

# MECE336– Microprocessors I

## Lecture 6 – Subroutines and Programming Examples

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

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

## Subroutines: Idea

### Observation

- When writing bigger programs, parts of the program are repeated in different places
- Example: Delay loops are needed in different parts of a program
- It is not desired to write the same part of a program multiple times
  - Leads to long files
  - Requires more memory
  - More difficult to trace the program

### Subroutine

- Program section that can be called from anywhere in a program
- Program calls and runs subroutine and then returns to point in the program where the subroutine was called
  - ⇒ Re-use program sections without re-writing

# Subroutines: Idea

## Illustration

# Subroutines: Realization

## Program Counter (PC)

- Loaded with the program code the microcontroller executes
- Always holds the (13 bit) address of the next instruction
- Address range on PIC 16F84A: 0000 to 03FF

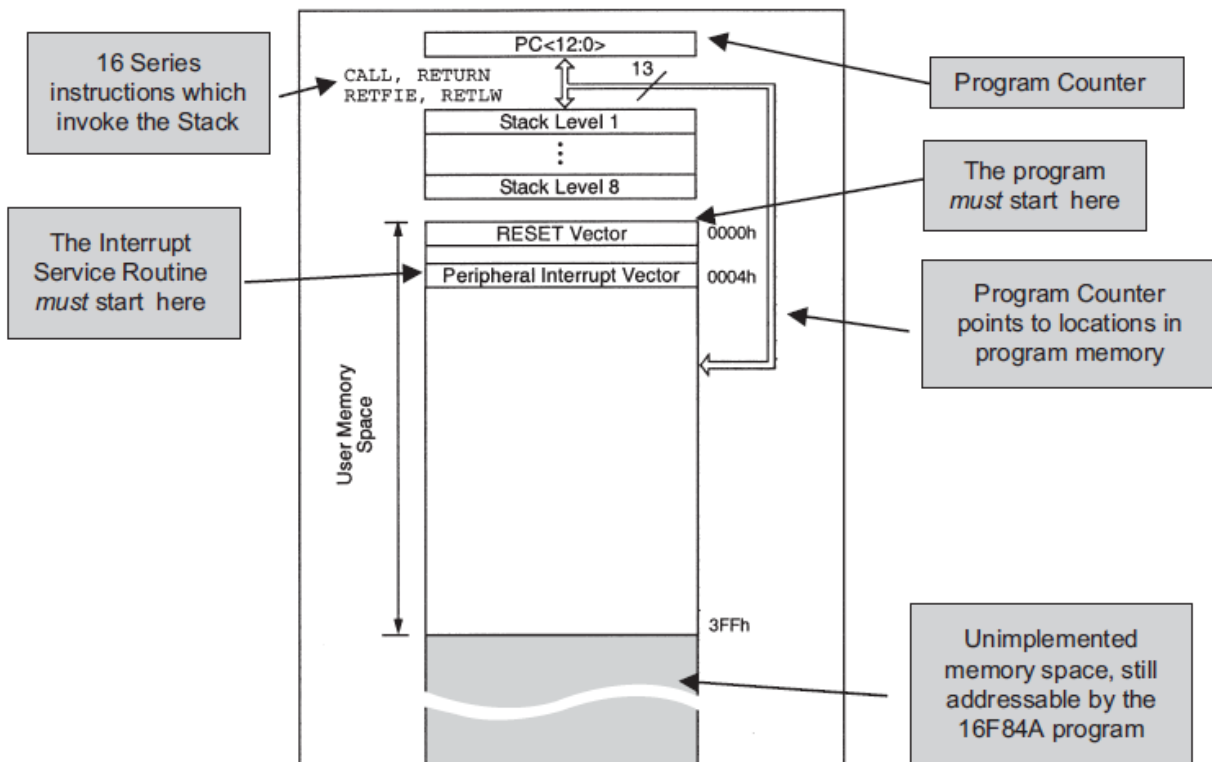
## Stack

- Temporary memory that is structured as LIFO (last in – first out)
- Value of program counter can be moved onto stack in case of subroutine or interrupt
- Related instructions: CALL, RETURN, RETFIE, RETLW

## User Memory Space

- Starts with RESET vector (first memory location for PC)
- Programmer must place first instruction to this location

## Subroutines: Memory Organization



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## Subroutines: Basic Usage

### Instructions

- `call k`: call subroutine with label `k`
- `return`: return to main program
- `retlw k`: return to main program with literal `k` in `W`

### Procedure

- call subroutine from main program using `CALL` instruction
  - Save PC content on stack; load subroutine start address into PC
- Exit from subroutine with `return` or `retlw` instruction
  - Load PC with content at top of the stack
  - Continue main program execution from this address
- It is possible to call subroutines from subroutines
  - One stack location is used for each call (limited to 8)

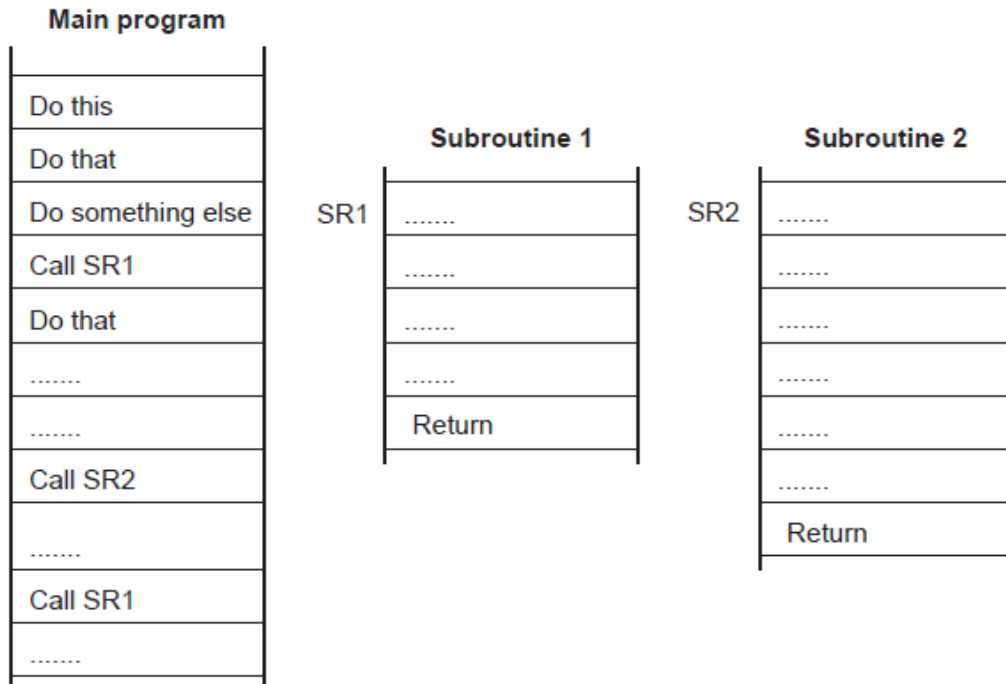
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# Subroutines: Multiple Calls

## Overview



# Subroutines: Basic Operation

## Explanation

## Subroutines: Examples

### Delay Subroutine

- Write a program that turns ON and OFF a LED connected to PORTB with a 1 ms delay using a subroutine for the delay. The oscillator frequency is 4 MHz.

## Subroutines: Examples

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### Long Delay Subroutine

- Write a program that turns ON and OFF a LED connected to PORTB with a 0.8 s delay using a subroutine for the delay. The oscillator frequency is 4 MHz.

## Subroutines: Examples

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### General Delay Subroutine

- Write a delay subroutine `delay_Nms` with a delay  $N \cdot 100$  ms. The oscillator frequency is 4 MHz. The value of  $N$  is passed in the working register `W`. Use the subroutine in a blinking LED application.

## Subroutines: Examples

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## Moving LEDs

- Write a program such that LEDs connected to the pins of PORTB are turned on one after another with a delay of 1 s. Start from RB0.



# Subroutines: Examples

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