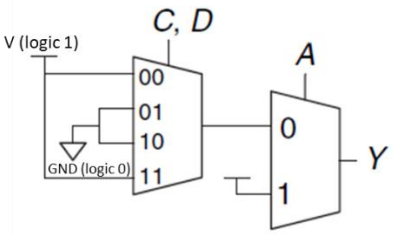
CSC 137 – Cokgor - Combinational Building Blocks Exercises (answers are at the back)

(Exercise reference: David M. Harris, Sarah L. Harris, Digital Design and Computer Architecture, 2nd Edition, Elsevier, 2013, ISBN-13: 978-0-12-394424-5)

1) Write a minimized Boolean equation for the function performed by the circuit shown below:



Hints: Start with constructing a truth table with three inputs (A, C, D) and one output (Y). Then, use K-maps to derive the minimized Boolean equation for Y.

2) Implement the following truth table using a) an 8:1 multiplexer; b) 4:1 multiplexer and one inverter; c) a 2:1 multiplexer and two other logic gates.

A	B	C	Y
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	1

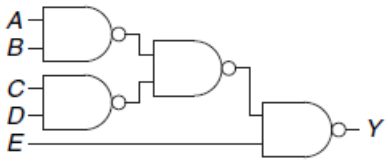
Hints:
i) For (b) and (c), use some of the inputs as inputs to the multiplexer rather than the select signals.
ii) For (b), the truth table for Y can be written as (investigate the full truth table above to understand this):

A	B	Y
0	0	$\overline{C}$
0	1	0
1	0	0
1	1	C

iii) For (c), the truth table for Y can be written as (investigate the full truth table above to understand this):

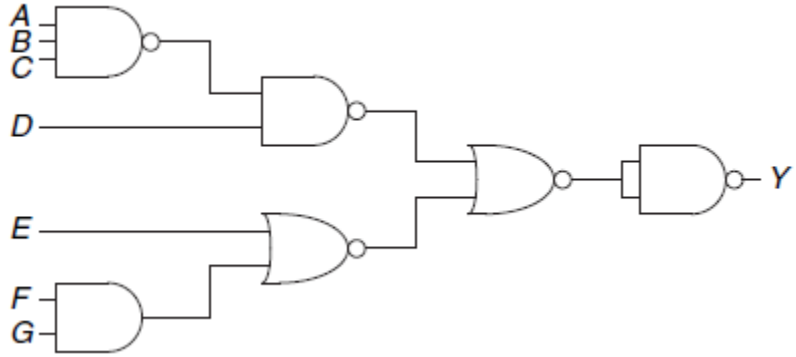
A	Y
0	$\overline{B}\overline{C}$
1	BC

3) Determine the propagation delay for the circuit given below. Assume the propagation delay for a two-input NAND gate is 20ps.



4) Determine the propagation delay for the circuit given below. Assume the propagation delay for a two-input. Suppose gate delays are given as follows:

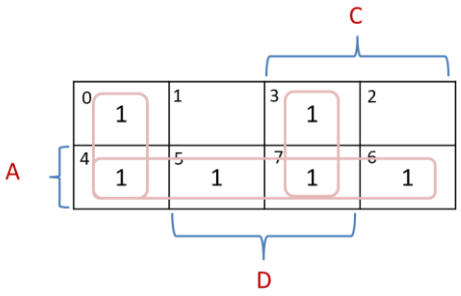
2-input NAND 20ps
3-input NAND 30ps
2-input NOR 30ps
2-input AND 30ps



Answers:

1)

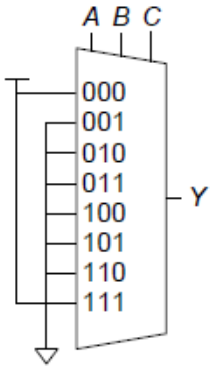
A	C	D	Y
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1



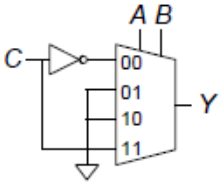
Y = A + CD + C'D'

2)

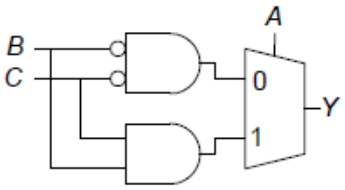
A	B	C	Y
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	1



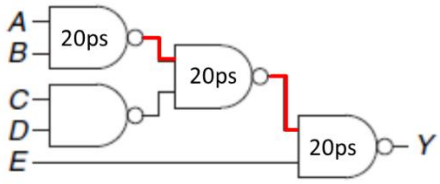
A	B	Y
0	0	$\overline{C}$
0	1	0
1	0	0
1	1	C



A	Y
0	$\overline{B}\overline{C}$
1	BC



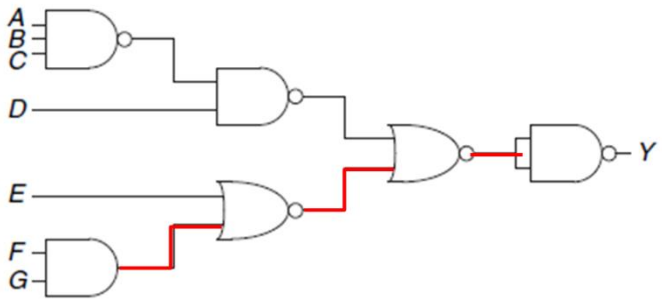
3)



Longest (critical) path shown in red above.

t_{pd} = 60ps

4)



Longest (critical) path shown in red above.

$t_{pd} = t_{pd\_AND2} + 2t_{pd\_NOR2} + t_{pd\_NAND2}$
$= [30 + 2\ (30) + 20]$ ps
$=$ **110 ps**