



**ELECTRICAL AND ELECTRONICS ENGINEERING  
&  
COMPUTER ENGINEERING**

**E E E   2 4 8 | C N G   2 3 2**  
Logic Design

**2 1 | S P R I N G | 2 2**

**HW III**  
Number of Questions: 4

**Due: June 10, 2022**  
Good Luck

**Dr. Gürtaç Yemişcioğlu**

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**Student Number:** **2453025**

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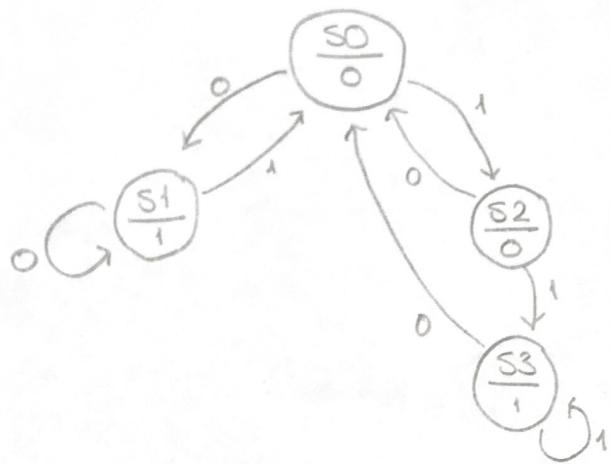
**Full Name:** **MERT CAN BİLGİN**

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Question	Achieved	Points
1		30
2		30
3		20
4		24
<b>TOTAL</b>		<b>104</b>

Question 1)

a)



b)

Present	input	Next	Output
S0	0	S1	0
S0	1	S2	0
S1	0	S1	1
S1	1	S0	1
S2	0	S0	0
S2	1	S3	0
S3	0	S0	1
S3	1	S3	1

Excitation table of JK

Q	Q <sup>+</sup>	J	K
0	0	0	X
0	1	1	X
1	0	X	1
1	1	X	0

↓↓

A B	x	Present	input	Next	Output	J <sub>A</sub> K <sub>A</sub>	J <sub>B</sub> K <sub>B</sub>
0 0	0	0 0	0	0 1	0	0 X	1 X
0 0	1	0 0	1	1 0	0	1 X	0 X
0 1	0	0 1	0	0 1	1	0 X	0 1
0 1	1	0 0	1	0 0	1	0 X	1
1 0	0	0 0	0	0 0	0	X 1	0 X
1 0	1	0 0	1	1 1	0	X 0	1 X
1 1	0	0 0	1	0 0	1	X 1	1
1 1	1	1 1	1	1 1	1	X 0	0

c)  $J_A$

		00	01	11	10
		0	1	0	0
A	$\bar{B}X$	0	1		
		1	X	X	X

$$J_A = \bar{B}'X$$

$K_A$

		00	01	11	10
		0	X	X	X
A	$\bar{B}X$	1	0	0	1
		1	1	0	1

$$K_A = X'$$

$J_B$

		00	01	11	10
		0	1	X	X
A	$\bar{B}X$	0	1	X	X
		1	0	1	X

$$\begin{aligned} J_B &= A'X' + AX \\ &= A \odot X \end{aligned}$$

$K_B$

		00	01	11	10
		0	X	X	0
A	$\bar{B}X$	0	X	X	0
		1	X	X	0

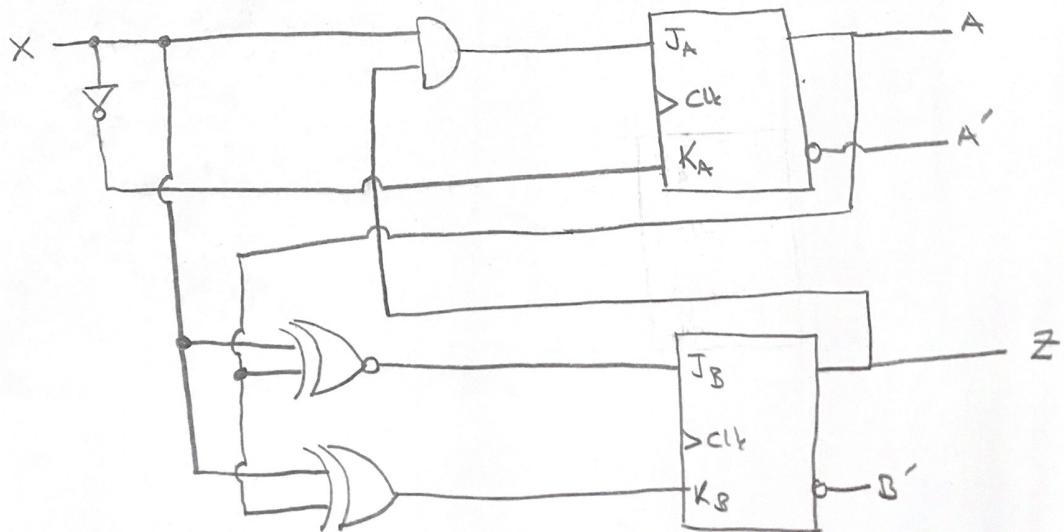
$$\begin{aligned} K_B &= A'X + AX' \\ &= A \oplus X \end{aligned}$$

$Z$

		00	01	11	10
		0	0	1	1
A	$\bar{B}X$	0	0	1	1
		1	0	0	1

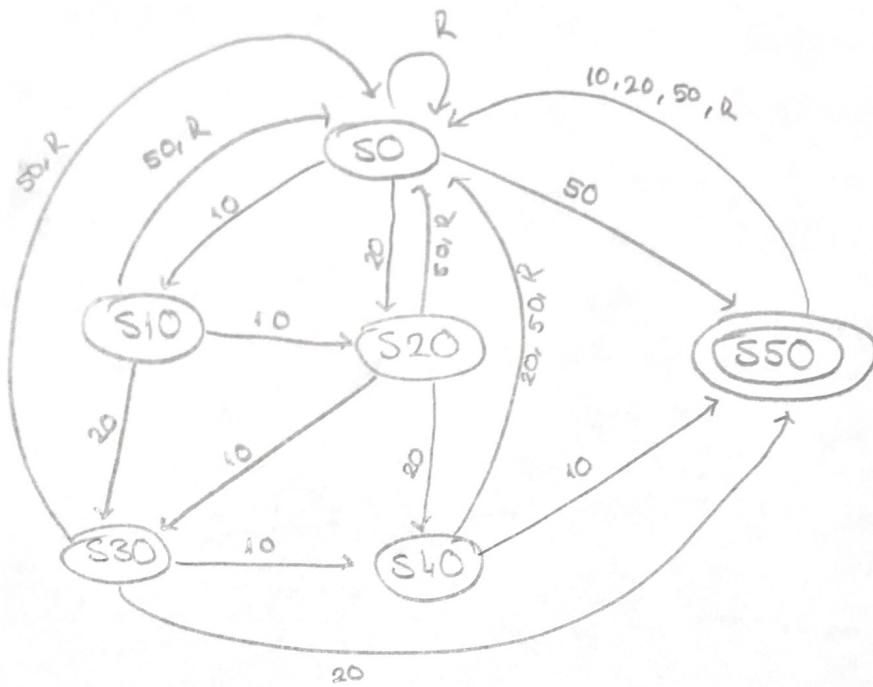
$$Z = B$$

d)



Question 2)

a)



b)

Present	input	Next
S0	10	S10
S0	20	S20
S0	50	S50
S0	R	SO
S10	10	S20
S10	20	S30
S10	50	SO
S10	R	SO
S20	10	S30
S20	20	S40
S20	50	SO
S20	R	SO
S30	10	S40
S30	20	S50
S30	50	SO
S30	R	SO
S40	10	S50
S40	20	SO
S40	50	SO
S40	R	SO
S50	10	SO
S50	20	SO
S50	50	SO
S50	R	SO

c)

$$SO = \cancel{SO \cdot R} + \cancel{S10 \cdot 50} + \cancel{S10 \cdot R} + \cancel{S20 \cdot 50} + \cancel{S20 \cdot R} + \cancel{S30 \cdot 50} + \cancel{S30 \cdot R}$$

$$+ \cancel{S40 \cdot 20} + \cancel{S40 \cdot 50} + \cancel{S40 \cdot R} + S50 (10 + 20 + 50 + R)$$

$$\Rightarrow R (SO + S10 + S20 + S30 + S40 + S50) + 50 (S10 + S20 + S30 + S40 + S50)$$

$$+ 20 (S40 + S50) + S50 \cdot 10 \Rightarrow D_0$$

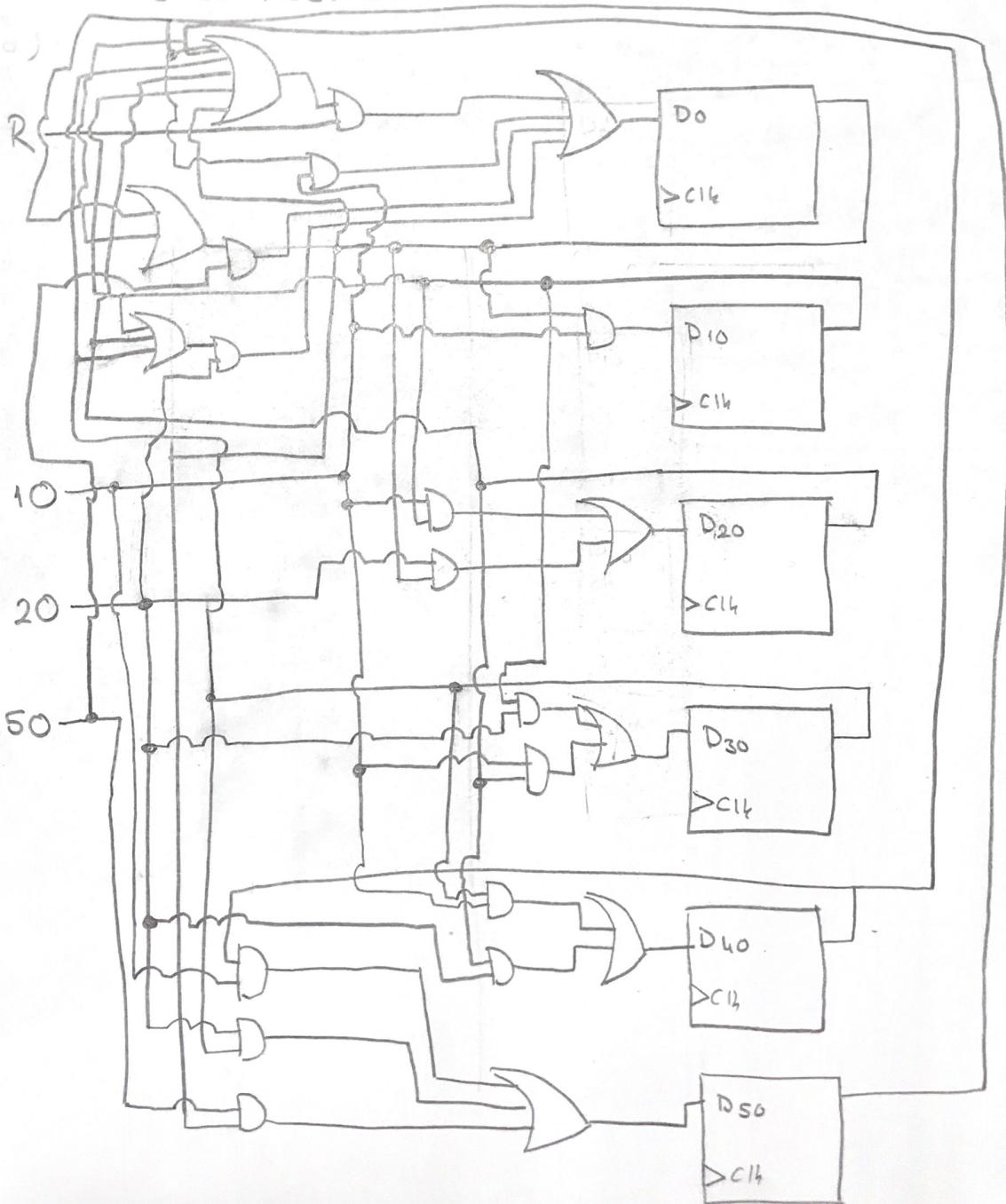
$$S10 = SO \cdot 10 \Rightarrow D_{10}$$

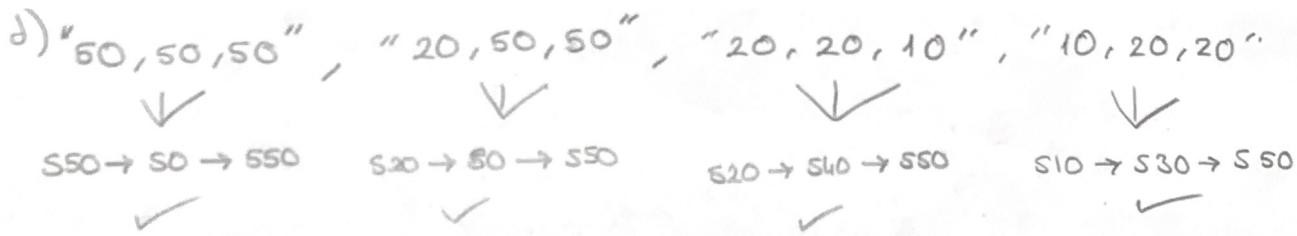
$$S20 = SO \cdot 20 + S10 \cdot 10 \Rightarrow D_{20}$$

$$S30 = S10 \cdot 20 + S20 \cdot 10 \Rightarrow D_{30}$$

$$S40 = S20 \cdot 20 + S30 \cdot 10 \Rightarrow D_{40}$$

$$S50 = SO \cdot 50 + S30 \cdot 20 + S40 \cdot 10 \Rightarrow D_{50}$$





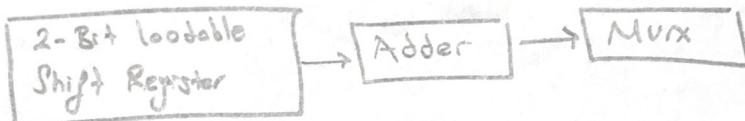
Question 3 (a)

If the path is:



$$t_p(\text{max}) = 100 \text{ ps} + 340 \text{ ps} + 30 \text{ ps} = 470 \text{ ps}$$

If the path is:



$$t_p(\text{max}) = 120 \text{ ps} + 340 \text{ ps} + 30 \text{ ps} = 490 \text{ ps}$$

, so we see that the second path has a bigger delay.

Therefore, Period of Clk =  $t_p(\text{max}) + t_{su} = 490 \text{ ps} + 60 \text{ ps} = 550 \text{ ps}$

$$\text{max frequency} = \frac{1}{\text{period}} , \text{ so } f_{\text{max}} = \frac{1}{550 \text{ ps}}$$

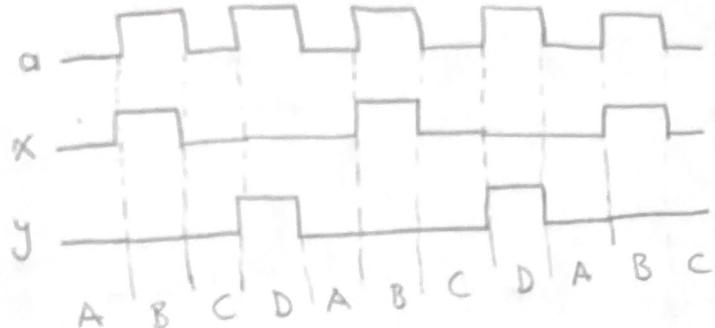
b) hold equation is:  $t_{p-min} + \text{hold} \geq t_{p-min} + t_{su}$

the worst case is between the shift registers.

$$70 - 10 = 60 \text{ ps}$$

Question 4

a)



b)

	A	B	C	D
a	0 (A)	C	0 (A)	
1	B (B)	D	D (D)	

c)

	0	1	1	0
0	00	11	11	00
1	01	01	10	10

$\Rightarrow A \oplus X \oplus Y$

d)

e)

