Homework 2

Rhea Mae Edwards
Student ID #
932-389-303

1) Truth Tables, Boolean Logic, Canonical Forms, Logic Minimizations, and NAND/NOR Implementation

2.1 Boolean Equations in Sum-of-Products Canonical Form

a.)

A	B	y
0	0	1
0	1	0
1	0	1
1	1	1

$y(A,B) = \Sigma(0,2,3)$

$\boxed{y = A'B' + AB' + AB}$

b.)

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

$y(A,B,C) = \Sigma(0,7)$

$\boxed{y = A'B'C' + ABC}$

c.)

A	B	C	y
0	0	0	1
0	0	1	0
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	1

$y(A,B,C) = \Sigma(0,2,4,5,7)$

$\boxed{y = A'B'C' + A'BC' + AB'C' + AB'C + ABC}$

d.)

A	B	C	D	y
0	0	0	0	1
0	0	0	1	1
0	0	1	0	1
0	0	1	1	1
0	1	0	0	0
0	1	0	1	0
0	1	1	0	0
0	1	1	1	0
1	0	0	0	1
1	0	0	1	0
1	0	1	0	1
1	0	1	1	0
1	1	0	0	0

A	B	C	D	y
1	1	0	1	0
1	1	1	0	1
1	1	1	1	0

$y(A,B,C,D) = \Sigma(0,1,2,3,8,10,14)$

$$\boxed{\begin{gathered} y = A'B'C'D' + A'B'C'D + A'B'CD' + A'B'CD + \\ AB'C'D' + AB'CD' + ABCD' \end{gathered}}$$

e)

A	B	C	D	y
0	0	0	0	1
0	0	0	1	0
0	0	1	0	0
0	0	1	1	1
0	1	0	0	0
0	1	0	1	1
0	1	1	0	1
0	1	1	1	0
1	0	0	0	0
1	0	0	1	1
1	0	1	0	1
1	0	1	1	0
1	1	0	0	1
1	1	0	1	0
1	1	1	0	0
1	1	1	1	1

$$y(A,B,C,D) = \Sigma(0,3,5,6,9,10,12,15)$$

$$\boxed{y = A'B'C'D' + A'B'CD + A'BC'D + A'BCD' + AB'C'D + AB'CD' + ABC'D' + ABCD}$$

22 Boolean Equation Sum-Of-Products Canonical Form

a)

A	B	y
0	0	0
0	1	1
1	0	1
1	1	1

$$y(A,B) = \Sigma(1,2,3)$$

$$\boxed{y = A'B + AB' + AB}$$

b)

A	B	C	y
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	0
1	1	0	1
1	1	1	0

$$y(A,B,C) = \Sigma(1,2,3,4,6)$$

$$\boxed{y = A'B'C + A'BC' + A'BC + AB'C' + ABC'}$$

c)

A	B	C	y
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	1
1	1	1	1

$$y(A,B,C) = \Sigma(1,6,7)$$

$$\boxed{y = A'B'C + ABC' + ABC}$$

2.3 Boolean Equation in Product-of-Sums Canonical Form

a)

A	B	y
0	0	1
0	1	0
1	0	1
1	1	1

$y(A,B) = \pi(1)$

$\boxed{y = A + B'}$

b)

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

$y(A,B,C) = \pi(1,2,3,4,5,6)$

$$\boxed{\begin{array}{l} y = (A+B+C') + (A+B'+C) + (A+B'+C') + \\ (A'+B+C) + (A'+B+C') + (A'+B'+C) \end{array}}$$

c)

A	B	C	y
0	0	0	1
0	0	1	0
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	1

$y(A,B,C) = \pi(1,3,6)$

$\boxed{y = (A+B+C') + (A+B'+C') + (A'+B'+C)}$

2.5 Minimize Boolean Equations from Exercise 2.1

a) $y = A'B' + AB' + AB$

$y(A,B) = \Sigma(0,2,3)$

y: B \ A	0	1
0	1 ($A'B'$)	1 (AB')
1		1 (AB)

$\boxed{y = B' + A}$

b) $y = A'B'C' + ABC$

$y(A,B,C) - (0,7)$

y: C \ AB	00	01	11	10
0	1			
1			1	

$\boxed{y = A'B'C' + ABC}$

c) $y = A'B'C' + A'BC' + AB'C' + AB'C + ABC$

$y(A,B,C) = (0,2,4,5,7)$

y: C \ AB	00	01	11	10
0	1			1
1	1		1	1

$\boxed{y = A'B' + AC + AB'}$

2.26 Minimize Boolean Equations from Exercise 2.2

a) $y(A,B) = \Sigma(1,2,3)$
$y = A'B + AB' + AB$

y B \ A	0	1
0		1
1	1	1

$\boxed{y = A + B}$

b) $y(A,B,C) = \Sigma(1,2,3,4,6)$
$y = A'B'C + A'BC' + A'BC + AB'C' + ABC'$

$\boxed{y = AC' + A'C + A'B}$

y C \ AB	00	01	11	10
0		1	1	1
1	1	1		

c) $y(A,B,C) = \Sigma(1,6,7)$
$y = A'B'C + ABC' + ABC$

y C \ AB	00	01	11	10
0			1	
1	1		1	

$\boxed{y = AB + A'B'C}$

2.28 Minimal Boolean Equation

A	B	C	D	y
0	0	0	0	X
0	0	0	1	X
0	0	1	0	X
0	0	1	1	0
0	1	0	0	0
0	1	0	1	X
0	1	1	0	0
0	1	1	1	X
1	0	0	0	1
1	0	0	1	0
1	0	1	0	X
1	0	1	1	1
1	1	0	0	1
1	1	0	1	1
1	1	1	0	X
1	1	1	1	1

y CD \ AB	00	01	11	10
00	X	0	1	1
01	X	X	1	0
11	0	X	1	1
10	X	0	X	X

$\boxed{y = AC + BD + AD'}$

[redacted]

2) Spring Picnics

2.33 Ben Bitdiddle is Picky about his Picnics

E = enjoyment
S = Sun
A = ants
H = hummingbirds
L = ladybugs

$E(S,A,H,L) = \Sigma(2,3,5,6,7,8,9,10,11,13,14,15)$

$E(S,A,H,L) = \pi(0,1,4,12)$

S	A	H	L	E
0	0	0	0	0
0	0	0	1	0
0	0	1	0	1
0	0	1	1	1
0	1	0	0	0
0	1	0	1	1
0	1	1	0	1
0	1	1	1	1
1	0	0	0	1
1	0	0	1	1
1	0	1	0	1
1	0	1	1	1
1	1	0	0	0
1	1	0	1	1
1	1	1	0	1
1	1	1	1	1

Just based off the description given by the problem statement we can conclude that...

$\boxed{E = SA' + H + AL}$

3) Combinational Logic Design

2.34 Design of a Seven-Segment Decoder

a)

A	B	C	D	SegA
0	0	0	0	0
0	0	0	1	1
0	0	1	0	0
0	0	1	1	0
0	1	0	0	1
0	1	0	1	0
0	1	1	0	0
0	1	1	1	0
1	0	0	0	0
1	0	0	1	0
1	0	1	0	0
1	0	1	1	0
1	1	0	0	0
1	1	0	1	0
1	1	1	0	0
1	1	1	1	0

$SegA(A,B,C,D) = \Sigma(1,4)$

SegA

CD \ AB	00	01	11	10
00		1		
01	1			
11				
10				

$\boxed{SegA = \overline{A}\,\overline{B}\,\overline{C}D + \overline{A}B\overline{C}\,\overline{D}}$

A	B	C	D	SegB
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	0
0	1	0	1	1
0	1	1	0	1
0	1	1	1	0
1	0	0	0	0
1	0	0	1	0
1	0	1	0	0
1	0	1	1	0
1	1	0	0	0
1	1	0	1	0
1	1	1	0	0
1	1	1	1	0

$SegB(A,B,C,D) = \Sigma(5,6)$

SegB (CD \ AB)	00	01	11	10
00				
01		1		
11				
10		1		

$\boxed{SegA = \bar{A}B\bar{C}D + \bar{A}BC\bar{D}}$

A	B	C	D	SegC
0	0	0	0	0
0	0	0	1	0
0	0	1	0	1
0	0	1	1	0
0	1	0	0	0
0	1	0	1	0
0	1	1	0	0
0	1	1	1	0
1	0	0	0	0
1	0	0	1	0
1	0	1	0	0
1	0	1	1	0
1	1	0	0	0
1	1	0	1	0
1	1	1	0	0
1	1	1	1	0

$SegC(A,B,C,D) = \Sigma(2)$

SegC (CD \ AB)	00	01	11	10
00				
01				
11				
10	1			

$\boxed{SegC = \bar{A}\bar{B}C\bar{D}}$

A	B	C	D	SegD
0	0	0	0	0
0	0	0	1	1
0	0	1	0	0
0	0	1	1	0
0	1	0	0	1
0	1	0	1	0
0	1	1	0	0
0	1	1	1	1
1	0	0	0	0
1	0	0	1	1
1	0	1	0	0
1	0	1	1	0
1	1	0	0	0

A	B	C	D	SegD
1	1	0	1	0
1	1	1	0	0
1	1	1	1	0

$SegD(A,B,C,D) =$

$\Sigma(1,4,7,9)$

SegD (CD \ AB)	00	01	11	10
00		1		
01	1			1
11		1		
10				

$\boxed{SegD = \bar{A}\bar{B}\bar{C}D + \bar{A}B\bar{C}D + \bar{A}BCD + A\bar{B}\bar{C}D}$

A	B	C	D	Seg E
0	0	0	0	0
0	0	0	1	1
0	0	1	0	0
0	0	1	1	1
0	1	0	0	1
0	1	0	1	1
0	1	1	0	0
0	1	1	1	1
1	0	0	0	0
1	0	0	1	1
1	0	1	0	0
1	0	1	1	0
1	1	0	0	0
1	1	0	1	0
1	1	1	0	0
1	1	1	1	0

$SegE(A,B,C,D) = \Sigma(1,3,4,5,7,9)$

SegE

CD \ AB	00	01	11	10
00		1		
01	1	1		1
11	1	1		
10				

$\boxed{SegE = \overline{A}D + \overline{A}B\overline{C} + \overline{B}\,\overline{C}D}$

A	B	C	D	Seg F
0	0	0	0	0
0	0	0	1	1
0	0	1	0	1
0	0	1	1	1
0	1	0	0	0
0	1	0	1	0
0	1	1	0	0
0	1	1	1	1
1	0	0	0	0
1	0	0	1	0
1	0	1	0	0
1	0	1	1	0
1	1	0	0	0
1	1	0	1	0
1	1	1	0	0
1	1	1	1	0

$SegF(A,B,C,D) = \Sigma(1,2,3,7)$

SegF

CD \ AB	00	01	11	10
00				
01	1			
11	1	1		
10	1			

$\boxed{SegF = \overline{A}CD + \overline{A}\,\overline{B}D + \overline{A}\,\overline{B}C}$

A	B	C	D	Seg G
0	0	0	0	1
0	0	0	1	1
0	0	1	0	0
0	0	1	1	0
0	1	0	0	0
0	1	0	1	0
0	1	1	0	0
0	1	1	1	1
1	0	0	0	0
1	0	0	1	0
1	0	1	0	0
1	0	1	1	0
1	1	0	0	0

A	B	C	D	Seg G
1	1	0	1	0
1	1	1	0	0
1	1	1	1	0

$SegG(A,B,C,D) =$

$\Sigma(0,1,7)$

$\boxed{SegG = \overline{A}\,\overline{B}\,\overline{C} + \overline{A}BCD}$

SegG

CD \ AB	00	01	11	10
00	1			
01	1			
11		1		
10				

6.)

A	B	C	D	SegA
0	0	0	0	0
0	0	0	1	1
0	0	1	0	0
0	0	1	1	0
0	1	0	0	1
0	1	0	1	0
0	1	1	0	0
0	1	1	1	0
1	0	0	0	0
1	0	0	1	0
1	0	1	0	X
1	0	1	1	X
1	1	0	0	X
1	1	0	1	X
1	1	1	0	X
1	1	1	1	X

$SegA(A,B,C,D) = \Sigma(1,4)$

SegA

CD \ AB	00	01	11	10
00		1	X	
01	1		X	
11			X	X
10			X	X

$$\boxed{SegA = B\bar{C}\bar{D} + \bar{A}\bar{B}\bar{C}D}$$

A	B	C	D	SegB
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	0
0	1	0	1	1
0	1	1	0	1
0	1	1	1	0
1	0	0	0	0
1	0	0	1	0
1	0	1	0	X
1	0	1	1	X
1	1	0	0	X
1	1	0	1	X
1	1	1	0	X
1	1	1	1	X

$SegB(A,B,C,D) = \Sigma(5,6)$

SegB

CD \ AB	00	01	11	10
00			X	
01		1	X	
11			X	X
10		1	X	X

$$\boxed{SegB = B\bar{C}D + BC\bar{D}}$$

A	B	C	D	SegC
0	0	0	0	0
0	0	0	1	0
0	0	1	0	1
0	0	1	1	0
0	1	0	0	0
0	1	0	1	0
0	1	1	0	0
0	1	1	1	0
1	0	0	0	0
1	0	0	1	0
1	0	1	0	X
1	0	1	1	X
1	1	0	0	X

A	B	C	D	SegC
1	1	0	1	X
1	1	1	0	X
1	1	1	1	X

$SegC(A,B,C,D) =$

$\Sigma(2)$

$$\boxed{SegC = \bar{B}C\bar{D}}$$

SegC

CD \ AB	00	01	11	10
00			X	
01			X	
11			X	X
10	1		X	X

A	B	C	D	Seg D
0	0	0	0	0
0	0	0	1	1
0	0	1	0	0
0	0	1	1	0
0	1	0	0	1
0	1	0	1	0
0	1	1	0	0
0	1	1	1	1
1	0	0	0	0
1	0	0	1	1
1	0	1	0	X
1	0	1	1	X
1	1	0	0	X
1	1	0	1	X
1	1	1	0	X
1	1	1	1	X

$SegD(A,B,C,D) = \Sigma(1,4,7,9)$

SegD

CD \ AB	00	01	11	10
00		1	X	
01	1		X	1
11		1	X	X
10			X	X

$\boxed{SegD = \overline{B}\,\overline{C}D + B\overline{C}\,\overline{D} + BCD}$

A	B	C	D	Seg E
0	0	0	0	0
0	0	0	1	1
0	0	1	0	0
0	0	1	1	1
0	1	0	0	1
0	1	0	1	1
0	1	1	0	0
0	1	1	1	1
1	0	0	0	0
1	0	0	1	1
1	0	1	0	X
1	0	1	1	X
1	1	0	0	X
1	1	0	1	X
1	1	1	0	X
1	1	1	1	X

$SegE(A,B,C,D) = \Sigma(1,3,4,5,7,9)$

SegE

CD \ AB	00	01	11	10
00		1	X	
01	1	1	X	1
11	1	1	X	X
10			X	X

$\boxed{SegE = D + B\overline{C}}$

A	B	C	D	Seg F
0	0	0	0	0
0	0	0	1	1
0	0	1	0	1
0	0	1	1	1
0	1	0	0	0
0	1	0	1	0
0	1	1	0	0
0	1	1	1	1
1	0	0	0	0
1	0	0	1	0
1	0	1	0	X
1	0	1	1	X
1	1	0	0	X

A	B	C	D	Seg F
1	1	0	1	X
1	1	1	0	X
1	1	1	1	X

$SegF(A,B,C,D) = \Sigma(1,2,3,7)$

SegF

CD \ AB	00	01	11	10
00			X	
01	1		X	
11	1	1	X	X
10	1		X	X

$\boxed{SegF = CD + \overline{B}C + \overline{A}\,\overline{B}D}$

A	B	C	D	Seg G
0	0	0	0	1
0	0	0	1	1
0	0	1	0	0
0	0	1	1	0
0	1	0	0	0
0	1	0	1	0
0	1	1	0	0
0	1	1	1	1
1	0	0	0	0
1	0	0	1	0
1	0	1	0	X
1	0	1	1	X
1	1	0	0	X
1	1	0	1	X
1	1	1	0	X
1	1	1	1	X

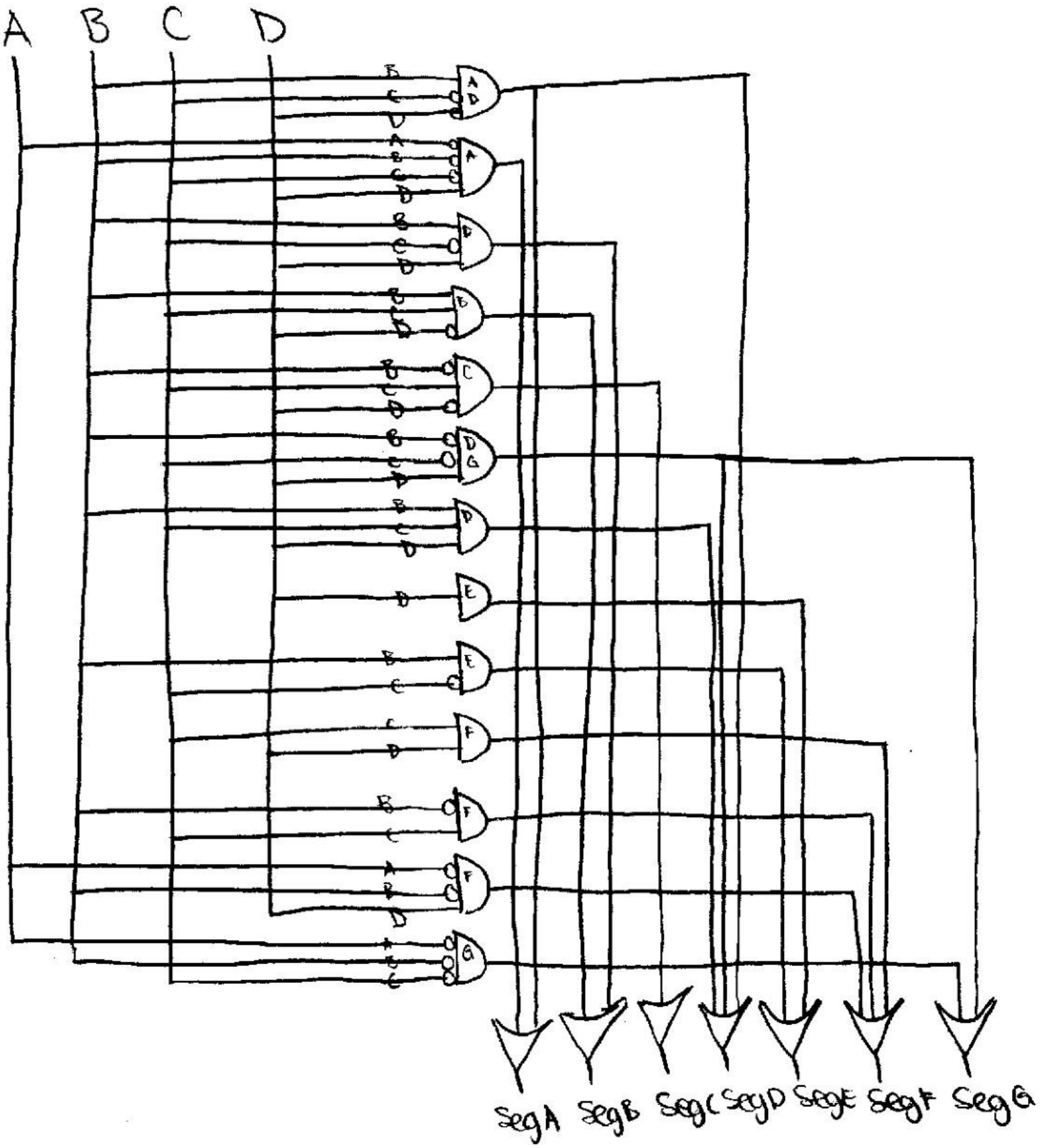
$SegG(A,B,C,D) = \Sigma(0,1,7)$

SegG

CD \ AB	00	01	11	10
00	1		X	
01	1		X	
11		1	X	X
10			X	X

$\boxed{SegG = \overline{A}\,\overline{B}\,\overline{C} + BCD}$

c)



2.35 Boolean Equation and Sketch of a 4-Input and 2-Output Circuit

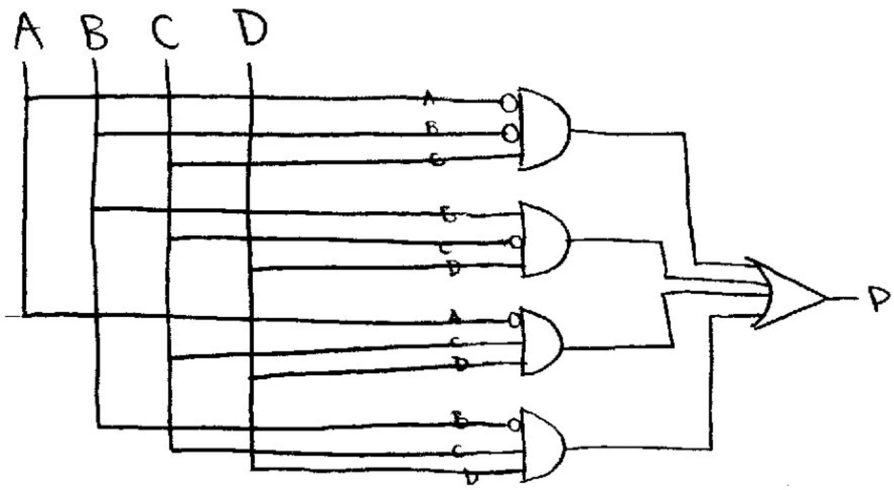
A	B	C	D	P	D
0	0	0	0	0	0
0	0	0	1	0	0
0	0	1	0	1	0
0	0	1	1	1	1
0	1	0	0	0	0
0	1	0	1	1	0
0	1	1	0	0	1
0	1	1	1	1	0
1	0	0	0	0	0
1	0	0	1	0	1
1	0	1	0	0	0
1	0	1	1	1	0
1	1	0	0	0	1
1	1	0	1	1	0
1	1	1	0	0	0
1	1	1	1	0	1

$P(A,B,C,D) = \Sigma(2,3,5,7,11,13)$

P

CD \ AB	00	01	11	10
00				
01		1	1	
11	1	1		1
10	1			

$\boxed{P = \bar{A}\bar{B}C + B\bar{C}D + \bar{A}CD + \bar{B}CD}$



4) Timing

2.43 Propagation Delay and Contamination Delay of Figure 2.83

t_{PD} = One 2-Input NAND Gate + One 2-Input NAND Gate +
One 2-Input NAND Gate =
3(2-Input NAND Gate) = 3(20) = 60 ps

t_{CD} = One 2-Input NAND Gate =
1(2-Input NAND Gate) = 1(15) = 15 ps

$$\boxed{\begin{aligned} t_{PD} &= 60\text{ps} \\ t_{CD} &= 15\text{ps} \end{aligned}}$$

2.44 Propagation Delay and Contamination Delay of Figure 2.84

t_{PD} = One 2-Input AND Gate + One 2-Input NOR Gate + One 2-Input NOR Gate + One NOT Gate = 1(2-Input AND Gate) + 2(2-Input NOR Gate) + 1(NOT Gate) = 1(30) + 2(30) + 1(15) = 105 ps

t_{CD} = One 2-Input NAND Gate + One 2-Input NOR Gate + One NOT Gate = 1(2-Input NAND Gate) + 1(2-Input NOR Gate) + 1(NOT Gate) = 1(15) + 1(25) + 1(10) = 50 ps

$$\boxed{\begin{aligned} t_{PD} &= 105\text{ps} \\ t_{CD} &= 50\text{ps} \end{aligned}}$$

5) Interview Questions

23 Tristate Buffer

A tristate buffer with two inputs (a data input and a control input) with an output. It allows the user to control when current passes through the device being used. A tristate buffer is a good way to control what gets on a bus of a device and what doesn't.