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Test1 Exam (100 points, 20% of your semester grade)

Topics:

1. Truth Table => Sum-of-products Form
2. Boolean Expression => Simplify Using Identities
3. Boolean Expression => Draw Circuit
4. Gates => Truth Table
5. Sequential Circuit => Truth Table
6. Boolean Expression => Simplify Using KMaps
7. KMaps => Simplify Boolean Expression
8. Convolutional code and Viterbi algorithm

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Chapter 1 Introduction

1. In what ways are hardware and software different? In what ways are they the same?

Ans.

Between hardware and software, hardware provides more speed, software provides more flexibility. Hardware and software are related through the **Principle of Equivalence of Hardware and Software**. They can solve problems equally, although solutions are often easier in one versus the other.

2.

- a) How many milliseconds (ms) are in 1 second?
- b) How many microseconds (μ s) are in 1 second?
- c) How many nanoseconds (ns) are in 1 millisecond?
- d) How many microseconds are in 1 millisecond?
- e) How many nanoseconds are in 1 microsecond?
- f) How many kilobytes (KB) are in 1 gigabyte (GB)?
- g) How many kilobytes are in 1 megabyte (MB)?
- h) How many megabytes are in 1 gigabyte (GB)?
- i) How many bytes are in 20 megabytes?
- j) How many kilobytes are in 2 gigabytes?

Ans.

- | | |
|--------------|---|
| a. 1,000 | f. 1,000,000 (or $2^{10}/2^{10}=2^0$) |
| b. 1,000,000 | g. 1,000 (or $2^{20}/2^{10}=2^{10}$) |
| c. 1,000,000 | h. 1,000 (or $2^{30}/2^{20}=2^{10}$) |
| d. 1,000 | i. 20,000,000 (or $20*2^{20}$) |
| e. 1,000 | j. 2,000,000 (or $2^{21}/2^{10}=2^{11}$) |



Chapter 3

Boolean Algebra and digital Logic

17. Simplify the following functional expressions using Boolean algebra and its identities.
List the identity used at each step.

a) $x(y + z)(x' + z')$

b) $xy + xyz + xy'z + x'y'z$

c) $xy'z + x(y + z')' + xy'z'$

Ans.

a) $x(y + z)(x' + z')$

$$\begin{aligned} &= x(x'y + yz' + x'z + zz') \\ &= xx'y + xyz' + xx'z + xzz' \\ &= 0 + xyz' + 0 + 0 \\ &= xyz' \end{aligned}$$

Distributive/Commutative

Distributive

Inverse/Null

Identity

b) $xy + xyz + xy'z + x'y'z$

$$\begin{aligned} &= xy(1 + z) + (x + x')y'z \\ &= xy(1) + (1)y'z \\ &= xy + y'z \end{aligned}$$

Distributive

Idempotent

Identity

c) $xy'z + x(y + z')' + xy'z'$

$$\begin{aligned} &= xy'z + xy'z + xy'z' \\ &= xy'z + xy'(z + z') \\ &= xy'z + xy'(1) \\ &= xy'z + xy' \\ &= xy'(z + 1) \\ &= xy'(1) \\ &= xy' \end{aligned}$$

DeMorgan

Distributive

Inverse

Identity

Distributive

Null

Identity

22. The truth table for a Boolean expression is shown below. Write the Boolean expression in sum-of-products form.

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$$\begin{aligned}
 b) xy + xyz + xy'z + x'y'z &= xy(1+z) + (x+x')y'z \\
 &= xy(1) + (1)y'z \\
 &= xy + y'z
 \end{aligned}$$

Distributive
Idempotent
Identity

$$\begin{aligned}
 c) xy'z + x(y + z)y' + xy'z' &= xy'z + xy'z + xy'z' \\
 &= xy'z + xy'(z + z') \\
 &= xy'z + xy'(1) \\
 &= xy'z + xy' \\
 &= xy'(z + 1) \\
 &= xy'(1) \\
 &= xy'
 \end{aligned}$$

DeMorgan
Distributive
Inverse
Identity
Distributive
Null
Identity

22. The truth table for a Boolean expression is shown below. Write the Boolean expression in sum-of-products form.

x	y	z	F
0	0	0	1
0	0	1	0
0	1	0	1
0	1	1	0
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

Ans.

$$F(x,y,z) = x'y'z' + x'y'z + xy'z + xy'z' + xyz$$

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c. Draw the logic diagram for the simplified expression in part c.

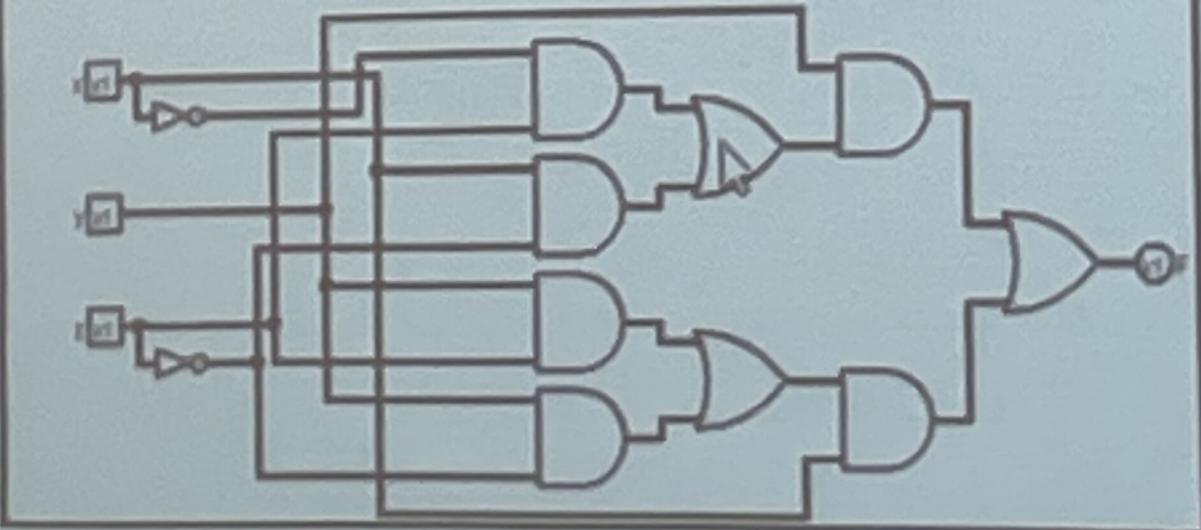
Ans.

a. Truth table for $F(x,y,z) = y(x'z + xz') + x(yz + yz')$

x	y	z	xz	x'	$y(x'z + xz')$	yz	z'	$x(yz + yz')$	$y(x'z + xz') + x(yz + yz')$	F
0	0	0	0	1	0	0	1	0	0	0
0	0	1	0	1	0	0	0	0	0	0
0	1	0	0	1	0	0	1	0	0	0
0	1	1	1	0	1	1	0	0	0	1
1	0	0	0	1	0	0	0	0	0	0
1	0	1	0	1	0	0	1	1	0	1
1	1	0	0	1	1	0	1	0	1	1
1	1	1	0	1	0	1	0	1	1	1

b. Logic diagram for $F(x,y,z) = y(x'z + xz') + x(yz + yz')$

Chapter 3 Question 27 (a) Draw the logic diagram using the original Boolean expression $F(x,y,z) = y(x'z + xz') + x(yz + yz')$
Program ID: Chas3Q27a.circ
Author: Kuo-pao Yang
Simulator: Logisim
$F(x,y,z) = y(x'z + xz') + x(yz + yz')$



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2. Ye
3. Bo
4. Ga
5. Se
6. Bo
7. KM
8. Co
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c. $y(x'z + xz') + x(yz + yz')$

$$\begin{aligned}
 &= x'y'z + xyz' + xyz + xyz' \\
 &= x'y'z + xyz + xyz' \\
 &= x'y'z + xyz + xyz + xyz' \\
 &= (x' + x)yz + xy(z + z') \\
 &= 1yz + xy1 \\
 &= xy + yz
 \end{aligned}$$

Distributive/Commutative
Idempotent
Idempotent
Distributive
Inverse
Identity

d. Truth table for $F(x,y,z) = xy + yz$

x	y	z	xy	yz	F
0	0	0	0	0	0
0	0	1	0	0	0
0	1	0	0	0	0
0	1	1	0	1	1
1	0	0	0	0	0
1	0	1	0	0	0
1	1	0	1	0	1
1	1	1	1	1	1

e. Logic diagram for $F(x,y,z) = xy + yz$

Chapter 3 Question 27 (e) Draw the logic diagram using the original Boolean expression $F(x,y,z) = xy + yz$
Program-ID: Chap3Q27e.vns
Author: Kun-pao Yang
Simulator: Logisim
$F(x,y,z) = xy + yz$



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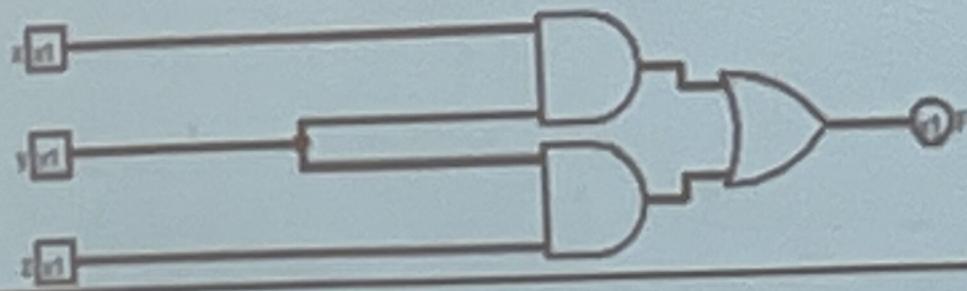
$$\begin{aligned}
 &= x'yz + xyz + xy'z \\
 &= x'yz + xyz + xyz + xyz' \\
 &= (x' + x)yz + xy(z + z') \\
 &= 1yz + xy1 \\
 &= xy + yz
 \end{aligned}
 \quad \begin{array}{l} \text{Idempotent} \\ \text{Distributive} \\ \text{Inverse} \\ \text{Identity} \end{array}$$

d. Truth table for $F(x,y,z) = xy + yz$

x	y	z	xy	yz	F
0	0	0	0	0	0
0	0	1	0	0	0
0	1	0	0	0	0
0	1	1	0	1	1
1	0	0	0	0	0
1	0	1	0	0	0
1	1	0	1	0	1
1	1	1	1	1	1

e. Logic diagram for $F(x,y,z) = xy + yz$

Chapter 3 Question 27 (e) Draw the logic diagram using the original Boolean expression $F(x,y,z) = xy + yz$
Program-ID: Chap3Q27e.six
Author: Kuo-pao Yang
Simulator: Logisim
$F(x,y,z) = xy + yz$



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31. Write a simplified expression for the Boolean function defined by each of the following K-maps.

a.

WX \ YZ	00	01	11	10
00	1	0	0	1
01	1	0	0	1
11	0	0	1	0
10	1	0	1	0

Ans.

$$w'z' + x'y'z' + wxyz$$

b.

WX \ YZ	00	01	11	10
00	1	1	1	1
01	0	0	1	1
11	1	1	1	1
10	1	0	0	1

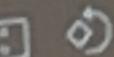
Ans.

$$w'x' + wz + x'x' + w'y \quad \text{OR} \quad w'x' + wz + x'x' + xy$$

c.

WX \ YZ	00	01	11	10
00	0	1	0	1

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33. Create the Kmaps and then simplify for the following functions:
- $F(w,x,y,z) = w'x'y'z' + w'x'y'z + w'xy'z + w'xyz + w'xy'z' + wx'y'z' + wx'y'z$
 - $F(w,x,y,z) = w'x'y'z' + w'x'y'z + wx'y'z + wx'y'z' + wx'y'z$
 - $F(w,x,y,z) = y'z + wy' + w'xy + w'x)y'z' + wx'y'z'$

Ans.
a. $x'y'z' + w'xy + w'xy$ or $x'y'z' + w'xz + w'yz'$

w\y	yz	00	01	11	10
00	1	0	0	0	0
01	0	1	1	1	1
11	0	0	0	0	0
10	1	0	0	0	1

b. $x'y' + wx'z'$

w\y	yz	00	01	11	10
00	1	1	0	0	0
01	0	0	0	0	0
11	0	0	0	0	0
10	1	1	0	0	1

c. $y'z + wy' + w'xy + x'y'z'$



36. Write a simplified expression for the Boolean function defined by each of the following K-maps.

a.

X \ YZ	00	01	11	10
0	1	1	0	X
1	1	1	1	1

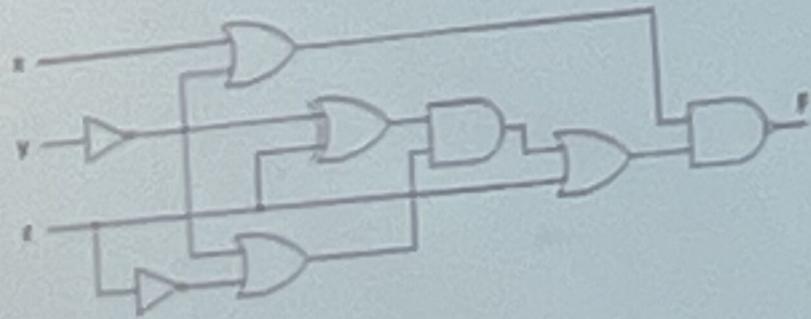
Ans.
 $x + y'$ (We don't want to include the "don't care" as it doesn't help us.)

b.

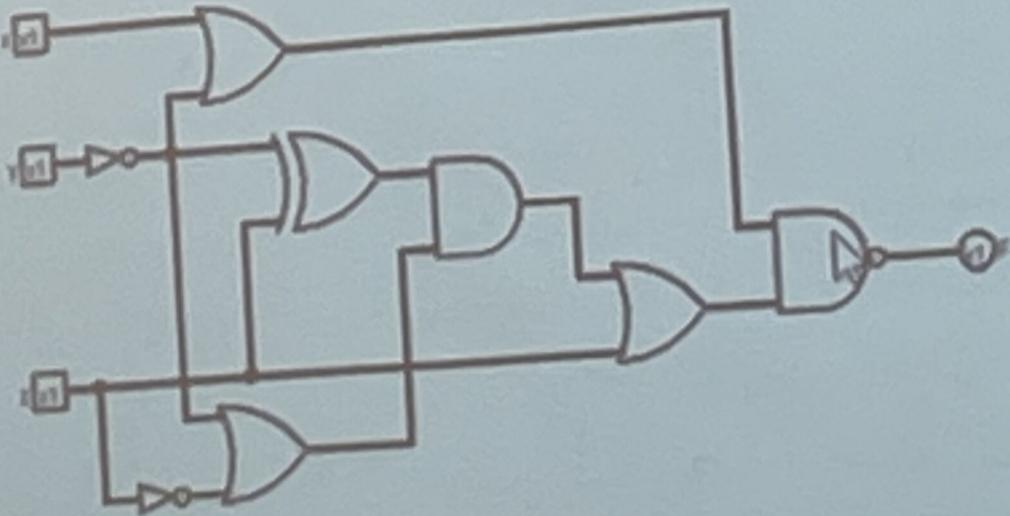
WX \ YZ	00	01	11	10
00	1	1	1	1
01	0	X	1	X
11	0	X	0	0
10	1	0	X	1

Ans.
 $x'y' + w'z$

50. Find the truth table that describes the following circuit:



Ans.



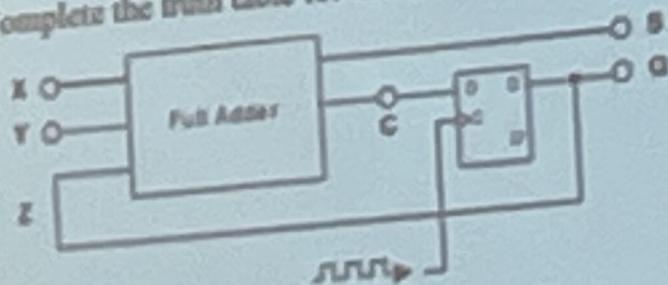
x	y	z	f
0	0	0	0
0	0	1	0
0	1	0	1
0	1	1	1
1	0	0	0



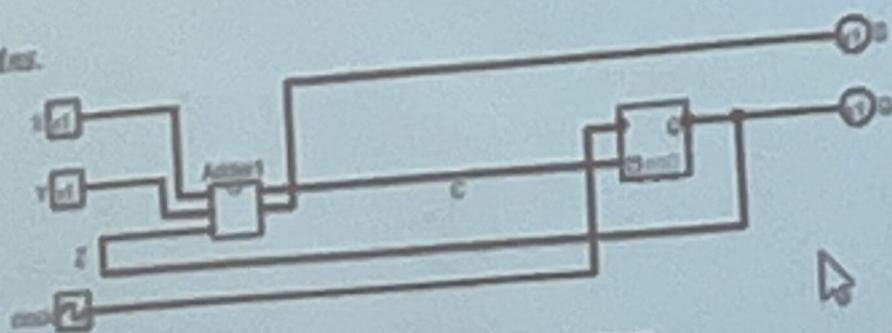
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66. Complete the truth table for the following sequential circuit:



Ans.

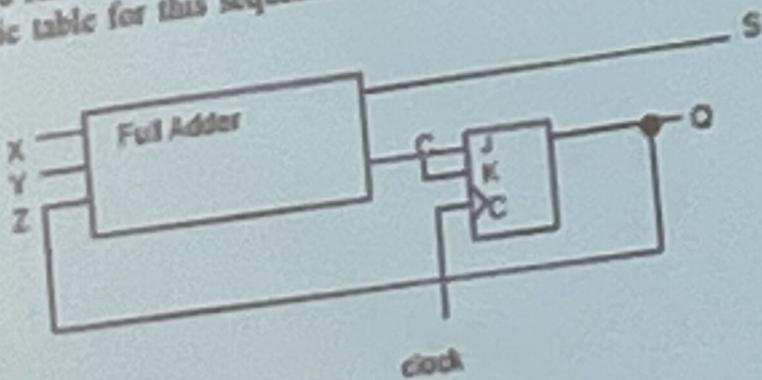


			Next State	
X	Y	Z	S	Q
0	0	0	0	0
0	0	1	0	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	1	1
1	1	1	1	1

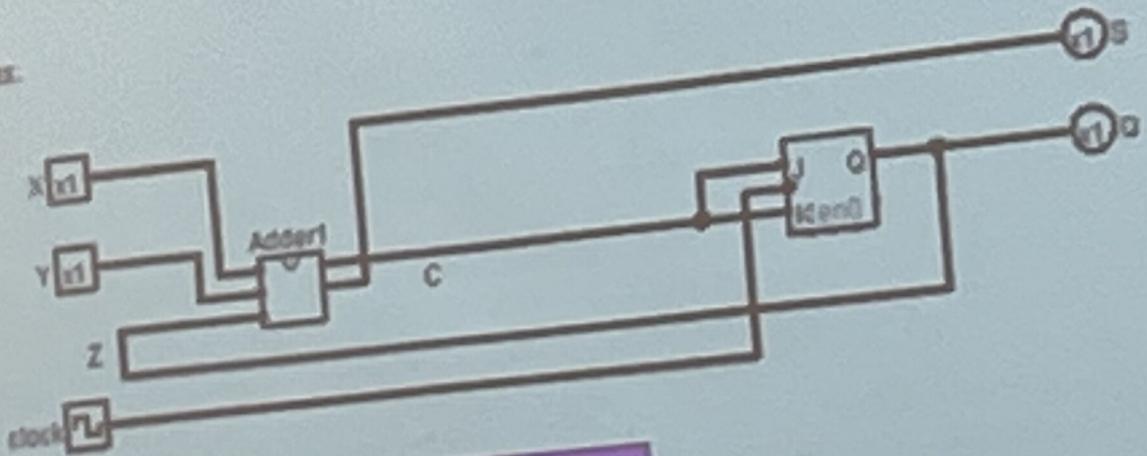
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consists of a full-adder circuit connected to a JK flip-flop, as shown below. Fill in the characteristic table for this sequential circuit by completing the Next State and Output columns.



Ans.



Present State (Q1)	Inputs		Next State	
	X	Y	Q1s1	S
0	0	0	0	0
0	0	1	0	1
0	1	0	0	1
0	1	1	1	1
1	0	0	1	1
1	0	1	0	1
1	1	0	0	0
1	1	1	1	0



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Topics:

1. Yes T
2. Yes B
3. Yes B
4. Yes C
5. Yes E
6. Yes F
7. Yes I
8. Conv

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FIGURE

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c) Which bit is in error in the string, 11 01 10 11 11 11 10? What is the probable value of the string?

Ans.

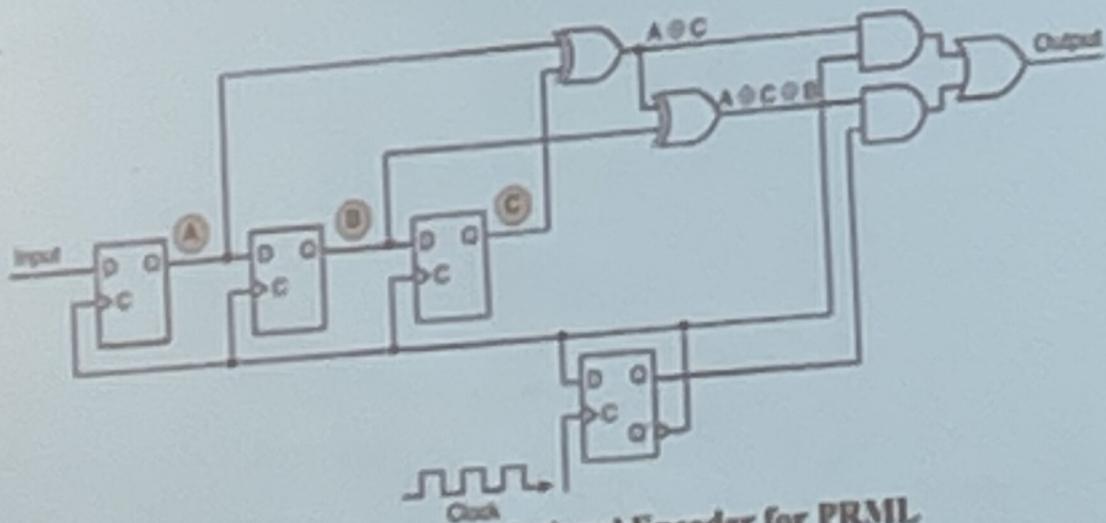


FIGURE 3.43 Convolutional Encoder for PRML

Input A	Current State B C	Next State B C	Output
0	00	00	00
1	00	10	11
0	01	00	11
1	01	10	00
0	10	01	10
1	10	11	01
0	11	01	01
1	11	11	10

TABLE 3.13 Characteristic Table for the Convolutional Encoder in Figure 3.43

a) $F(1001\ 0110) = 11\ 10\ 11\ 11\ 10\ 00\ 01\ 01$

The encoder is in State 1

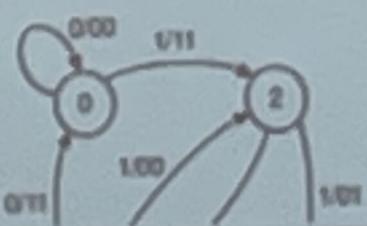




FIGURE 3.43 Convolutional Encoder for PRML

Input A	Current State B C	Next State B C	Output
0	00	00	00
1	00	10	11
0	01	00	11
1	01	10	00
0	10	01	10
1	10	11	01
0	11	01	01
1	11	11	10

TABLE 3.13 Characteristic Table for the Convolutional Encoder in Figure 3.43

a) $F(1001\ 0110) = 11\ 10\ 11\ 11\ 10\ 00\ 01\ 01$

b) The encoder is in State 1

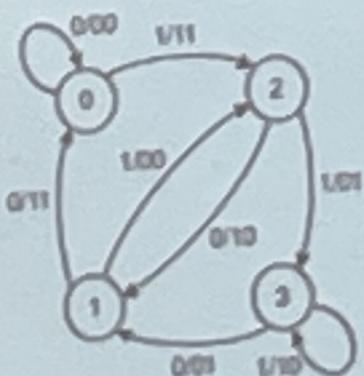


FIGURE 3.45 Mealy Machine for the Convolutional Encoder in Figure 3.43

c) Counting left to right beginning with 1, bit 7 is in error. The string should be:
 $11\ 01\ 10\ 01\ 11\ 11\ 10$

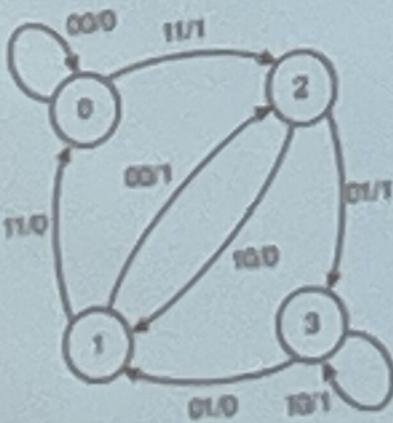
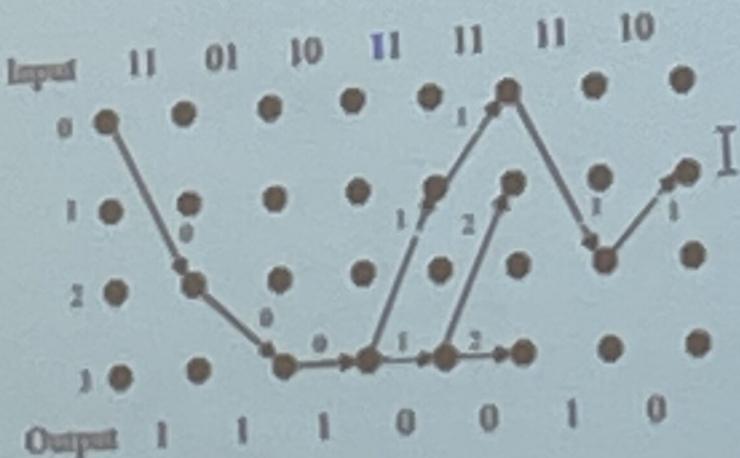


FIGURE 3.46 Mealy Machine for a Convolutional Decoder



Start State 0, Path: $0 \rightarrow 2 \rightarrow 3 \rightarrow 3 \rightarrow 1 \rightarrow 0 \rightarrow 2 \rightarrow 1$
 Error: bit 7

c) Counting left to right beginning with 1, bit 7 is in error. The string should be:
11 01 10 01 11 11 10

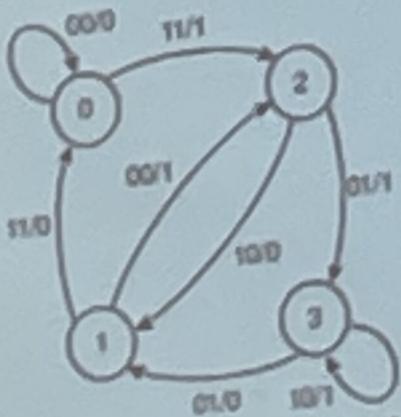
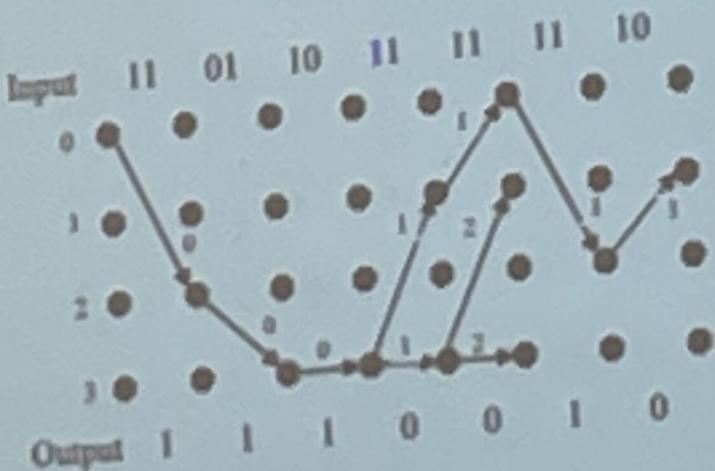


FIGURE 3.46 Mealy Machine for a Convolutional Decoder



Start State 0, Path: 0 \rightarrow 2 \rightarrow 3 \rightarrow 3 \rightarrow 1 \rightarrow 0 \rightarrow 2 \rightarrow 1

Error: bit 7

Correct String: 11 01 10 01 11 11 10