

# Digital Systems HW7

1. Design a system which can identify the following three shapes:



The shapes are represented by 4 pixels P0-P3:

P <sub>0</sub>	P <sub>1</sub>
P <sub>2</sub>	P <sub>3</sub>

which have an output of "1" when they detect light ("white pixels") and an output of "0" for black. The system should be able to identify the shapes at any rotation (0, 90, 180 or 270 degrees). The identification should then be coded into a 2 bit output signifying each shape by its number (1, 2 or 3). Find the minimal function (SOP) needed to represent the system and implement it using logic gates.

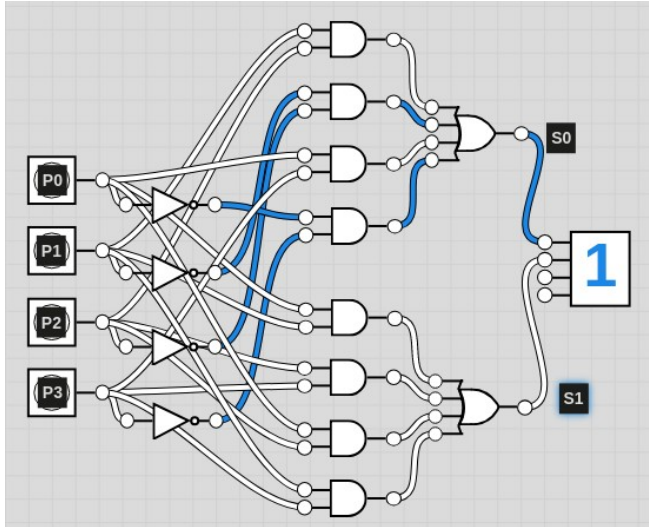
P0	P1	P2	P3	S1	S0
0	0	0	0	Φ	Φ
0	0	0	1	0	1
0	0	1	0	0	1
0	0	1	1	1	0
0	1	0	0	0	1
0	1	0	1	1	0
0	1	1	0	Φ	Φ
0	1	1	1	1	1
1	0	0	0	0	1
1	0	0	1	Φ	Φ
1	0	1	0	1	0
1	0	1	1	1	1
1	1	0	0	1	0
1	1	0	1	1	1
1	1	1	0	1	1
1	1	1	1	Φ	Φ

S0	P0'P1'	P0'P1	P0P1	P0P1'
P2'P3'	Φ	1	0	1
P2'P3	1	0	1	Φ
P2P3	0	1	Φ	1
P2P3'	1	Φ	1	0

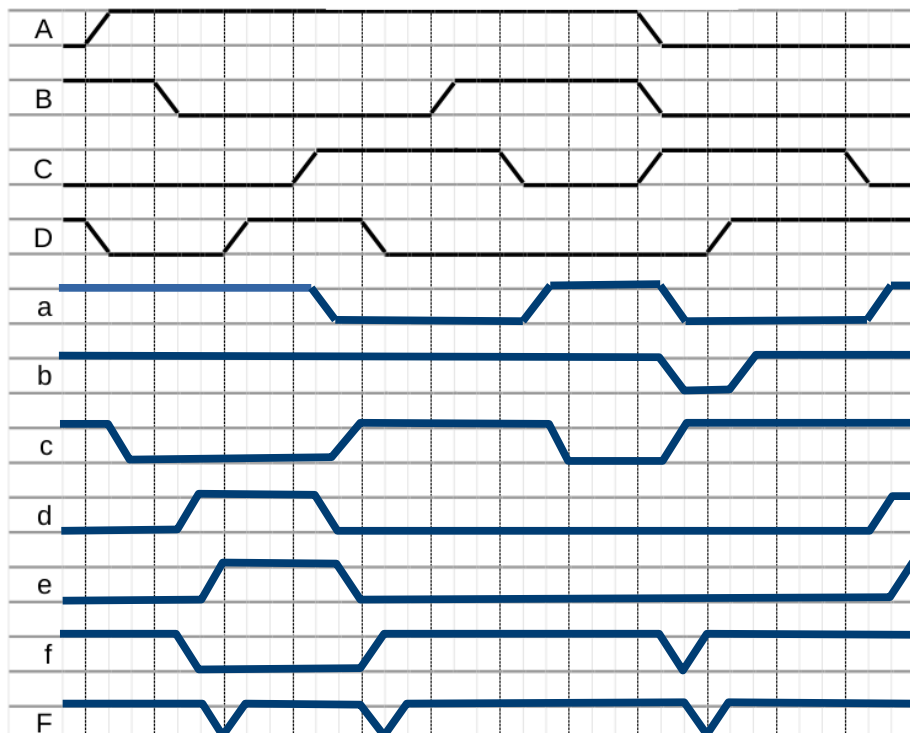
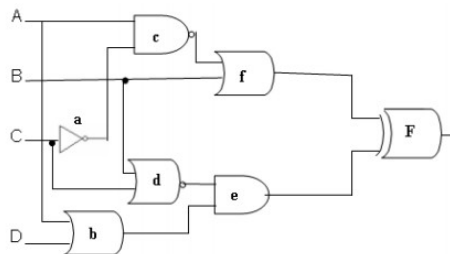
$$S0 = P1P2 + P1'P2' + P0P3 + P0'P3'$$

S1	$P_0'P_1'$	$P_0'P_1$	$P_0P_1$	$P_0P_1'$
$P_2'P_3'$	$\phi$	0	1	0
$P_2'P_3$	0	1	1	$\phi$
$P_2P_3$	1	1	$\phi$	1
$P_2P_3'$	0	$\phi$	1	1

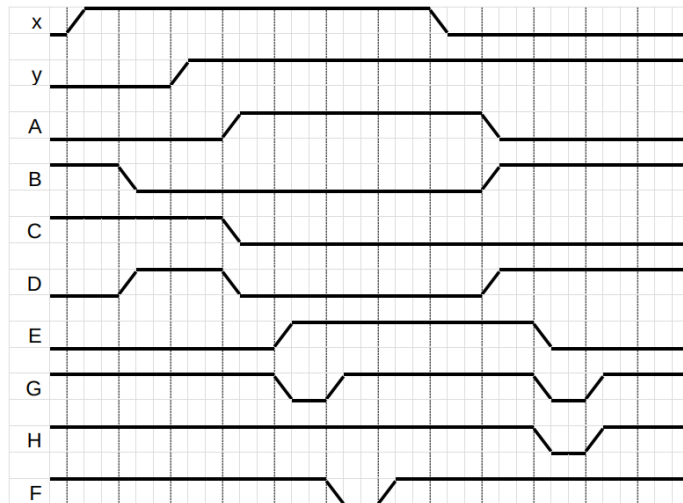
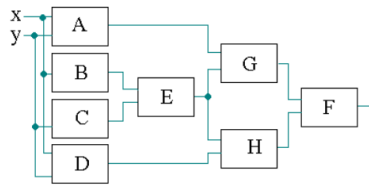
$$S1 = P_0P_1 + P_2P_3 + P_1P_3 + P_0P_2$$



2. Fill in the time diagrams below based on the following circuit:



3. The following circuit contains 8 hidden logic gates: Based on the time diagram below determine which gates have been used. (the gates can be any of the following: NOT, AND, OR, NAND, NOR, XOR, XNOR not all must appear, some may be used multiple times).



- A) AND
- B) NOT
- C) NOT
- D) XOR
- E) NOR
- F) XNOR
- G) XNOR
- H) NAND