Embedded Systems

ECE 4010

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8051 PROGRAMMING IN C

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- Compilers produce hex files that is downloaded to ROM of microcontroller
  - The size of hex file is the main concern
  - Microcontrollers have limited on-chip ROM
  - Code space for 8051 is limited to 64K bytes
- C programming is less time consuming, but has larger hex file size
- The reasons for writing programs in C
  - It is easier and less time consuming to write in C than Assembly
  - C is easier to modify and update
  - C code is portable to other microcontroller with little of no modification

8051 PROGRAMMING IN C – Data Types

- A good understanding of C data types for 8051 can help programmers to create smaller hex files
  - Unsigned char
  - Signed char
  - Unsigned int
  - Signed int
  - Sbit (single bit)
  - Bit and sfr

8051 PROGRAMMING IN C – Data Types

Unsigned char

- The character data type is the most natural choice
- Unsigned char is an 8-bit data type in the range of 0 – 255 (00 – FFH)
- C compilers use the signed char as the default if we do not put the keyword unsigned

- One of the most widely used data types for the 8051
- Counter value
- ASCII characters

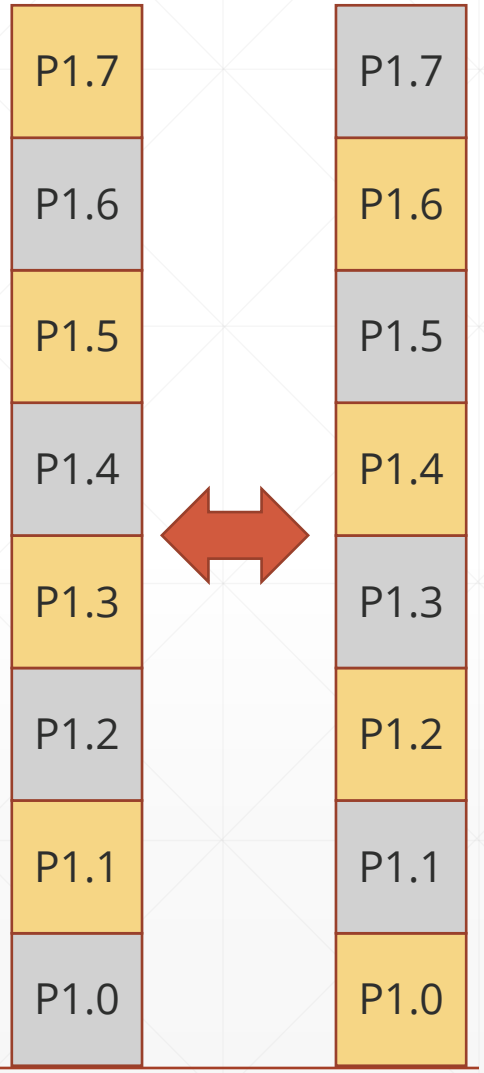
8051 PROGRAMMING IN C – Data Types

Write an 8051 C program to send values 00 – FF to port P1

```
#include <reg51.h>
void main(void)
{
unsigned char z;
for (z=0;z<=255;z++)
      P1=z;
}
```

8051 PROGRAMMING IN C – Data Types

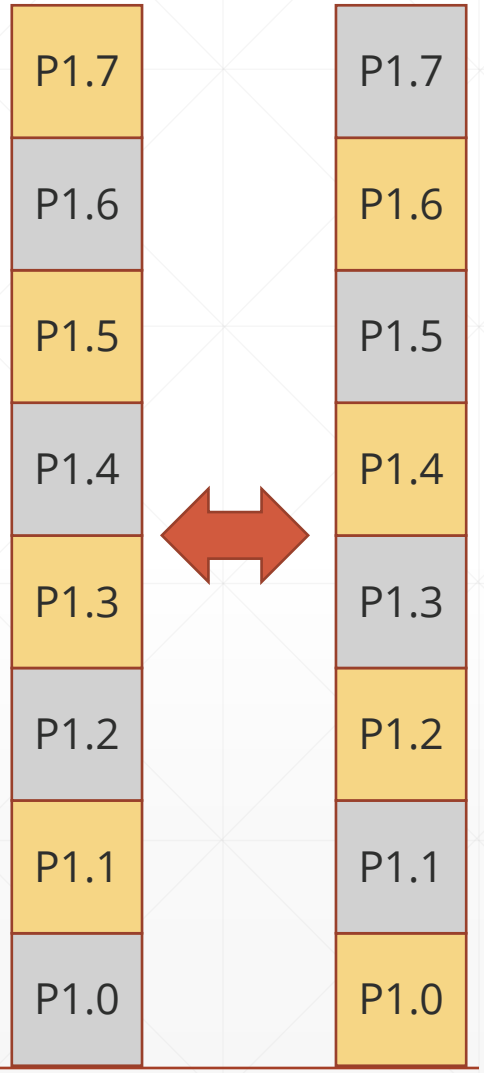
Write an 8051 C program to toggle all the bits of P1 continuously.



8051 PROGRAMMING IN C – Data Types

Write an 8051 C program to toggle all the bits of P1 continuously.

```
#include <reg51.h>
void main(void)
{
        for (;;)
        {
                p1=0xAA; p1=0x55;
        }
}
```



8051 PROGRAMMING IN C – Data Types

Signed char

- The signed char is an 8-bit data type
- Use the MSB D7 to represent – or +
- Give us values from –128 to +127
- We should stick with the unsigned char unless the data needs to be represented as signed numbers
- Temperature

8051 PROGRAMMING IN C – Data Types

Write an 8051 C program to send values of –4 to +4 to port P1.

```
#include <reg51.h>
void main(void)
{
char mynum[]={+1,-1,+2,-2,+3,-3,+4,-4};
unsigned char z;
for (z=0;z<=8;z++)
P1=mynum[z];
}
```

8051 PROGRAMMING IN C – Data Types

Unsigned int

- Takes a value in the range of 0 to 65535 (0000 – FFFFH)
- Define 16-bit variables such as memory addresses
- Set counter values of more than 256
- Since registers and memory accesses are in 8-bit chunks, the misuse of int variables will result in a larger hex file

Signed int

- Signed int is a 16-bit data type
- Use the MSB D15 to represent – or +
- We have 15 bits for the magnitude of the number from –32768 to +32767

8051 PROGRAMMING IN C – Data Types

Write an 8051 C program to toggle bit D0 of the port P1 (P1.0) 50,000 times.

```
#include <reg51.h>
sbit MYBIT=P1^0;
void main(void)
{
unsigned int z;
for (z=0;z<=50000;z++){
      MYBIT=0;  MYBIT=1;
}}
```

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sbit keyword allows access to the single bits of the SFR registers

8051 PROGRAMMING IN C – Data Types

- The bit data type allows access to single bits of bit-addressable memory spaces 20 – 2FH
- To access the byte-size SFR registers, we use the sfr data type

Data Type	Size in Bits	Data Range/Usage
unsigned char	8-bit	0 to 255
(signed) char	8-bit	-128 to +127
unsigned int	16-bit	0 to 65535
(signed) int	16-bit	-32768 to +32767
sbit	1-bit	SFR bit-addressable only
bit	1-bit	RAM bit-addressable only
sfr	8-bit	RAM addresses 80 – FFH only

8051 PROGRAMMING IN C – Time Delay

- There are **two ways** to create a time delay in 8051 C
- Using the 8051 timer
- Using a simple for loop
- Be mindful of **three factors** that can affect the accuracy of the delay
- The 8051 design
  - The number of machine cycle
  - The number of clock periods per machine cycle
- The crystal frequency connected to the X1 – X2 input pins
- Compiler choice
  - C compiler converts the C statements and functions to Assembly language instructions
  - Different compilers produce different code