INF2270 — Spring 2011

Lecture 10: Summary and Hints for Exam

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content

From Digital Gates to Sequential Logic

- Boolean Algebra
- Binary Numbers
- Combinational Logic
- Sequential Logic

From Von Neumann to Performance Optimization in Modern CPUs

- Memory Hierarchy
- Pipelining
- Superscalar CPU
- Multi Core

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From Von Neumann to Performance Optimization in Modern CPUs
- Memory Hierarchy
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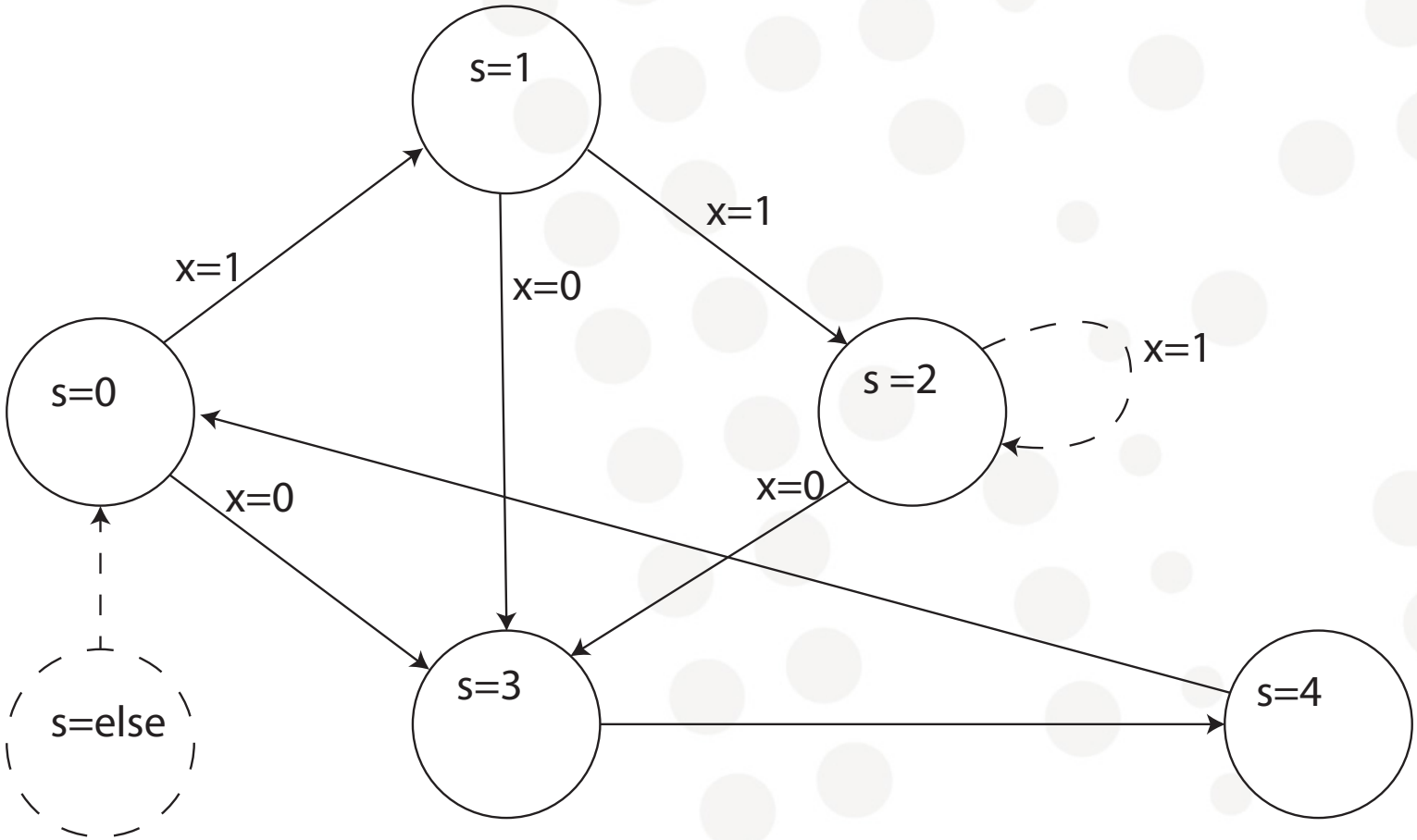
- Superscalar CPU
- Multi Core

Main theme for exam: Application and construction

For example:

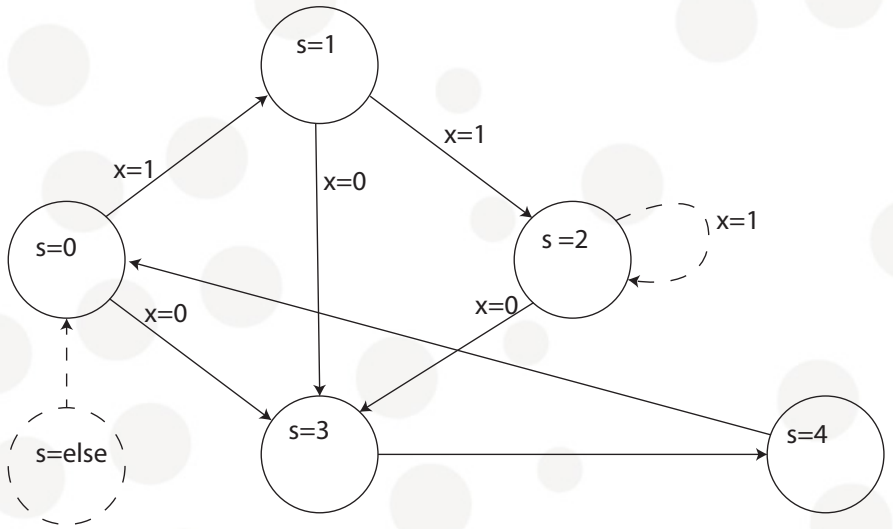
- Handling of binary numbers
- Manipulation/simplification of Boolean expressions
- Construction/analysis of combinational/sequential logic

State Transition Graph



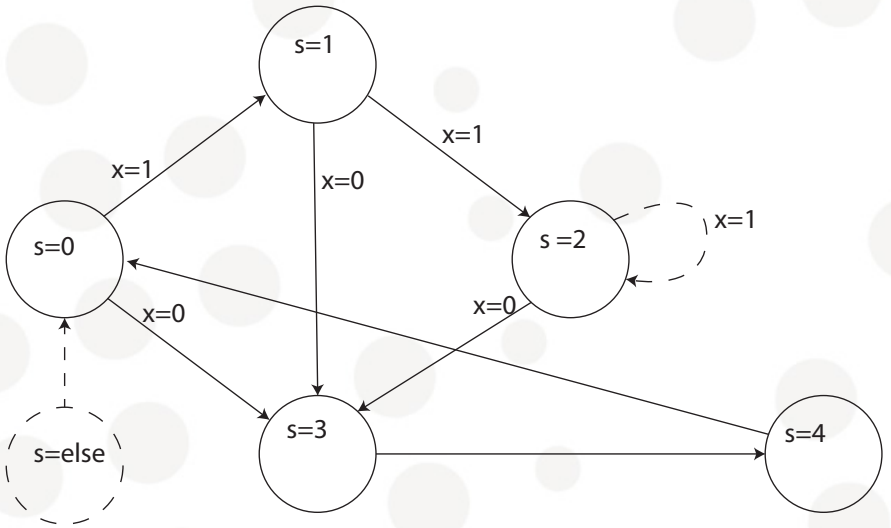
Characteristic/State Transition Table

x	$S_{present}$			S_{next}
0	0	0	0	
0	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	0	0	0	
1	0	0	1	
1	0	1	0	
1	0	1	1	
1	1	0	0	
1	1	0	1	
1	1	1	0	
1	1	1	1	



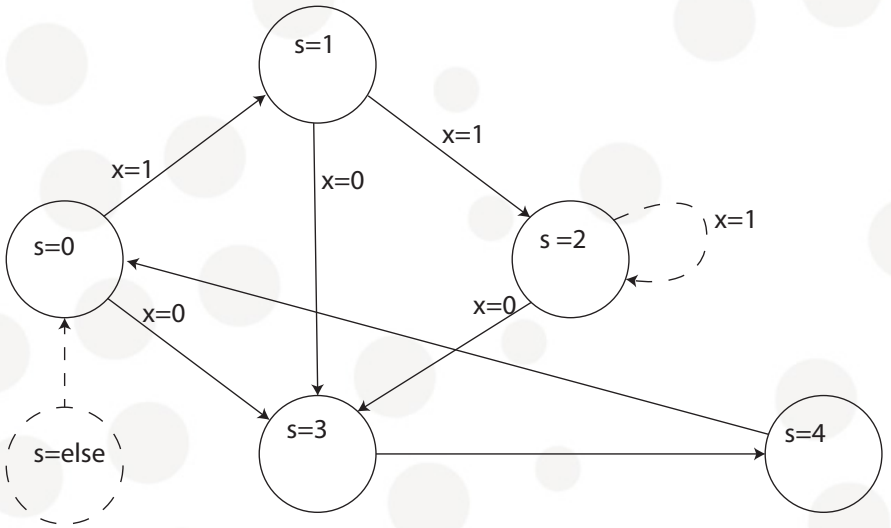
Characteristic/State Transition Table

x	$S_{present}$			S_{next}		
0	0	0	0	**0**	**1**	**1**
0	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	0	0	0			
1	0	0	1			
1	0	1	0			
1	0	1	1			
1	1	0	0			
1	1	0	1			
1	1	1	0			
1	1	1	1			



Characteristic/State Transition Table

x	$S_{present}$			S_{next}		
0	0	0	0	0	1	1
0	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	0	0	0	**0**	**0**	**1**
1	0	0	1			
1	0	1	0			
1	0	1	1			
1	1	0	0			
1	1	0	1			
1	1	1	0			
1	1	1	1			



Characteristic/State Transition Table

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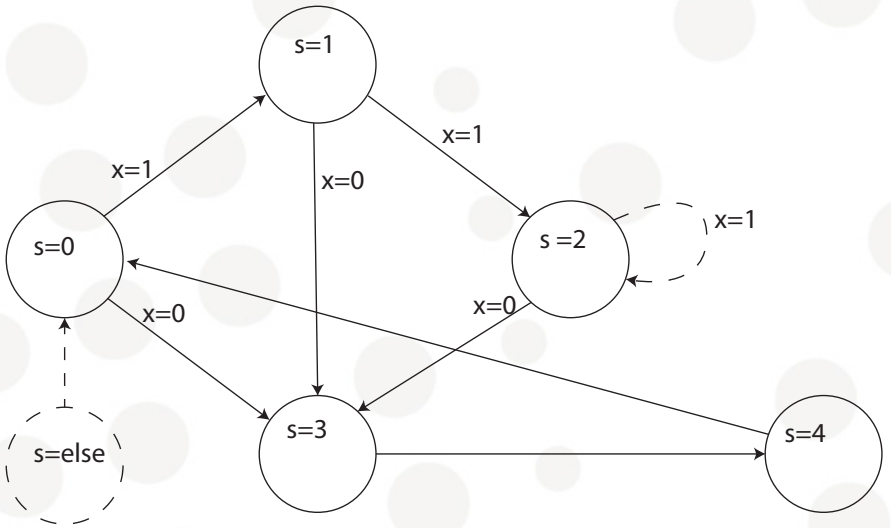
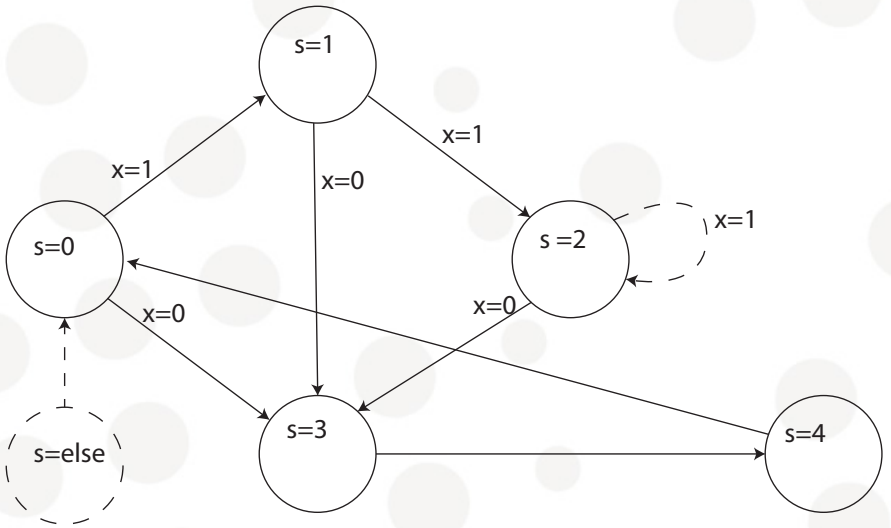
0	0	0	0	0	1	1
0	0	0	1	**0**	**1**	**1**
0	0	1	0			
0	0	1	1			
0	1	0	0			
0	1	0	1			
0	1	1	0			
0	1	1	1			
1	0	0	0	0	0	1
1	0	0	1			
1	0	1	0			
1	0	1	1			
1	1	0	0			
1	1	0	1			
1	1	1	0			
1	1	1	1			



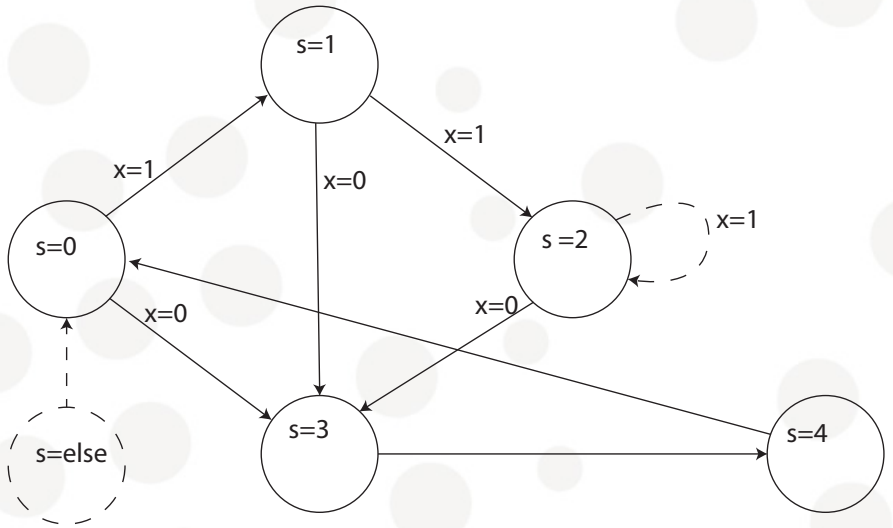
Characteristic/State Transition Table

x	$S_{present}$			S_{next}		
0	0	0	0	0	1	1
0	0	0	1	0	1	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	0	0	0	0	0	1
1	0	0	1	**0**	**1**	**0**
1	0	1	0			
1	0	1	1			
1	1	0	0			
1	1	0	1			
1	1	1	0			
1	1	1	1			



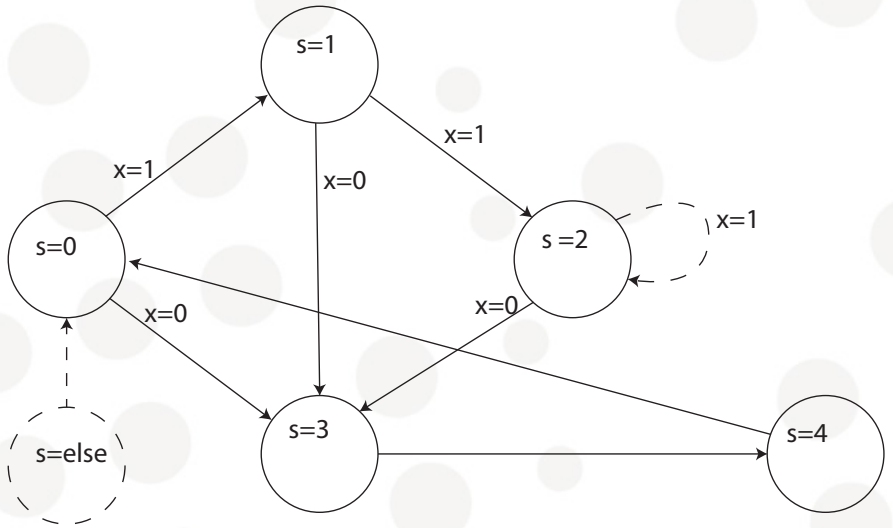
Characteristic/State Transition Table

x	$S_{present}$			S_{next}		
0	0	0	0	0	1	1
0	0	0	1	0	1	1
0	0	1	0	**0**	**1**	**1**
0	0	1	1			
0	1	0	0			
0	1	0	1			
0	1	1	0			
0	1	1	1			
1	0	0	0	0	0	1
1	0	0	1	0	1	0
1	0	1	0			
1	0	1	1			
1	1	0	0			
1	1	0	1			
1	1	1	0			
1	1	1	1			



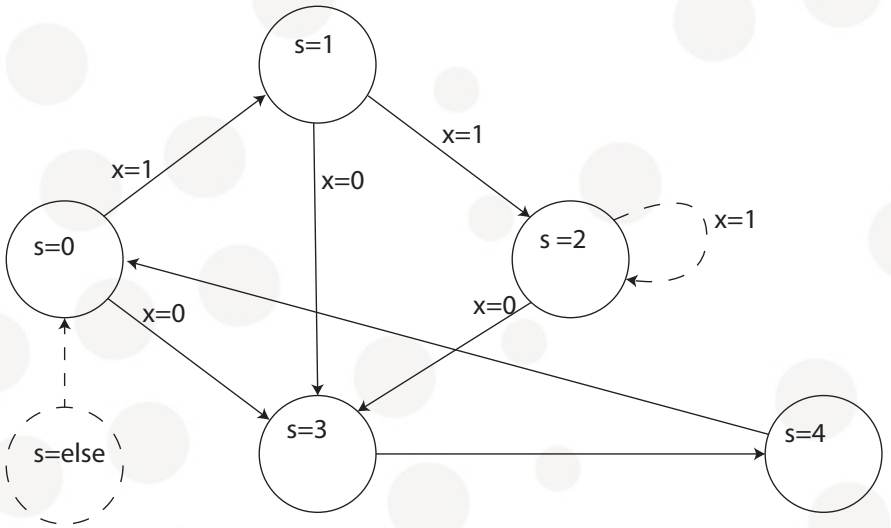
Characteristic/State Transition Table

x	$S_{present}$			S_{next}		
0	0	0	0	0	1	1
0	0	0	1	0	1	1
0	0	1	0	0	1	1
0	0	1	1			
0	1	0	0			
0	1	0	1			
0	1	1	0			
0	1	1	1			
1	0	0	0	0	0	1
1	0	0	1	0	1	0
1	0	1	0	**0**	**1**	**0**
1	0	1	1			
1	1	0	0			
1	1	0	1			
1	1	1	0			
1	1	1	1			



Characteristic/State Transition Table

x	$S_{present}$			S_{next}		
0	0	0	0	0	1	1
0	0	0	1	0	1	1
0	0	1	0	0	1	1
0	0	1	1	**1**	**0**	**0**
0	1	0	0			
0	1	0	1			
0	1	1	0			
0	1	1	1			
1	0	0	0	0	0	1
1	0	0	1	0	1	0
1	0	1	0	0	1	0
1	0	1	1	**1**	**0**	**0**
1	1	0	0			
1	1	0	1			
1	1	1	0			
1	1	1	1			



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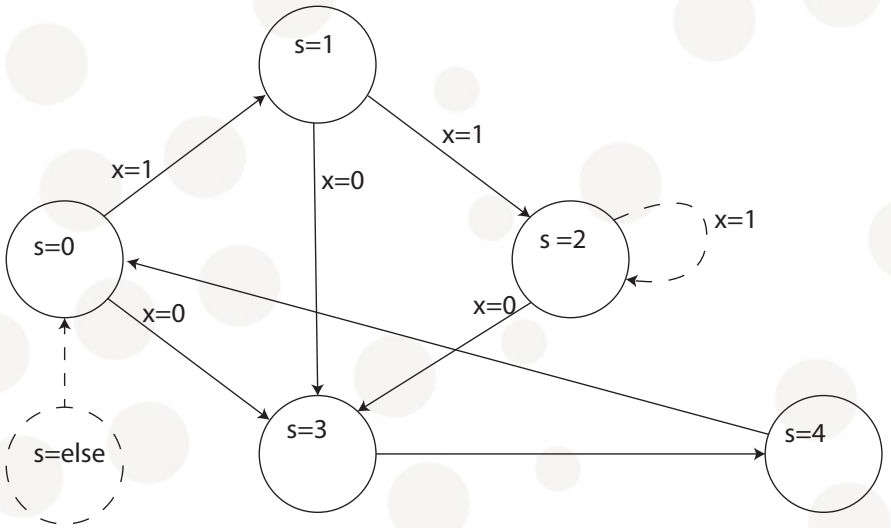
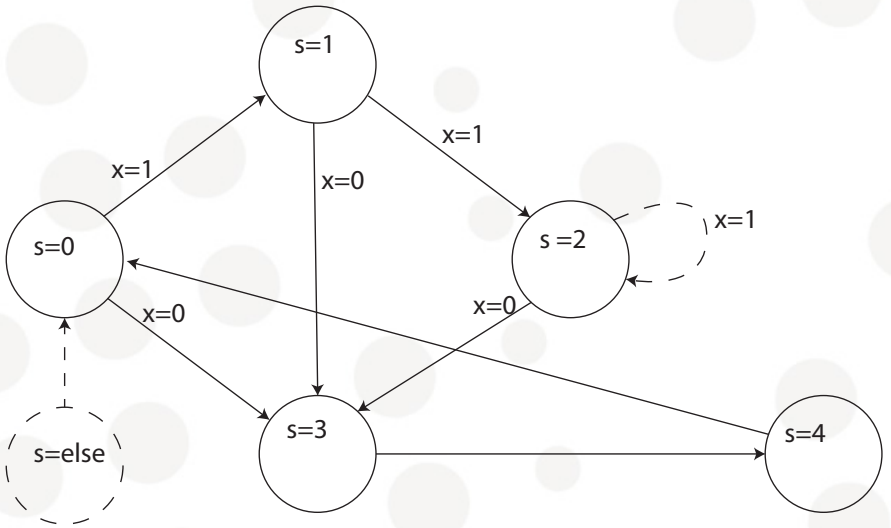
x	$S_{present}$			S_{next}		
0	0	0	0	0	1	1
0	0	0	1	0	1	1
0	0	1	0	0	1	1
0	0	1	1	1	0	0
0	1	0	0	**0**	**0**	**0**
0	1	0	1			
0	1	1	0			
0	1	1	1			
1	0	0	0	0	0	1
1	0	0	1	0	1	0
1	0	1	0	0	1	0
1	0	1	1	1	0	0
1	1	0	0	**0**	**0**	**0**
1	1	0	1			
1	1	1	0			
1	1	1	1			



Characteristic/State Transition Table

x	$S_{present}$			S_{next}		
0	0	0	0	0	1	1
0	0	0	1	0	1	1
0	0	1	0	0	1	1
0	0	1	1	1	0	0
0	1	0	0	0	0	0
0	1	0	1	0	0	0
0	1	1	0	0	0	0
0	1	1	1	0	0	0
1	0	0	0	0	0	1
1	0	0	1	0	1	0
1	0	1	0	0	1	0
1	0	1	1	1	0	0
1	1	0	0	0	0	0
1	1	0	1	0	0	0
1	1	1	0	0	0	0
1	1	1	1	0	0	0



K-map s_0

x	$S_{present}$			S_{next}		
0	0	0	0	0	1	1
0	0	0	1	0	1	1
0	0	1	0	0	1	1
0	0	1	1	**1**	0	0
0	1	0	0	0	0	0
0	1	0	1	0	0	0
0	1	1	0	0	0	0
0	1	1	1	0	0	0
1	0	0	0	0	0	1
1	0	0	1	0	1	0
1	0	1	0	0	1	0
1	0	1	1	**1**	0	0
1	1	0	0	0	0	0
1	1	0	1	0	0	0
1	1	1	0	0	0	0
1	1	1	1	0	0	0

s_0:

$x\ s_2 \backslash s_1 s_0$	00	10	11	01
00	0	0	1	0
10	0	0	1	0
11	0	0	0	0
01	0	0	0	0

$s_0 = \overline{s_2} \wedge s_1 \wedge s_0$

K-map s_1

x	$S_{present}$			S_{next}		
0	0	0	0	0	**1**	1
0	0	0	1	0	**1**	1
0	0	1	0	0	**1**	1
0	0	1	1	1	0	0
0	1	0	0	0	0	0
0	1	0	1	0	0	0
0	1	1	0	0	0	0
0	1	1	1	0	0	0
1	0	0	0	0	0	1
1	0	0	1	0	**1**	0
1	0	1	0	0	**1**	0
1	0	1	1	1	0	0
1	1	0	0	0	0	0
1	1	0	1	0	0	0
1	1	1	0	0	0	0
1	1	1	1	0	0	0

using the zeros:

s_1:

$x\ s_2 \backslash s_1 s_0$	00	10	11	01
00	1	1	0	1
10	0	1	0	1
11	0	0	0	0
01	0	0	0	0

$$
\begin{aligned}
s_1 &= \neg(s_2 \\
&\vee\ s_1 \wedge s_0 \\
&\vee\ x \wedge \overline{s_1} \wedge \overline{s_0}) \\
&= \\
&\quad \overline{s_2} \\
&\wedge\ (\overline{s_1} \vee \overline{s_0}) \\
&\wedge\ (\overline{x} \vee s_1 \vee s_0)
\end{aligned}
$$

K-map s_2

x	$S_{present}$			S_{next}		
0	0	0	0	0	1	**1**
0	0	0	1	0	1	**1**
0	0	1	0	0	1	**1**
0	0	1	1	1	0	0
0	1	0	0	0	0	0
0	1	0	1	0	0	0
0	1	1	0	0	0	0
0	1	1	1	0	0	0
1	0	0	0	0	0	**1**
1	0	0	1	0	1	0
1	0	1	0	0	1	0
1	0	1	1	1	0	0
1	1	0	0	0	0	0
1	1	0	1	0	0	0
1	1	1	0	0	0	0
1	1	1	1	0	0	0

s_2:

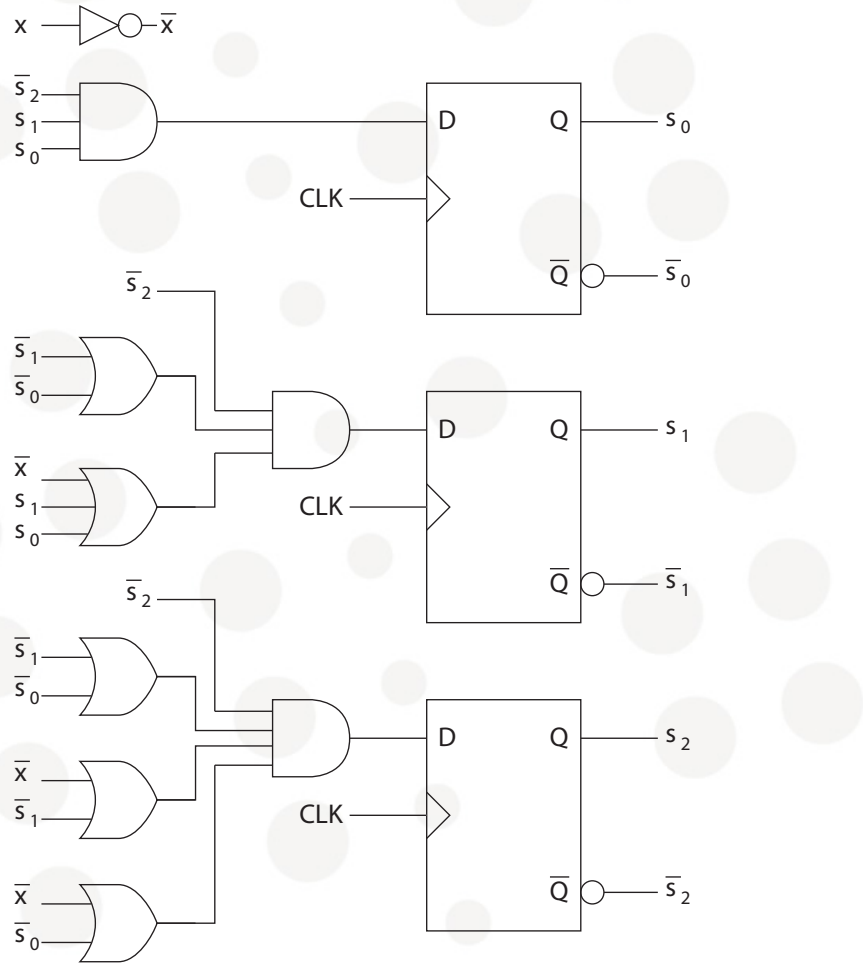
$x\ s_2 \backslash s_1 s_0$	00	10	11	01
00	1	1	0	1
10	1	0	0	0
11	0	0	0	0
01	0	0	0	0

using the zeros:

$$
\begin{aligned}
s_2 &= \neg(s_2 \\
&\vee\ s_1 \wedge s_0 \\
&\vee\ x \wedge s_1 \\
&\vee\ x \wedge s_0) \\
&= \\
&\quad \overline{s_2} \\
&\wedge\ (\overline{s_1} \vee \overline{s_0}) \\
&\wedge\ (\overline{x} \vee \overline{s_1}) \\
&\wedge\ (\overline{x} \vee \overline{s_0})
\end{aligned}
$$

Schematic

$$
\begin{aligned}
s_0 &= \overline{s_2} \wedge s_1 \wedge s_0 \\
s_1 &= \overline{s_2} \\
&\wedge (\overline{s_1} \vee \overline{s_0}) \\
&\wedge (\overline{x} \vee s_1 \vee s_0) \\
s_2 &= \overline{s_2} \\
&\wedge (\overline{s_1} \vee \overline{s_0}) \\
&\wedge (\overline{x} \vee \overline{s_1}) \\
&\wedge (\overline{x} \vee \overline{s_0})
\end{aligned}
$$



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From Von Neumann to Performance Optimization in Modern CPUs
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Main theme for exam: knowledge and consequences/connections

For example:

- Multiple choice with true/false statements
- Comparison of optimization approaches in different situations