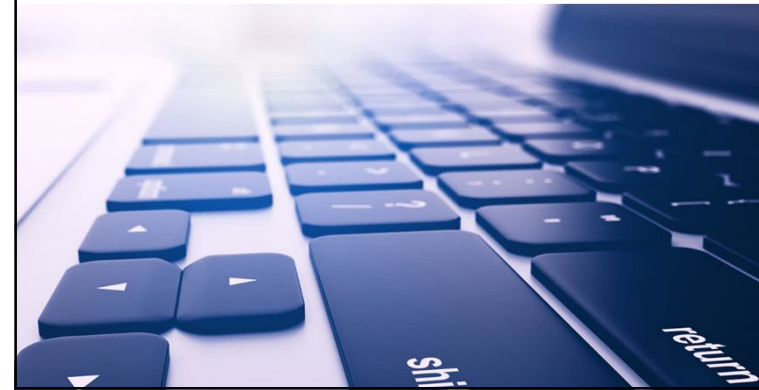




جلسه چهارم: زبان انتقال بین ثبات ها
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زبان انتقال بین ثبات ها

$R2 \leftarrow R1$

$\text{If } (P = 1) \text{ then } (R2 \leftarrow R1) \quad P: R2 \leftarrow R1$

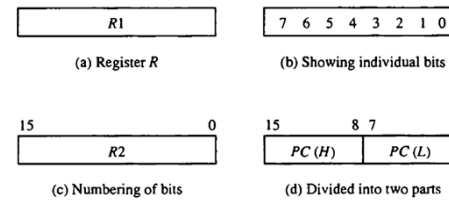
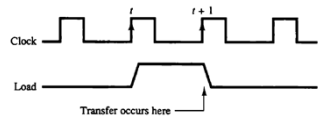
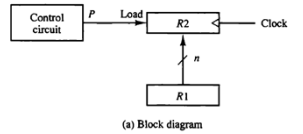


Figure 4-1 Block diagram of register.

زبان انتقال بین ثبات ها با توجه به پالس ساعت

Figure 4-2 Transfer from R1 to R2 when P = 1.



جدول زبان انتقال بین ثبات ها

TABLE 4-1 Basic Symbols for Register Transfers

| Symbol | Description | Examples |
|------------------------|---------------------------------|------------------|
| Letters (and numerals) | Denotes a register | MAR, R2 |
| Parentheses () | Denotes a part of a register | R2(0-7), R2(L) |
| Arrow ← | Denotes transfer of information | R2 ← R1 |
| Comma , | Separates two microoperations | R2 ← R1, R1 ← R2 |

T: R2 ← R1, R1 ← R2

گذرگاه داده

Figure 4-3 Bus system for four registers.

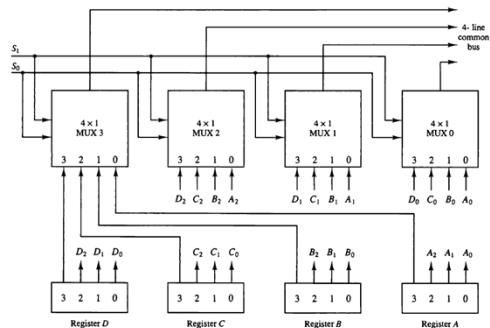


TABLE 4-2 Function Table for Bus of Fig. 4-3

| S ₁ | S ₀ | Register selected |
|----------------|----------------|-------------------|
| 0 | 0 | A |
| 0 | 1 | B |
| 1 | 0 | C |
| 1 | 1 | D |

بافر سه حالت

Figure 4-4 Graphic symbols for three-state buffer.

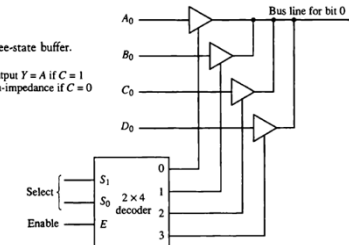
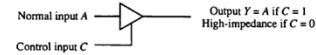


Figure 4-5 Bus line with three state-buffers.

جدول عملگرهای حسابی

TABLE 4-3 Arithmetic Microoperations

| Symbolic designation | Description |
|--|--|
| $R3 \leftarrow R1 + R2$ | Contents of R1 plus R2 transferred to R3 |
| $R3 \leftarrow R1 - R2$ | Contents of R1 minus R2 transferred to R3 |
| $R2 \leftarrow \overline{R2}$ | Complement the contents of R2 (1's complement) |
| $R2 \leftarrow \overline{R2} + 1$ | 2's complement the contents of R2 (negate) |
| $R3 \leftarrow R1 + \overline{R2} + 1$ | R1 plus the 2's complement of R2 (subtraction) |
| $R1 \leftarrow R1 + 1$ | Increment the contents of R1 by one |
| $R1 \leftarrow R1 - 1$ | Decrement the contents of R1 by one |

جمع و تفریق کننده

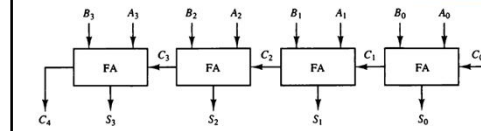


Figure 4-6 4-bit binary adder.

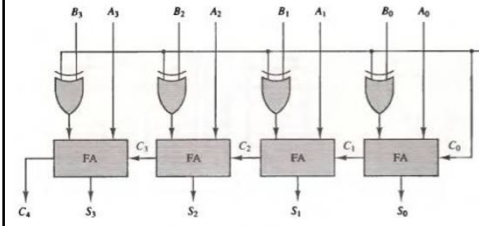
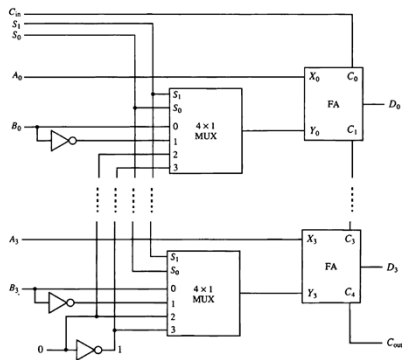
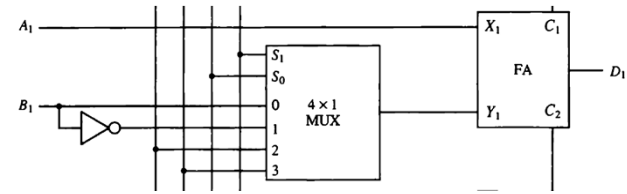


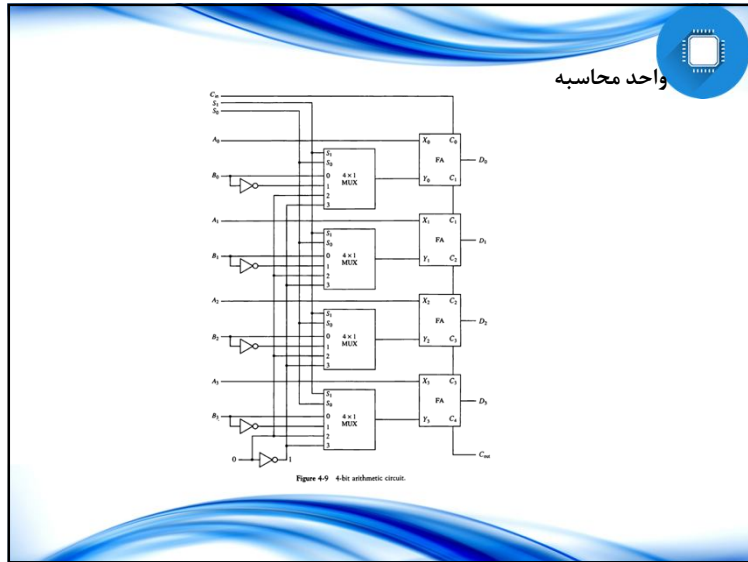
Figure 4-7 4-bit adder-subtractor.

واحد محاسبه



واحد محاسبه





جدول توابع محاسبه

TABLE 4-4 Arithmetic Circuit Function Table

| Select | | | Input | Output | Microoperation |
|--------|-------|----------|-----------|-----------------------|----------------------|
| S_1 | S_0 | C_{in} | Y | $D = A + Y + C_{in}$ | |
| 0 | 0 | 0 | B | $D = A + B$ | Add |
| 0 | 0 | 1 | B | $D = A + B + 1$ | Add with carry |
| 0 | 1 | 0 | \bar{B} | $D = A + \bar{B}$ | Subtract with borrow |
| 0 | 1 | 1 | \bar{B} | $D = A + \bar{B} + 1$ | Subtract |
| 1 | 0 | 0 | 0 | $D = A$ | Transfer A |
| 1 | 0 | 1 | 0 | $D = A + 1$ | Increment A |
| 1 | 1 | 0 | 1 | $D = A - 1$ | Decrement A |
| 1 | 1 | 1 | 1 | $D = A$ | Transfer A |

جدول توابع منطقی

$P: R1 \leftarrow R1 \oplus R2$
 1010 Content of $R1$
 1100 Content of $R2$
 0110 Content of $R1$ after $P = 1$

$P + Q: R1 \leftarrow R2 + R3, R4 \leftarrow R5 \vee R6$

TABLE 4-5 Truth Tables for 16 Functions of Two Variables

| x | y | F_0 | F_1 | F_2 | F_3 | F_4 | F_5 | F_6 | F_7 | F_8 | F_9 | F_{10} | F_{11} | F_{12} | F_{13} | F_{14} | F_{15} |
|-----|-----|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|----------|----------|----------|----------|----------|----------|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 |
| 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 |

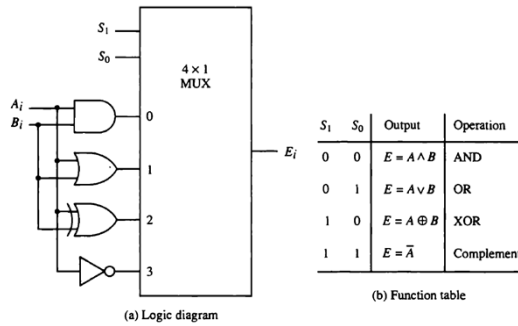
جدول توابع منطقی

TABLE 4-6 Sixteen Logic Microoperations

| Boolean function | Microoperation | Name |
|-----------------------|---------------------------------------|----------------|
| $F_0 = 0$ | $F \leftarrow 0$ | Clear |
| $F_1 = xy$ | $F \leftarrow A \wedge B$ | AND |
| $F_2 = xy'$ | $F \leftarrow A \wedge \bar{B}$ | |
| $F_3 = x$ | $F \leftarrow A$ | Transfer A |
| $F_4 = x'y$ | $F \leftarrow \bar{A} \wedge B$ | |
| $F_5 = y$ | $F \leftarrow B$ | Transfer B |
| $F_6 = x \oplus y$ | $F \leftarrow A \oplus B$ | Exclusive-OR |
| $F_7 = x + y$ | $F \leftarrow A \vee B$ | OR |
| $F_8 = (x + y)'$ | $F \leftarrow \bar{A} \vee \bar{B}$ | NOR |
| $F_9 = (x \oplus y)'$ | $F \leftarrow \bar{A} \oplus \bar{B}$ | Exclusive-NOR |
| $F_{10} = y'$ | $F \leftarrow \bar{B}$ | Complement B |
| $F_{11} = x + y'$ | $F \leftarrow A \vee \bar{B}$ | |
| $F_{12} = x'$ | $F \leftarrow \bar{A}$ | Complement A |
| $F_{13} = x' + y$ | $F \leftarrow \bar{A} \vee B$ | |
| $F_{14} = (xy)'$ | $F \leftarrow \bar{A} \wedge \bar{B}$ | NAND |
| $F_{15} = 1$ | $F \leftarrow \text{all 1's}$ | Set to all 1's |

یک واحد مدار منطقی

Figure 4-10 One stage of logic circuit.



selective-set

| | |
|-------------|-------------------|
| 1010 | A before |
| <u>1100</u> | B (logic operand) |
| 1110 | A after |

selective-complement

| | |
|-------------|-------------------|
| 1010 | A before |
| <u>1100</u> | B (logic operand) |
| 0110 | A after |

selective-clear

| | |
|-------------|-------------------|
| 1010 | A before |
| <u>1100</u> | B (logic operand) |
| 0010 | A after |

| | | |
|-------------|-------------|-----------------|
| 0110 | 1010 | A before |
| <u>0000</u> | <u>1111</u> | B (mask) |
| 0000 | 1010 | A after masking |

| | | |
|-------------|-------------|-------------------|
| 0000 | 1010 | A before |
| <u>1001</u> | <u>0000</u> | B (insert) |
| 1001 | 1010 | A after insertion |

| | |
|-------------|---------------------------|
| 1010 | A |
| <u>1010</u> | B |
| 0000 | $A \leftarrow A \oplus B$ |

TABLE 4-7 Shift Microoperations

| Symbolic designation | Description |
|-------------------------------|-----------------------------------|
| $R \leftarrow \text{shl } R$ | Shift-left register R |
| $R \leftarrow \text{shr } R$ | Shift-right register R |
| $R \leftarrow \text{cil } R$ | Circular shift-left register R |
| $R \leftarrow \text{cir } R$ | Circular shift-right register R |
| $R \leftarrow \text{ashl } R$ | Arithmetic shift-left R |
| $R \leftarrow \text{ashr } R$ | Arithmetic shift-right R |

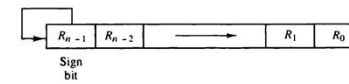


Figure 4-11 Arithmetic shift right.

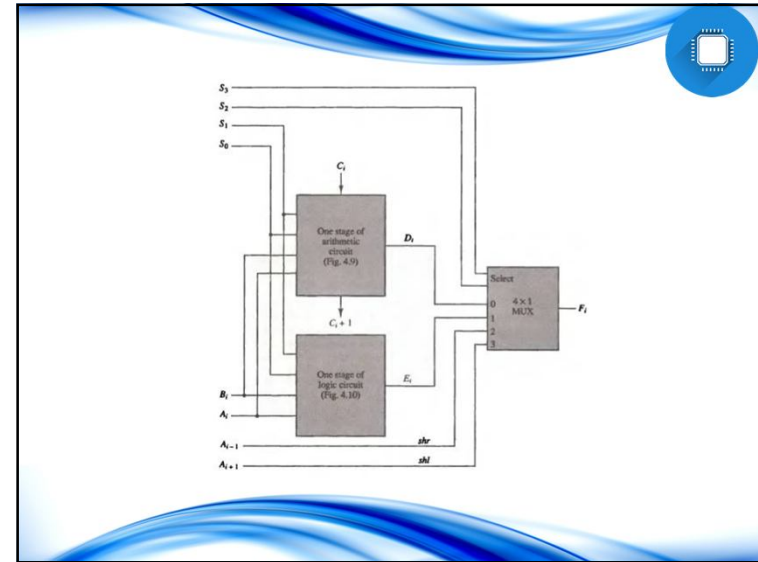
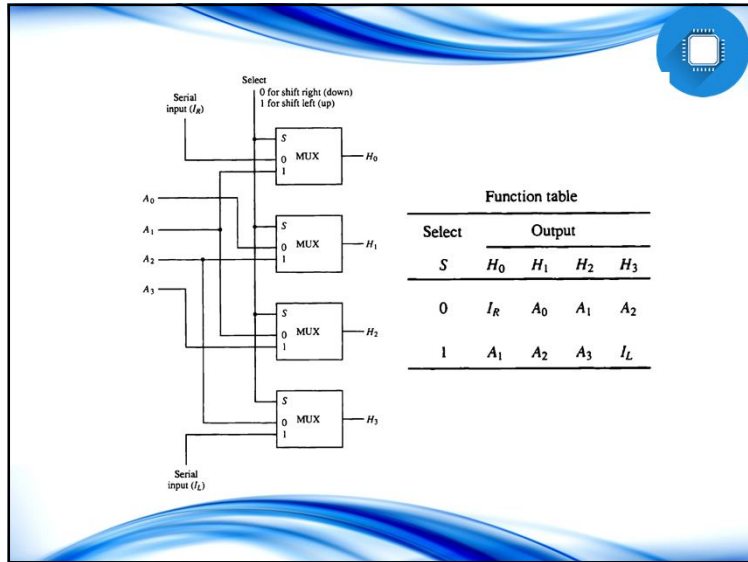


TABLE 4-8 Function Table for Arithmetic Logic Shift Unit

| Operation select | | | | | Operation | Function |
|------------------|-------|-------|-------|----------|-----------------------|--------------------------|
| S_3 | S_2 | S_1 | S_0 | C_{in} | | |
| 0 | 0 | 0 | 0 | 0 | $F = A$ | Transfer A |
| 0 | 0 | 0 | 0 | 1 | $F = A + 1$ | Increment A |
| 0 | 0 | 0 | 1 | 0 | $F = A + B$ | Addition |
| 0 | 0 | 0 | 1 | 1 | $F = A + B + 1$ | Add with carry |
| 0 | 0 | 1 | 0 | 0 | $F = A + \bar{B}$ | Subtract with borrow |
| 0 | 0 | 1 | 0 | 1 | $F = A + \bar{B} + 1$ | Subtraction |
| 0 | 0 | 1 | 1 | 0 | $F = A - 1$ | Decrement A |
| 0 | 0 | 1 | 1 | 1 | $F = A$ | Transfer A |
| 0 | 1 | 0 | 0 | x | $F = A \wedge B$ | AND |
| 0 | 1 | 0 | 1 | x | $F = A \vee B$ | OR |
| 0 | 1 | 1 | 0 | x | $F = A \oplus B$ | XOR |
| 0 | 1 | 1 | 1 | x | $F = \bar{A}$ | Complement A |
| 1 | 0 | x | x | x | $F = shr A$ | Shift right A into F |
| 1 | 1 | x | x | x | $F = shl A$ | Shift left A into F |

لیست تمرین های مهم فصل چهار

| | |
|------|-----|
| ۸ • | ۱ • |
| ۱۰ • | ۲ • |
| ۱۲ • | ۳ • |
| ۱۵ • | ۴ • |
| ۱۷ • | ۵ • |
| | ۷ • |