MECE336– Microprocessors I

Lecture 7 – Logic Operations

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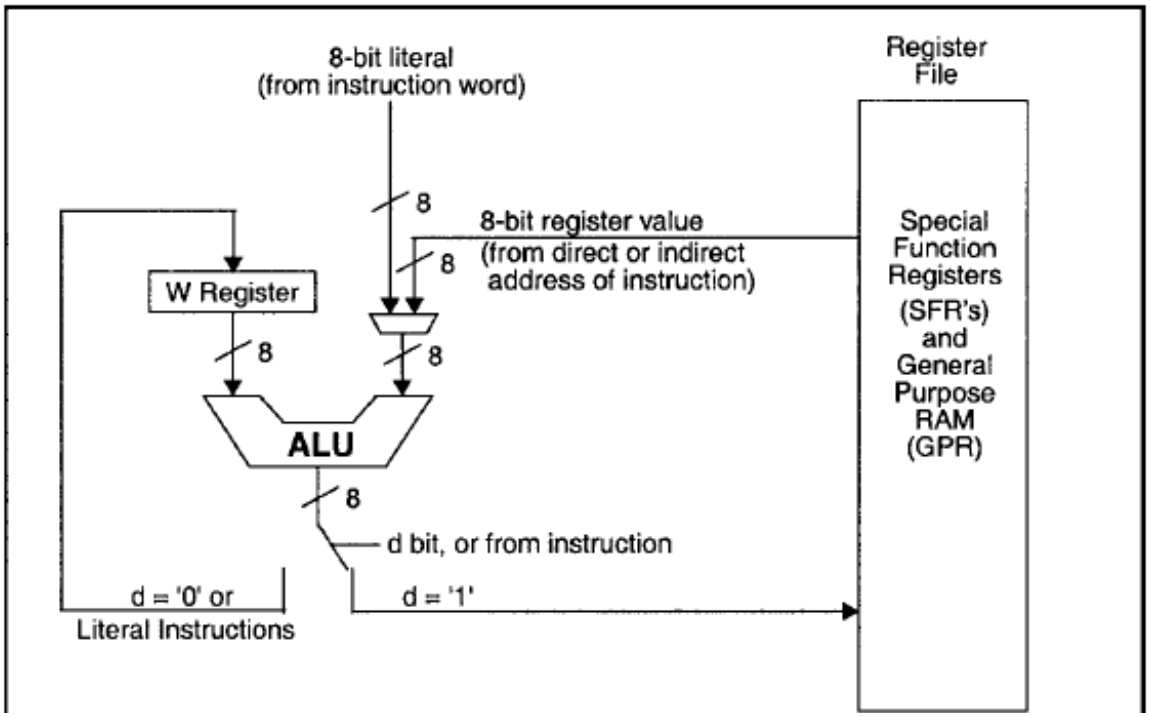
Compulsory Course in Mechatronics Engineering
Credits (3/2/4)

Course Webpage: http://MECE336.cankaya.edu.tr

Arithmetic Logic Unit: Basics

Block Diagram



Arithmetic Logic Unit: Basics

ALU Operates on Data from two Sources

- Working Register `W`
- Literal value or value from data memory

Literal

- One byte of data the programmer writes in the program

Data Memory

- Memory location is called "register files" by Microchip

⇒ There will be instructions using data memory or literals

Result of an Operation

- Working register
- Data memory

⇒ Depending on instruction

Arithmetic Logic Unit: Logical Instructions

Byte-oriented File Register Operations

OPCODE	Operand 1	Operand 2

- `andwf f,d` (AND W with f)
- `comf f,d` (Complement f)
- `iorwf f,d` (Inclusive OR W with f)
- `xorwf f,d` (Exclusive OR W with f)

Literal Operations

OPCODE	Operand 1

- `andlw k` (AND literal with W)
- `iorlw k` (Inclusive OR literal with W)
- `xorlw k` (Exclusive OR literal with W)

Arithmetic Logic Unit: ANDWF

AND W with f

- `andwf f,d`: Bitwise AND of the contents of the `W` register and the memory location `f`
  - Write the result to the `W` register if the `d` bit is set to 0
  - Write the result to the memory location `f` if the `d` bit is set to 1

Example

Compute `B'00101010' AND B'10110110'`. Write the result to `0x0C`.

Arithmetic Logic Unit: COMF

Complement f

- `comf f,d`: Bitwise complement of the contents of memory location `f`
  - Write the result to the `W` register if the `d` bit is set to 0
  - Write the result to the memory location `f` if the `d` bit is set to 1

Example

Write `B'00101010'` to he memory location `0x0D`. Compute the complement of the memory location `0x0D`. Write the result to `0x0D`.

Arithmetic Logic Unit: IORWF

Inclusive OR W with f

- `iorwf f,d`: Bitwise OR of the contents of the `W` register and the memory location `f`
  - Write the result to the `W` register if the `d` bit is set to 0
  - Write the result to the memory location `f` if the `d` bit is set to 1

Example

Compute `B'00101010' OR B'10110110'`. Write the result to `0x0E`.

Arithmetic Logic Unit: XORWF

Exclusive OR W with f

- `xorwf f,d`: Bitwise XOR of the contents of the `W` register and the memory location `f`
  - Write the result to the `W` register if the `d` bit is set to 0
  - Write the result to the memory location `f` if the `d` bit is set to 1

Example

Compute `B'00101010' XOR B'10110110'`. Write the result to `0x0F`.

Arithmetic Logic Unit: ANDLW

AND Literal with W

- `andlw k`: Bitwise AND of the contents of the `W` register and the literal `k`
- Write the result to the `W` register

Example
Write `B'00101010'` to the `W` register. `AND W` and `B'10110110'`.

Arithmetic Logic Unit: IORLW

Inclusive OR Literal with W

- `iorlw k`: Bitwise XOR of the contents of the `W` register and the literal `k`
- Write the result in the `W` register

Example
Write `B'00101010'` to the `W` register. `OR W` and `B'10110110'`.

Arithmetic Logic Unit: XORLW

Exclusive OR Literal with W

- `xorlw f,d`: Bitwise XOR of the contents of the `W` register and the literal `k`
- Write the result to the `W` register

Example

Write `B'00101010'` to the `W` register. `XOR W` and `B'10110110'`.

Arithmetic Logic Unit: Status Register

Flag Z in the Status Register

R/W-0	R/W-0	R/W-0	R-1	R-1	R/W-x	R/W-x	R/W-x
IRP	RP1	RP0	$\overline{TO}$	$\overline{PD}$	Z	DC	C
bit 7							bit 0

$\rightarrow$ Zero flag `Z` (bit 2) is set if the result of any logic operation is zero

Examples

Programming Examples

Check if PORTA contains `B'01010101'`

Programming Examples

Check if bit 4 of PORTA is 1 using `andlw` **and** `comf`

Programming Examples

Write a program that turns on a LED at RB0 if the buttons connected to RA1 & RA2 are pressed. Use `xorlw`.

Programming Examples

Programming Examples

Write a program that turns on a LED at RB0 if the buttons connected to RA1 & RA2 are pressed. Use `iorlw`.

Programming Examples

Turn on a LED at RB1 if either RA3 or RB5 are 1. Also draw the circuit.

Programming Examples

Turn on the LEDs on all even-numbered pins at PORTB. Turn off all LEDs and turn on the LEDs on all odd-numbered pins at PORTB after a delay of 200 ms. Repeat the process. The oscillator frequency is 50 kHz.

Programming Examples