output sequence. **(12 Marks)**

b. Prove the theorem:
If a synchronizing sequence for an n-state machine M exists, then its length is at most $(n-1)^2 n/2$. **(08 Marks)**

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