CSSE2010

# CSSE2010/CSSE7201
# Lecture 14

# More C
# C Programming on the AVR

School of Information Technology and Electrical Engineering
The University of Queensland

# Admin and Reminders

- Assignment 1 – part 1 marks will be released this week Friday
- Assignment 1 – part 2 marks will be released next week.
- Quiz 6 is due this week Friday

# Remaining Labs of this Course

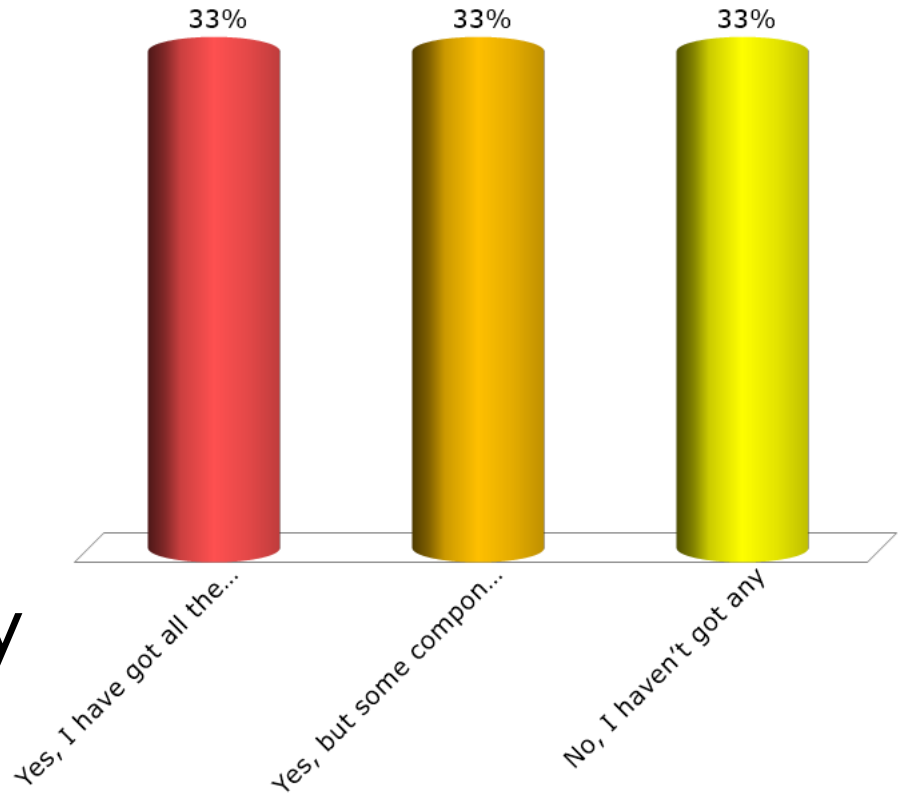
| | Week 1-7<br>Digital Logic | Week 8-13<br>AVR Microcontroller |
|---|---|---|
| IN Students | Logic chips and breadboard circuits | ATmega324A microcontroller and other peripherals in the lab kit. Programming through Microchip Studio and Pololu USB programmer |
| EX Students | Logisim simulations | Arduino Uno (ATmega328), breadboard and other components and peripherals you should have acquired by now. Programming through Microchip Studio and Arduino in-built programmer |

# EX Students: Have you acquired your Arduino based lab hardware components?

A. Yes, I have got all the components

B. Yes, but some components are missing, but I have the Arduino Uno

C. No, I haven't got any



# AVR Assembly Instructions (last time)

# Data types in ISA (last lecture)

- Other data types can be supported through software!
  - 16-bit integer operations can be built out of 8-bit operations, using a sequence of instructions.
  - e.g. AVR add 16-bit quantity r5:r4 to r11:r10

# Bit shifts in C

- Recall **`lsl`**, **`lsr`**, **`asr`** from last lecture

C equivalents are:

- **`a << b`** means a shifted left by b bits
- **`a >> b`** means a shifted right by b bits
  - Performs logical shift right if a is unsigned
  - Performs arithmetic shift right if a is signed

# Arrays in C (Were mentioned in Lab 9)

- Declaring an array

```
type variable_name[size];
```

  - Examples:

```
char message[16];
int values[10];
```

- Accessing elements within an array

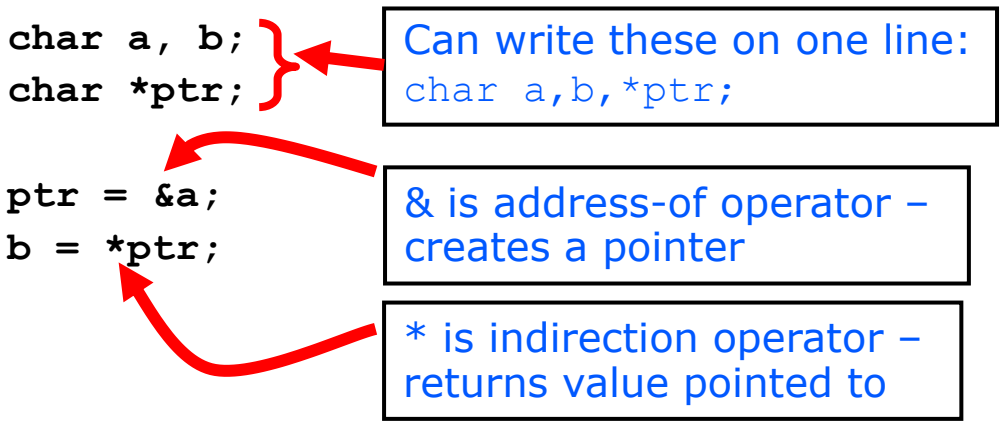
```
variable_name[index]
```

  - index = 0 … size-1
    - This is called zero-based indexing
  - Examples:

```
message[0] = 'c';
values[9] = values[8]++;
```

# Pointers

- C has concept of pointers
- Pointer declaration
  - ***type * variable_name;***
  - *variable-name* is a pointer to something of given *type*
    - How? – pointer variables store memory addresses
- Example:



# Pointers and Arrays

- Array name can be treated as a pointer to the first element
  - i.e. address of first element
- Example:

```
int a[10];
int *ptr;

/* following statements are same */
ptr = a;
ptr = &a[0];
```

# Operations on Pointers

- Addition/subtraction operations on pointers work in multiples of the size of the object being pointed to
- Example

```
int a[10];
int *ptr;

/* following statements are same */
ptr = a+5;
ptr = &a[5];
```

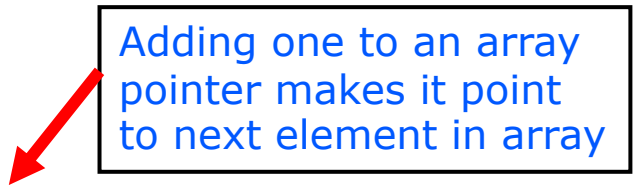
# Traversing an Array

- Two examples of clearing an array
- Using **index**:

```
int a[10];
int index;
for(index=0; index<10; index++) {
        a[index] = 0;
}
```

- Using **pointer**:

```
int a[10], *ptr;
for(ptr=a; ptr < a+10; ptr++) {
        *ptr = 0;
}
```



# Arrays in Memory

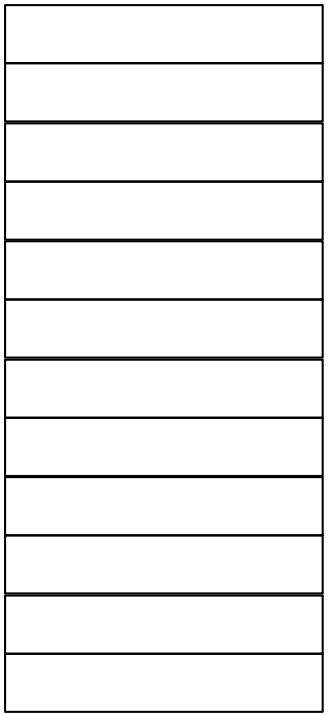
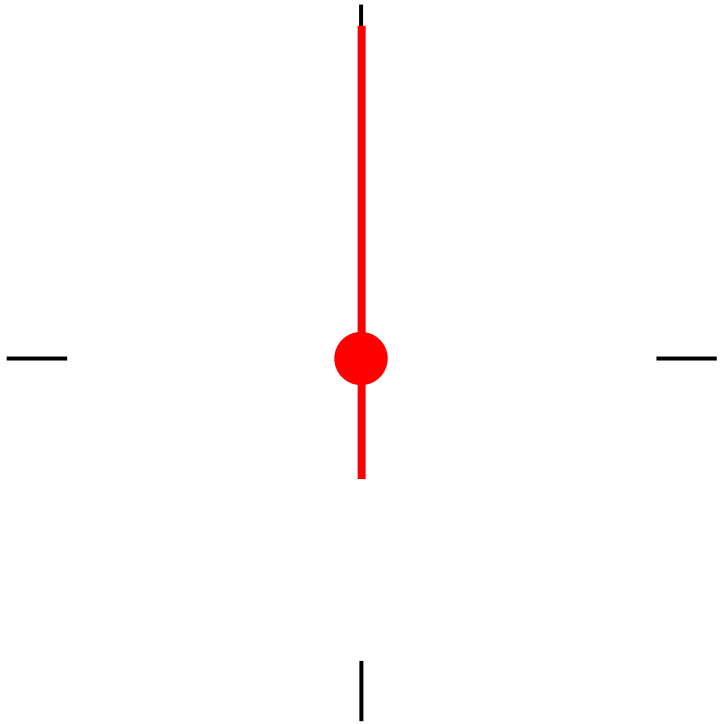


*Figure to be completed in class*

# Short Break

- Stand up and stretch



# Preprocessor

- C programs are first parsed by a preprocessor
- Preprocessor replaces preprocessor directives with substitute text
- Examples

  **`#include`** …

  **`#define`** … (macros)

  - many others

    **`#if`**
    **`#ifdef`**
    **`#else`**
    **`#undef`**
    …

# Header (.h) files

- Header files (.h files) are used for common macros, function prototypes etc
  - Like m324Adef.inc for assembly
- Examples
  - stdio.h – includes prototypes of printf() etc
    - AVR has a simplified version of this (e.g. no files)
      - printf() will only work if you specify where the characters go, e.g. sent via serial port
  - avr/io.h – AVR has this to define useful constants and functions/macros
    - Definitions depend on the actual device targeted

# Preprocessor Examples

**#include<filename.h>**

**#include”filename.h”**

**Macros – textual substitutions**

**#define pi 3.1415**

**#define EVER ; ;**

**#define sum(a,b) (a+b)**

**Given**

```
#define SQUARE(x)  (x*x)
```

**What is the result of `SQUARE(1+2)`?**

11% 1

11% 2

11% 3

11% 4

11% 5

11% 6

11% 7

11% 8

11% 9

10

# AVR C Macro Examples

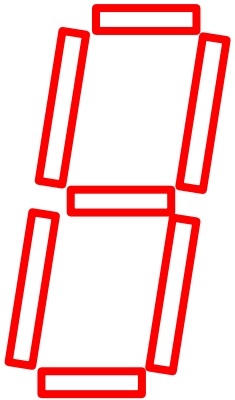
```
#define _MMIO_BYTE(mem_addr) \
                (*(volatile uint8_t *)(mem_addr))
#define _SFR_IO8(io_addr) \
                _MMIO_BYTE((io_addr) + 0x20)

/* Input Pins, Port A */
#define PINA      _SFR_IO8(0x00)

/* Data Direction Register, Port A */
#define DDRA      _SFR_IO8(0x01)

/* Data Register, Port A */
#define PORTA     _SFR_IO8(0x02)
```

# AVR C Macro Examples (cont.)

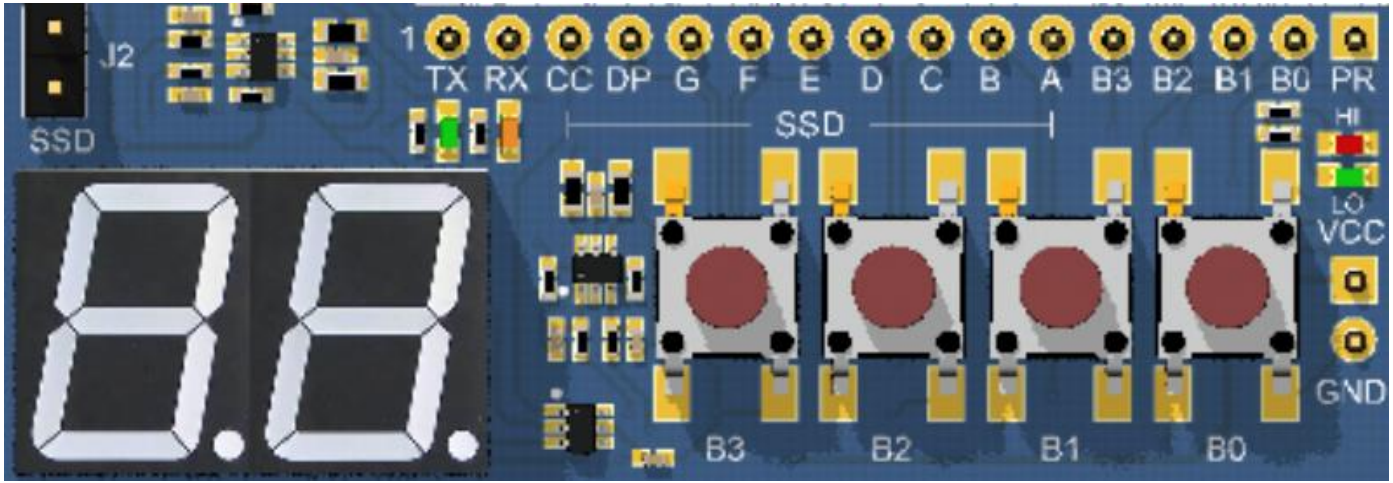
- Upshot of these macro definitions…
  - I/O register names can be used as variables, e.g.
    - `DDRA = 0xFF;`
    - `PORTA = PINC | 0xF0;`

# Seven Segment Display Programming Example

- To be covered in class



# Seven Segment Display on IO Board




**FD students**

**EX students: you will interface your 2-digit seven segment display to the Arduino Uno using the breadboard.**

```
#include <avr/io.h>

/* Seven segment display values */
uint8_t seven_seg[10] = { 63,6,91,79,102,109,125,7,127,111};

int main(void) {
   uint8_t digit;

   /* Set port A pins to be outputs, port C pins to be inputs */
   DDRA = 0xFF;
   DDRC = 0;     /* This is the default, could omit. */
   while(1) {
      /* Read in a digit from lower half of port C pins */
      /* We read the whole byte and mask out upper bits */
      digit = PINC & 0x0F;
      /* Write out seven segment display value to port A */
      if(digit < 10) {
          PORTA = seven_seg[digit];
      } else {
          PORTA = 0;
      }
   }
}
```