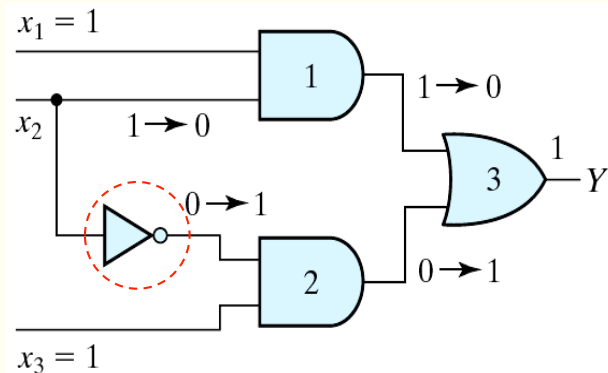# *Chapter* 9

Asynchronous Sequential Logic

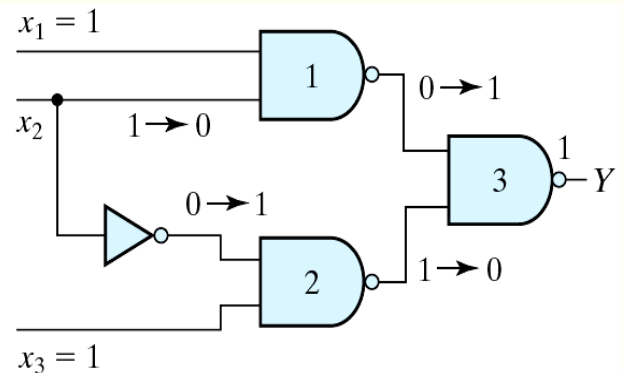**Most topics mentioned in Text Book are skipped here.**

Hazards

- **Unwanted switching transients at the output**
    - different paths exhibit different propagation delays
    - temporary false-output value in combinational circuits
    - may result in a transition to a wrong stable state in asynchronous sequential circuits

Hazards

- **Hazards in combinational circuits**
  - ▫ **examples**

(a) AND–OR circuit   (b) NAND circuit

```
input     Y
1 1 1     1
1 0 1     1 (the output may momentarily go to 0, then go to 1)
```

Static Hazard

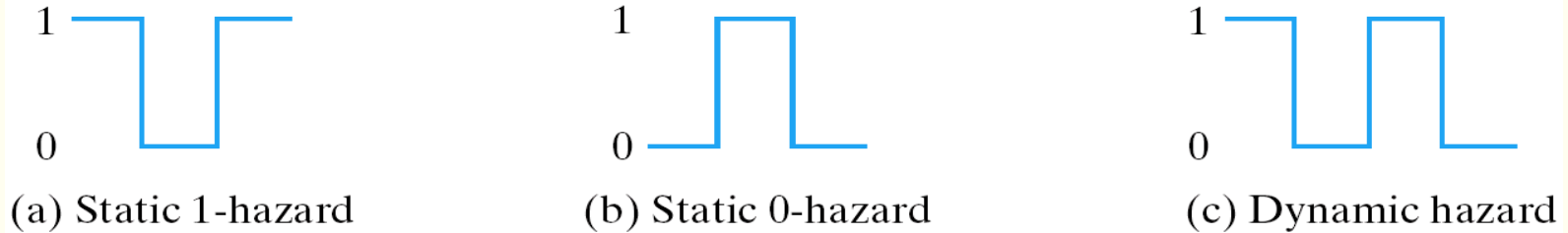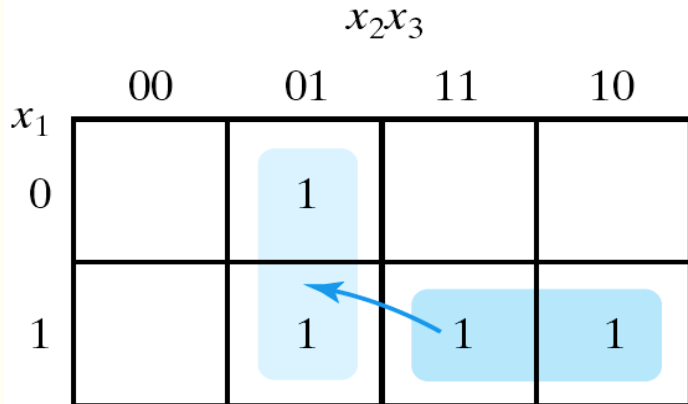(a) Static 1-hazard   (b) Static 0-hazard   (c) Dynamic hazard
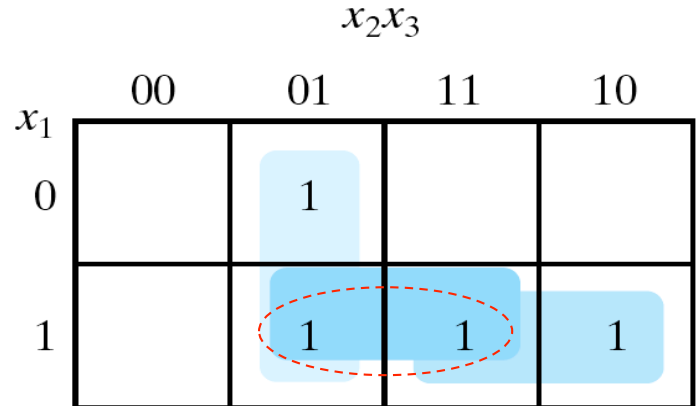
Fig. 9.34
Types of hazards

- **static 1-hazard (sum of products)**
  - **the removal of static 1-hazard guarantees that no static 0-hazards or dynamic hazards**

Hazard Free

- the circuit moves from one product term to another

- additional redundant gate

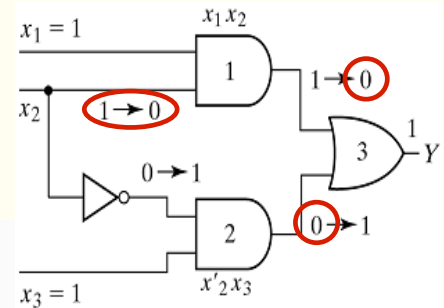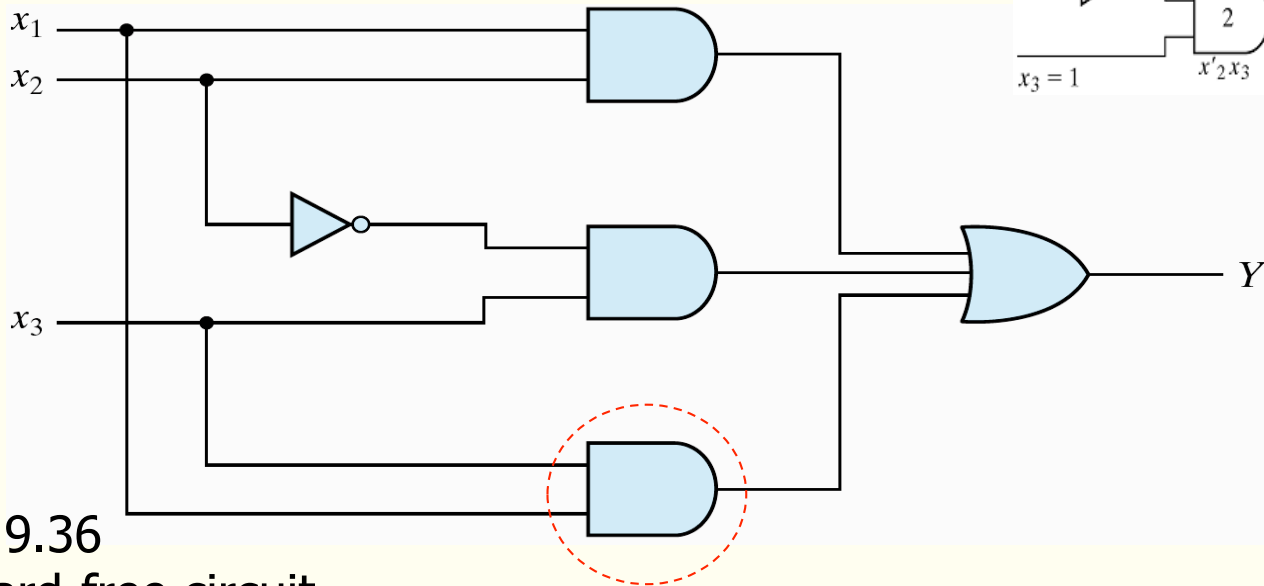(a) $Y = x_1 x_2 + x'_2 x_3$

(b) $Y = x_1 x_2 + x'_2 x_3 + x_1 x_3$

Hazard-free circuit

Fig. 9.36
Hazard-free circuit