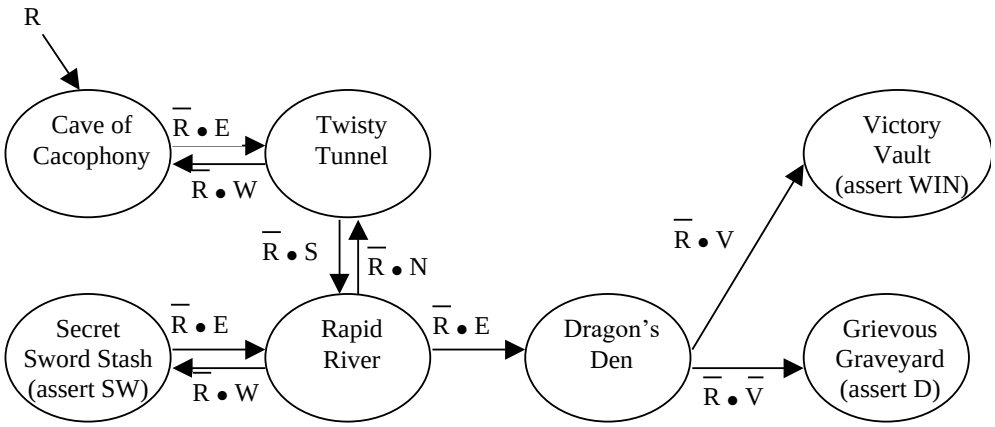
1) Time

For the clock, usually we use the Crystal Oscillator to generate a high frequency. In this lab, you can generate the clock signal by yourself. Connect the pin to one of the switches and then you can obtain the clock signal by manually turning on and off. You can set the input first and then set the clock by turning on the switch.

2) State Transition Diagram



3) State Tables

Note 1: We will use don't care's for illegal directions from various rooms to simplify the design. It is the responsibility of the player to move in a valid direction.
Note 2: If you used resettable/settable flip-flops, the reset input R, does not need to be included in your state transition tables.

ROOM FSM

State	N	S	E	W	R	V	Next State
X	X	X	X	X	1	X	CC
CC	X	X	1	X	0	X	TT
TT	X	X	X	1	0	X	CC
TT	X	1	X	X	0	X	RR
RR	1	X	X	X	0	X	TT
RR	X	X	X	1	0	X	SS
RR	X	X	1	X	0	X	DD
SS	X	X	1	X	0	X	RR
DD	X	X	X	X	0	0	GG
DD	X	X	X	X	0	1	VV

State Transition Table

Current State	SW	D	WIN
CC	0	0	0
TT	0	0	0
RR	0	0	0
SS	1	0	0
DD	0	0	0

GG	0	1	0
VV	0	0	1

Output Table

SWORD FSM

Current State	SW	R	Next State
X	X	1	NoSword
NoSword	0	0	NoSword
X	1	0	HasSword
HasSword	X	0	HasSword

State Transition Table

Current State	V
NoSword	0
HasSword	1

Output Table

4) State Encodings

```
CC = 0000001      NoSword = 0
TT = 0000010      HasSword = 1
RR = 0000100
SS = 0001000
DD = 0010000
GG = 0100000
VV = 1000000
```

5) Revised (Encoded) State Transition Tables and Output Tables

ROOM FSM

State	N	S	E	W	R	V	Next State
X	X	X	X	X	1	X	0000001
0000001	X	X	1	X	0	X	0000010
0000010	X	X	X	1	0	X	0000001
0000010	X	1	X	X	0	X	0000100
0000100	1	X	X	X	0	X	0000010
0000100	X	X	X	1	0	X	0001000
0000100	X	X	1	X	0	X	0010000
0001000	X	X	1	X	0	X	0000100
0010000	X	X	X	X	0	0	0100000
0010000	X	X	X	X	0	1	1000000

State Transition Table

Current State	SW	D	WIN
0000001	0	0	0
0000010	0	0	0
0000100	0	0	0
0001000	1	0	0
0010000	0	0	0
0100000	0	1	0
1000000	0	0	1

Output Table

SWORD FSM

State	SW	R	Next State
X	X	1	0
0	0	0	0
X	1	0	1
1	X	0	1

State Transition Table

Current State	V
0	0
1	1

Output Table

6) Boolean Equations

To reduce your work, here is the Boolean equation.

Note that !x is used to indicate the complement of a variable x. Let SX be the state variable for the Sword FSM and S7…S1 be the state variables for the Room FSM.

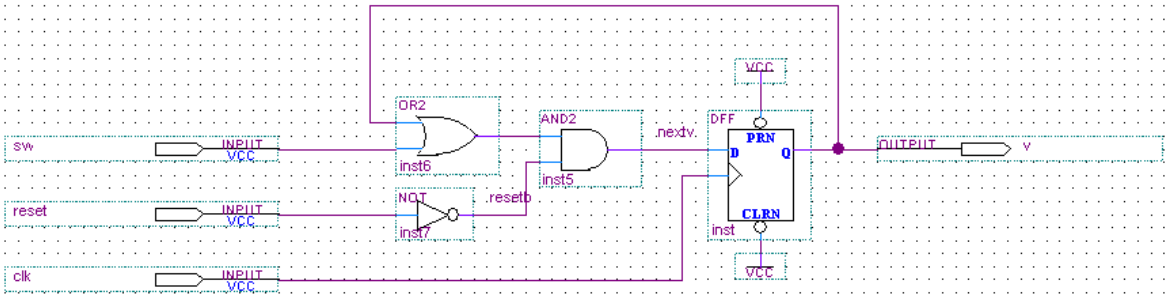
```
S1′ = R + S2•W
S2′ = S1•E•!R + S3•N•!R
S3′ = S2•S•!R + S4•E•!R
S4′ = S3•W•!R
S5′ = S3•E•!R
S6′ = S5•!V•!R
S7′ = S5•V•!R
SW  = S4
D   = S6
WIN = S7

SX′ = (SW + SX)•!R
V   = SX′
```

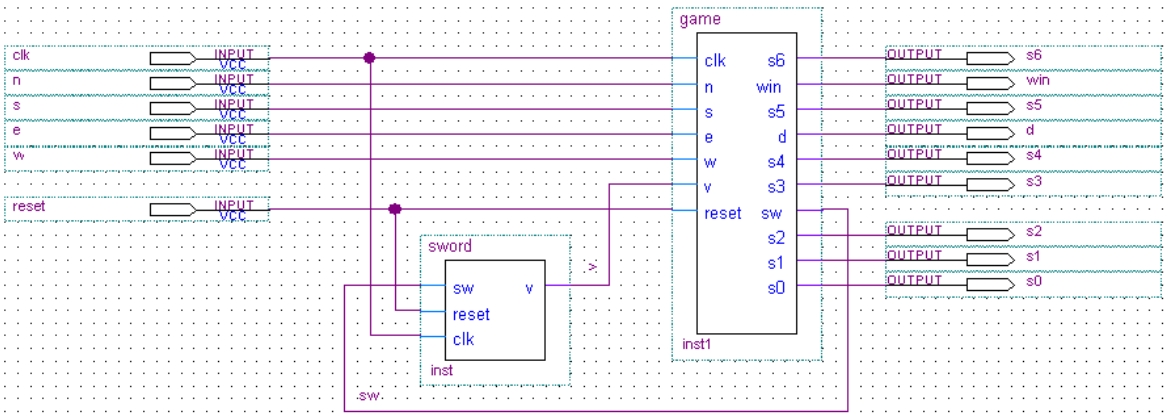
7) Room and Sword Schematics

Here I show one example, you still need to finish the room FSM by yourself:

Sword FSM:

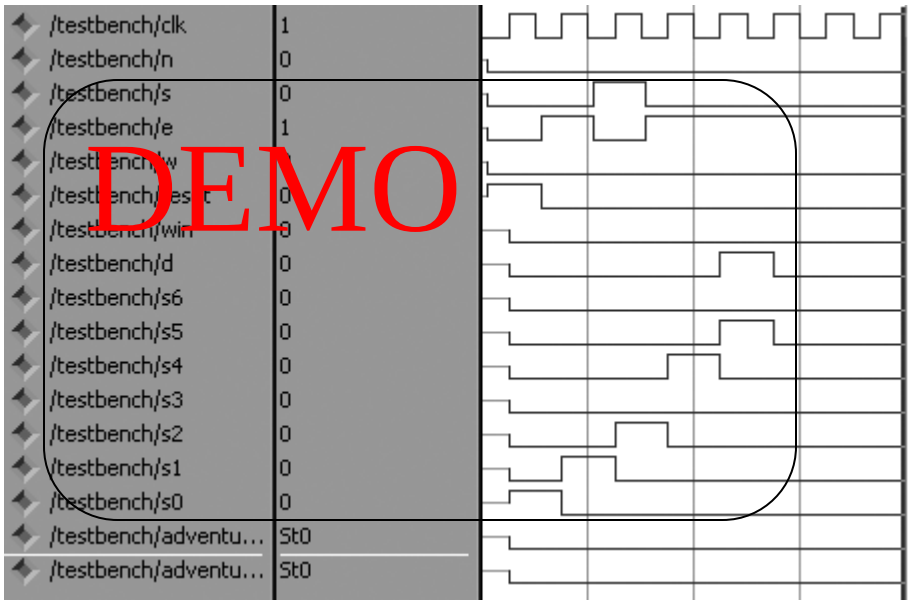


8) Top Level Schematic:



9) Waveforms:

Losing Sequence:



Winning Sequence: