

# MECE336– Microprocessors I

## Lecture 9 – Subtraction and Lookup Tables

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

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

## Subtraction: 16 bit numbers

### Idea

- Use two 8bit file registers – higher byte (HB) and lower byte (LB)
- Borrow from HB if necessary

### Example Computations

# Subtraction: Program Outline

## Flowchart

## Explanation

# Subtraction: Implementation as Subroutine

## Assumptions

- Minuend HB is placed in file register 0x0C
- Minuend LB is placed in file register 0x0D
- Subtrahend HB is placed in file register 0x0E
- Subtrahend LB is placed in file register 0x0F
- Result HB is placed in file register 0x0C
- Result LB is placed in file register 0x0D

## Considerations

# Subtraction: Implementation as Subroutine

## Subroutine

# Subtraction: Implementation as Subroutine

# Subtraction: Implementation as Subroutine

**Example Program Call: Compute**  $4523_{10} - 2380_{10}$

# Lookup Tables: Basics

## Idea

- Block of data in program memory that can be accessed by program
- Formulated as a subroutine on PIC16F84A
- Every data byte in lookup table is accompanied by a `retlw` instruction
- Selection of the correct `retlw` instruction by using "computed goto"
  - Use instruction `addwf pcl`
  - Content of the working register `W` is added to the program counter `pcl`
- `retlw k` instruction: return from subroutine with the value `k` in the `W` register

## Example Table

table

```

addwf pcl
retlw 0x23
retlw 0x3F
retlw 0x47
retlw 0x7F
retlw 0xA2
retlw 0x1F
retlw 0x03
retlw 0x67
  
```

## Lookup Tables: Example

### Example Program

```
movlw 0x03
call table
movwf PORTB
clrw
movlw 0x05
call table

table addwf pcl
      retlw 0x23
      retlw 0x3F
      retlw 0x47
      retlw 0x7F
      retlw 0xA2
      retlw 0x1F
      retlw 0x03
      retlw 0x67

end
```

### Program Counter and Working Register

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## Lookup Tables: Example

### Example Program

```
movlw 0x03
call table
movwf PORTB
clrw
movlw 0x09
call table

table addwf pcl
      retlw 0x23
      retlw 0x3F
      retlw 0x47
      retlw 0x7F
      retlw 0xA2
      retlw 0x1F
      retlw 0x03
      retlw 0x67

end
```

### Program Counter and Working Register

⇒ Content of W must not exceed size of table!

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# Lookup Tables: Program Counter

## Example Program

# 7-Segment Display: Types

## Common Cathode (CC)

- All cathode connections are joined together to logic "0" (ground)
  - All segments are off if logic "1" is applied to cathode
- Each segment is turned on by applying logic "1" to corresponding pin
  - Segment is off if logic "0" is applied
- Current limiting resistors are used at the input pins

## Schematic

Note: 7-segment display in the lab is CA

## 7-Segment Display: Types

### Common Anode (CA)

- All anode connections are joined together to logic "1" (supply)  
→ All segments are off if logic "0" is applied to anode
- Each segment is turned on by applying logic "0" to corresponding pin  
→ Segment is off if logic "1" is applied
- Current limiting resistors are used at the input pins

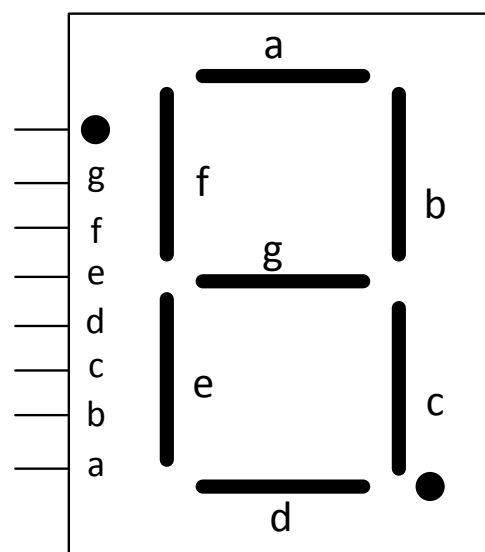
### Schematic

## 7-Segment Display: Truth Table (Common Cathode)

### Digits

	●	g	f	e	d	c	b	a	Hex
0	0	0	1	1	1	1	1	1	0x3F
1	0	0	0	0	0	1	1	0	0x06
2	0	1	0	1	1	0	1	1	0x5B
3	0	1	0	0	1	1	1	1	0x4F
4	0	1	1	0	0	1	1	0	0x66
5	0	1	1	0	1	1	0	1	0x6D
6	0	1	1	1	1	1	0	1	0x7D
7	0	0	0	0	0	1	1	1	0x07
8	0	1	1	1	1	1	1	1	0x7F
9	0	1	1	0	1	1	1	1	0x6F
Digit with decimal point: add 0x80 to Hex									
0.	1	0	1	1	1	1	1	1	0xBF

### Display



## 7-Segment Display: Connection

### Connection to PORTB of PIC

⇒ Obtain digit by writing one byte to PORTB

## 7-Segment Display: Lookup Table

### Lookup Table for Digits

```
table
    addlw    pcl
    retlw    0x3F
    retlw    0x06
    retlw    0x5B
    retlw    0x4F
    retlw    0x66
    retlw    0x6D
    retlw    0x7D
    retlw    0x07
    retlw    0x7F
    retlw    0x6F
```

→ Extend to table including decimal point if desired

### Numbers

Digit	Hex	Digit	Hex
0	0x3F	0.	0xBF
1	0x06	1.	0x86
2	0x5B	2.	0xDB
3	0x4F	3.	0xCF
4	0x66	4.	0xE6
5	0x6D	5.	0xED
6	0x7D	6.	0xFD
7	0x07	7.	0x87
8	0x7F	8.	0xFF
9	0x6F	9.	0xEF



# 7-Segment Display: Example Program

## Counter with Delay

- Repeatedly count from 0 to 9 with a delay of 1 s between increments. Show the digit on a 7-segment display.

# 7-Segment Display: Example Program

## 7-Segment Display: Example Program

## 7-Segment Display: Two Displays in Parallel

### **Multiplexing (Common Cathode)**

- Turn on the two displays back to back with high speed (not simultaneously)
  - appears as if both displays are turned on at the same time
- Enable one display by setting common cathode to 0
- Disable other display by setting common cathode to 1
- Write digit to display that is turned on

### **Circuit**

# 7-Segment Display: Two Displays in Parallel

## Example Program

# 7-Segment Display: Two Displays in Parallel