



**Cairo University**  
**Faculty of Computers and Artificial Intelligence**  
**Final Exam**



Department: Information Technology  
Course Name: Logic Design  
Course Code: SIT213  
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Date: 19 September 2021  
Duration: 2 hours  
Number of pages: 7  
Total Marks: 60

**تعليمات هامة**

- حيازة التليفون المحمول مفتوحا داخل لجنة الإمتحان يعتبر حالة غش تستوجب العقاب وإذا كان ضروري الدخول بالمحمول فيوضع مغلقا في الحقائب.
- لا يسمح بدخول سماعة الأذن أو البلوتوث.
- لايسمح بدخول أي كتب أو ملازم أو أوراق داخل اللجنة والمخالفة تعتبر حالة غش.

**Only solutions in the bubble sheet will be considered**

**Note: *None* in the answers means that none of the mentioned solutions is right.**

**A. Using k-map to simplify the following Boolean function as a Product of Sum (PoS):**

$$F(W, X, Y, Z) = WXY + WXZ + Y\bar{Z} + XYZ + WXY\bar{Z} + d(W\bar{Y}\bar{Z} + \bar{W}\bar{X}Z + \bar{X}YZ)$$

1. Which of the following is a minterm of F?  
a. 0                      b. 1                      c. 2                      d. 3                      e. None
2. Which of the following is a maxterm of F?  
a. 0                      b. 1                      c. 2                      d. 3                      e. None
3. How many terms exit in the simplified SoP function?  
a. 1                      b. 2                      c. 3                      d. 4                      e. None
4. Which of the following is a term in the simplified SoP function?  
a.  $\bar{W}$                       b.  $WY$                       c.  $YZ$                       d.  $WZ$                       e. None
5. Which of the following is a term in the simplified SoP function?  
a.  $W$                       b.  $XZ$                       c.  $WXY$                       d.  $WXZ$                       e. None
6. How many AND gates are needed to build the simplified SoP function?  
a. 0                      b. 1                      c. 2                      d. 3                      e. None
7. How many OR gates are needed to build the simplified SoP function?  
a. 0                      b. 1                      c. 2                      d. 3                      e. None
8. If the propagation delay of NOT, AND, OR gates are 3, 10 and 10 nsec respectively. What is the propagation delay of the simplified PoS function?  
a. 20 nsec                      b. 23 nsec                      c. 10 nsec                      d. 13 nsec                      e. None

**B.** Having a circuit with one input X, two JK flip-flops (A & B) and an output Y. The following represent the max terms of the next state of the two JK flip-flops (A & B) and the output Y.

$$A = \pi_M(0,1,2,3,5,6) \quad B = \pi_M(0,3,4,7) \quad Y = \pi_M(0,1,2,4,5,6)$$

9. What is the next state for a present state 00 & an input of 0?  
a. 00                      b. 01                      c. 10                      d. 11                      e. None
10. What is the next state for a present state 01 & an input of 0?  
a. 00                      b. 01                      c. 10                      d. 11                      e. None
11. What is the next state for a present state 10 & an input of 1?  
a. 00                      b. 01                      c. 10                      d. 11                      e. None
12. What is the next state for a present state 11 & an input of 1?  
a. 00                      b. 01                      c. 10                      d. 11                      e. None

	Present State		Input
	A	B	X
13.	0	0	0
14.	0	0	1
15.	0	1	0
16.	0	1	1
17.	1	0	0
18.	1	0	1
19.	1	1	0
20.	1	1	1

This table represents the state table of this circuit. What is the value of  $J_A$   $K_A$  –  $J_B$   $K_B$  for each of the following stated present states – input?

13. a. 0 X – 0 X      b. 0 X – X 0      c. 0 X – 1 X      d. 0 X – X 1      e. None
14. a. 1 X – 0 X      b. 1 X – X 0      c. 1 X – 1 X      d. 1 X – X 1      e. None
15. a. X 1 – 0 X      b. 0 X – X 0      c. X 1 – 1 X      d. X 1 – X 1      e. None
16. a. X 1 – 0 X      b. X 1 – X 0      c. 0 X – X 1      d. X 1 – X 1      e. None
17. a. X 0 – 0 X      b. X 0 – X 0      c. X 0 – 1 X      d. X 0 – X 1      e. None
18. a. X 1 – 0 X      b. X 1 – X 0      c. X 1 – 1 X      d. X 1 – X 1      e. None
19. a. X 1 – 0 X      b. X 1 – X 0      c. X 1 – 1 X      d. X 1 – X 1      e. None
20. a. X 1 – 0 X      b. X 1 – X 0      c. X 1 – 1 X      d. X 1 – X 1      e. None

21. For this circuit, what is the simplified equation of  $J_A$ ?  
a. A                      b.  $B\bar{X}$                       c. ABX                      d.  $AB\bar{X}$                       e. None
22. For this circuit, what is the simplified equation of  $K_A$ ?  
a.  $B + \bar{X}$                       b.  $B + X$                       c.  $AB + AX$                       d.  $AB + B\bar{X}$                       e. None
23. For this circuit, what is the simplified equation of  $J_B$ ?  
a.  $\bar{B}X$                       b.  $B\bar{X}$                       c. X                      d.  $\bar{X}$                       e. None
24. For this circuit, what is the simplified equation of  $K_B$ ?  
a.  $\bar{B}X$                       b.  $B\bar{X}$                       c. X                      d.  $\bar{X}$                       e. None
25. For this circuit, what is the simplified equation of Y?  
a.  $A\bar{B}\bar{X}$                       b. BX                      c.  $A\bar{B}$                       d. ABX                      e. None

**C.** For the following state table, reduce the number of states, always start with the states in the upper rows, and in case of matching always keep the state in the upper rows.

26. What is the removed state after the first reduction?

- a. C      b. G      c. H      d. E      e. None

27. What is the removed state after the second reduction?

- a. F      b. G      c. B      d. E      e. None

28. What is the removed state after the third reduction?

- a. C      b. G      c. H      d. E      e. None

29. What is the removed state after the fourth reduction?

- a. F      b. G      c. B      d. C      e. None

Present State	Next State		Output	
	X=0	X=1	X=0	X=1
a	f	b	0	0
b	d	c	0	0
c	a	e	0	0
d	g	a	1	0
e	d	c	0	0
f	f	b	0	0
g	g	h	0	1
h	g	a	1	0

30. What is the number of flip flops needed to build the circuit before → after the reduction?

- a. 3→3      b. 4→3      c. 3→2      d. 4→4      e. None

**D.** Using the minimum number of half adder(s) and full adder(s), design a combinational circuit that adds six to a 4-bit binary number (A3 A2 A1 A0). Note CP is the carry resulting from adding previous bit.

31. How many half adders are needed?

- a. 0      b. 1      c. 2      d. 3      e. None

32. How many full adders are needed?

- a. 0      b. 1      c. 2      d. 3      e. None

33. What are the inputs of the least significant bit if using half adder?

- a. A0, 0      b. A0, 1      c. A1, 0      d. A1, 1      e. Do not need a half adder

34. What are the inputs of the second bit (from the right side) if using full adder?

- a. A1, 1, CP      b. A1, 0, CP      c. A2, 1, CP      d. A1, 0, CP      e. Do not need a full adder

35. What are the inputs of the third bit (from the right side) if using full adder?

- a. A2, 1, CP      b. A2, 0, CP      c. A3, 1, CP      d. A3, 1, CP      e. Do not need a full adder

36. What are the inputs of the fourth bit (from the right side) if using half adder?

- a. A3, CP      b. A3, 1      c. A3, 1, CP      d. A3, 1, CP      e. Do not need a half adder

**E.** Using various codes, answer the following:

37. How is (0101.1001)<sub>7421</sub> represented in decimal?

- a. 22.41      b. 22.9      c. 5.9      d. 5.8      e. None

38. How is (0011.1001)<sub>Excess-3</sub> represented in BCD?

- a. 3.9      b. 000.110      c. 0000.0110      d. 0011.1100      e. None

39. What is the 9's Complement of (0110.0111)<sub>BCD</sub>?

- a. 1011.1001      b. 1011.1010      c. 0101.0011      d. 0101.0100      e. None

40. How is (0110.0101)<sub>BCD</sub> represented in Gray Code?

- a. 0101.0111      b. 0000.0110      c. 0000.0110      d. 0011.1100      e. None

**F.** Subtracting the two BCD numbers A and B where is A 0101 1001 and B is 0011 0101:

41. What is the 9's complement of B?  
a. 0110 0100      b. 0110 0101      c. 0010 0100      d. 0110 0110      e. None
42. What is the 10's complement of B?  
a. 0110 0100      b. 0110 0101      c. 0010 0100      d. 0110 0110      e. None
43. What is the initial result of subtracting A and B?  
a. 1110 0100      b. 1011 1111      c. 1011 1110      d. 1011 0110      e. None
44. What is the value needed to be added in the correction step (if needed)?  
a. 0111      b. 0011      c. 0110      d. 1      e. None
45. What is the final result of subtracting A and B?  
a. 0000 0100      b. 0100 0100      c. 0010 0100      d. 1011 1110      e. None

**G.** Using tabular method to simplify the following function as SoP:  $F(A,B,C)=\sum m(0,1,2,4,6)+d(7)$ , then answer the following:

46. How many groups are initially formed?  
a. 2      b. 4      c. 6      d. 8      e. None
47. Which of the following numbers form the second group?  
a. 1,2,4,6      b. 1,2,4      c. 0,1,2,4      d. 4,6,7      e. None
48. Which of the following numbers form the third group?  
a. 4,6      b. 4,7      c. 6      d. 6,7      e. None
49. Which of the following combined terms is formed in the first iteration?  
a. 1,2      b. 4,7      c. 4,6      d. 2,7      e. None
50. Which of the following combined terms is formed in the first iteration?  
a. 1,4      b. 1,6      c. 2,6      d. 1,7      e. None
51. Which of the following combined terms is formed in the first iteration?  
a. 2,7      b. 3,7      c. 1,4      d. 4,7      e. None
52. Which of the following combined terms is formed in the second iteration?  
a. 0,4,2,6      b. 1,7,2,6      c. 1,2,4,6      d. 4,7,6,2      e. None
53. Using simple gates (AND, OR, NOT), which of the following is a term in the simplified function?  
a.  $\overline{A}\overline{B}$       b. BC      c.  $B\overline{C}$       d. AB      e. None
54. Using simple gates (AND, OR, NOT), how many inverters are needed to build the simplified function?  
a. 0      b. 1      c. 2      d. 3      e. None
55. Using simple gates (AND, OR, NOT), how many AND or OR are needed to build the simplified function?  
a. 0      b. 1      c. 2      d. 3      e. None

**H.** Design a combinational circuit that builds the following: having a four-bit number ABCD. Two outputs X & Y are used, the output X equals one if two or more successive zeros occurs in the input, while Y equals one if two or more successive ones occurs in the input

The following table represents the truth table of this circuit. What is the value of the outputs XY in case of the following inputs ABCD?

		Inputs								
		A	B	C	D					
56.		0	0	0	0	a. 00	b. 01	c. 10	d. 11	e. None
57.		0	0	0	1	a. 00	b. 01	c. 10	d. 11	e. None
58.		0	0	1	0	a. 00	b. 01	c. 10	d. 11	e. None
59.		0	0	1	1	a. 00	b. 01	c. 10	d. 11	e. None
60.		0	1	0	0	a. 00	b. 01	c. 10	d. 11	e. None
61.		0	1	0	1	a. 00	b. 01	c. 10	d. 11	e. None
62.		0	1	1	0	a. 00	b. 01	c. 10	d. 11	e. None
63.		0	1	1	1	a. 00	b. 01	c. 10	d. 11	e. None
64.		1	0	0	0	a. 00	b. 01	c. 10	d. 11	e. None
65.		1	0	0	1	a. 00	b. 01	c. 10	d. 11	e. None
66.		1	0	1	0	a. 00	b. 01	c. 10	d. 11	e. None
67.		1	0	1	1	a. 00	b. 01	c. 10	d. 11	e. None
68.		1	1	0	0	a. 00	b. 01	c. 10	d. 11	e. None
69.		1	1	0	1	a. 00	b. 01	c. 10	d. 11	e. None
70.		1	1	1	0	a. 00	b. 01	c. 10	d. 11	e. None
71.		1	1	1	1	a. 00	b. 01	c. 10	d. 11	e. None

72. Which of the following is a term in the simplified function X as SoP?

- a. AB                      b.  $\overline{A}\overline{B}$                       c.  $\overline{C}$                       d.  $A\overline{C}$                       e. None

73. Which of the following is a term in the simplified function X as SoP?

- a. AC                      b.  $\overline{B}\overline{C}$                       c.  $\overline{B}\overline{C}D$                       d.  $A\overline{B}$                       e. None

74. How many inverters are needed to build X as SoP?

- a. 1                      b. 2                      c. 3                      d. 4                      e. None

75. How terms are there in the simplified function X as SoP?

- a. 3                      b. 4                      c. 5                      d. 6                      e. None

76. Which of the following is a term in the simplified function Y as SoP?

- a. ABC                      b.  $\overline{A}\overline{B}$                       c. CD                      d.  $\overline{A}\overline{B}\overline{D}$                       e. None

77. Which of the following is a term in the simplified function Y as SoP?  
 a. AB                      b.  $A\bar{C}$                       c.  $\bar{B}D$                       d. AC                      e. None
78. How terms are there in the simplified function Y as Sum of Product (SoP)?  
 a. 1                      b. 2                      c. 3                      d. 4                      e. None
79. What is the optimal size of the decoder needed to build this circuit?  
 a. 3x8                      b. 3x16                      c. 4x16                      d. 4x8                      e. None
80. If only a multiplexer is used to build X, what is the size of this multiplexer?  
 a. 32x1                      b. 16x1                      c. 8x1                      d. 4x1                      e. None
81. How many multiplexers (with the size in question 80) are used to build this circuit?  
 a. 1                      b. 2                      c. 3                      d. 4                      e. None

**I.** Having the following function: if ( $A=B$  or  $C=D$ ) then  $F(A,B,C,D)=D$  else  $F(A,B,C,D)=BD$

82. What is the optimal multiplexer size used to build the above function?  
 a. 32x1                      b. 16x1                      c. 8x1                      d. 4x1                      e. None
83. Using AB as selectors, what is the size of multiplexer used to build the above function?  
 a. 32x1                      b. 16x1                      c. 8x1                      d. 4x1                      e. None
84. Using ABC as selectors, what is the input to the 1<sup>st</sup> input to the multiplexer?  
 a. D                      b.  $\bar{D}$                       c. 0                      d. 1                      e. None
85. Using ABC as selectors, what is the input to the 5<sup>nd</sup> input to the multiplexer?  
 a. D                      b.  $\bar{D}$                       c. 0                      d. 1                      e. None
86. Using AB as selectors, what is the input to the 3<sup>rd</sup> input to the multiplexer?  
 a. 1                      b. CD                      c. 0                      d.  $\bar{CD}$                       e. None
87. Using AB as selectors, what is the input to the last input of the multiplexer?  
 a. CD                      b.  $C+D$                       c. 0                      d. 1                      e. None

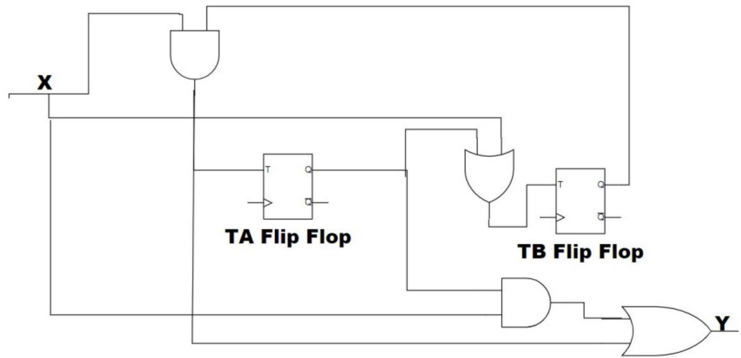
**J.** The shown sequential circuit has an input Z, two flip flops X and Y and an output W.

88. For a T flip-flop, if  $T=1$ , what is the value of  $Q(t+1)$ ?

- a. 0      b. 1      c.  $Q(t)$   
d.  $\overline{Q(t)}$       e. None

89. For a T flip-flop, if  $T=0$ , what is the value of  $Q(t+1)$ ?

- a. 0      b. 1      c.  $Q(t)$   
d.  $\overline{Q(t)}$       e. None



90. For this circuit, what is the equation of  $T_A$ ?

- a.  $BX$       b.  $AX$       c.  $A + X$       d.  $B + X$       e. None

91. For this circuit, what is the equation of  $T_B$ ?

- a.  $BX$       b.  $AX$       c.  $A + X$       d.  $B + X$       e. None

92. For this circuit, what is the equation of  $W$ ?

- a.  $BX$       b.  $AX$       c.  $A + X$       d.  $B + X$       e. None

	Present State		Input
	A	B	X
93.	0	0	0
94.	0	0	1
95.	0	1	0
96.	0	1	1
97.	1	0	0
98.	1	0	1
99.	1	1	0
100.	1	1	1

This table represents the state table of this circuit. What are the flip-flops next state–output (AB–W) for each of the stated flip flops’s present state and input (ABX)?

93. a. 00–0      b. 00–1      c. 01–0      d. 01–1      e. None  
 94. a. 00–0      b. 00–1      c. 01–0      d. 01–1      e. None  
 95. a. 00–0      b. 00–1      c. 01–0      d. 01–1      e. None  
 96. a. 00–0      b. 00–1      c. 01–0      d. 10–1      e. None  
 97. a. 10–0      b. 10–1      c. 11–1      d. 11–0      e. None  
 98. a. 00–0      b. 11–1      c. 01–0      d. 01–1      e. None  
 99. a. 00–0      b. 00–1      c. 10–0      d. 01–1      e. None  
 100. a. 00–0      b. 00–1      c. 01–0      d. 01–1      e. None

*Good Luck  
Dr. Dina Tarek*