

CprE 288 – Introduction to Embedded Systems Exam 1 Review

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Overview of Today's Lecture

- Announcements
- Exam 1 Review

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Announcements

- Homework 5 is due next Thursday (turn in during class)
- Thursday, 9/27, Exam 1
 - Open book, open notes, calculator allowed
 - 1 hour and 15 minutes (starts from 9:30am and 2:30pm)

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Announcements

Very important

Morning class: Do **NOT** disclose the exam questions

- Don't discuss the exam with anyone until the end of day

Afternoon class: Do **NOT** try getting any info about the exam

If you see any sign of cheating, report to the instructors/TAs

Any offender will be dismissed from the class immediately, with follow-on consequences from the department, college and/or university

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EXAM FORMAT

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Exam Format

- Focus on C programming, some questions may be specific to the AVR ATmega128 processor
- Open notes, no electronic devices except calculators
- Covers first 5 weeks of class
 - No questions about timers
 - No questions about interrupt
- 60 points total
 - 15% of your final grade

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EXAM TOPICS

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Exam Topics

Suggested preparation steps:

- Review the following slides. You should have a deep understanding of the content that appears on them
- If not, go back and review the lecture material on the given topic
- Run through the questions at the end of this PowerPoint

This set of slides are *not comprehensive*

- Review all lecture slides
- Review homework questions, try to re-do those questions

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Exam Topic: Keywords

- | | | |
|----------|-------------------|-----------------------|
| • char | • break | • auto |
| • short | • case | • const |
| • int | • continue | • extern |
| • long | • default | • register |
| • float | • do | • signed |
| • double | • else | • static |
| | • for | • unsigned |
| • enum | • goto | • volatile |
| • struct | • if | |
| • union | • return | • sizeof |
| | • switch | • typedef |
| | • while | • void |

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Exam Topic: Syntax

- Could you write the following statements by hand?
 - Loops (for, while, do)
 - Write a **for loop** to sum elements of an array or count characters in a string
 - Do you know the syntax of a **do while loop**, **for loop**, and **while loop**?
 - typedef
 - Could you write a typedef definition
 - Do you know what it means when you see a variable type like **uint8_t**?
 - Switch statements
 - Do you know where the semi-colon and colons go in a switch/case statement?
 - Do you understand how the control flow can fall through a case?
 - Control flow
 - Do you understand the keywords **break** and **continue** and their use?

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Know your Operators

- Do you know the difference between these two sets of operators?



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Know your Operators

```
char a = 20, b = 10, r = 5;

// math operations
r = a + b;
r = a - b;
r = a * b;
r = a / b;
r = a % b;

// bitwise operators
r = a & 3;
r = a | b;
r = a ^ 0xFF;
r = ~a;
r = a >> 3;
r = b << r;

// conditional
r = (r) ? a : b;

// boolean
r = a || b;
r = a && b;
r = !a;
r = a < 20;
r = b <= 15;
r = b > 10;
r = a >= b;

// post and prefix
a++;
++a;
b--;
--b;

// assignments
r = a = b = 42;
r += a;
r -= b;
```

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Know your Operators

- Array access
- Pointers
 - Dereference
 - Address operator
- Access members of structs and unions

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Pointers

- What are pointers
- Relationship between
 - pointers
 - array names
 - function names
- Pointer arithmetic

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Know your Declarations

- Do these declarations make sense?

```
void main() {
    char x = 5, y = 10;
    char z;
    char array1[10];
    char array2[] = {1, 2, 3};
    char array3[5] = {1, 2, 3};
    char *str = "Hello!";

    int i = 7;
    int *ptr = &i;
    int **pp = &ptr;
    char *p;
}
```

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Know your Declarations

- Do these declarations make sense?

```
struct House {
    unsigned long value;
    unsigned char baths;
    unsigned char bedrooms;
    unsigned char stories;
    unsigned long footage;
};

void main() {
    struct House my_home;
    struct House *bob_home = malloc(sizeof(House));

    my_home.baths = 1;
    my_home.value = 115000;
    bob_home->baths = 3;
    bob_home->value = 230000;
}
```

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Know how to use Operator Precedence

- Can you use this table?

Precedence	Operator	Description	Associativity
1	++ --	Prefix/postfix increment and decrement	left-to-right
	()	Function call	
	[]	Array subscripting	
	.	Element selection by reference	
2	-->	Element selection through pointer	right-to-left
	++ --	Prefix increment and decrement	
	+	Unary plus and minus	
	! ~	Logical NOT and bitwise NOT	
	(type)	Type cast	
	*	Indirection (dereference)	
	&	Address-of	
3	sizeof	Size of	left-to-right
	* / %	Multiplication, division, and modulus (remainder)	
	+ -	Addition and subtraction	
	<< >>	Bitwise left shift and right shift	
	< >	For relational operators < and > respectively	
	<= >=	For relational operators <= and >= respectively	
	= !=	For relational = and != respectively	
	&		
	!		
14	?:	Ternary conditional	right-to-left
	=	Direct assignment	
	+= -= *= /=	Assignment by sum and difference	
	*= /=	Assignment by product, quotient, and remainder	
15	<< >>	Assignment by bitwise left shift and right shift	left-to-right
	& ^	Assignment by bitwise AND, XOR, and OR	
15	,	Comma	left-to-right

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QUESTIONS

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Question 1

- A. How many bytes are each of the following types (on the ATmega128)?
- char, short, int, long, float, double
- B. What range of values can be stored in an unsigned char?
- C. What range of values can be stored in a signed char?
- D. What is the value stored in x after this code runs?

```
int x, y, z;
x = y = z = 10;
```

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Question 1 (answer)

Name	Number of Bytes sizeof()	Range
char	1	-128 to 127
signed char	1	-128 to 127
unsigned char	1	0 to 255
short	2	-32,768 to 32,767
unsigned short	2	0 to 65,535
int (on ATmega 128)	2	-32,768 to 32,767
(pointer on ATmega 128)	2	Address Space
long	4	-2147483648 to 2147483647
signed long	4	-2147483648 to 2147483647
unsigned long	4	0 to 4294967295
long long	8	-4294967295 to 4294967295
float	4	$\pm 1.175e-38$ to $\pm 3.402e38$
double (on ATmega 128)	4	$\pm 1.175e-38$ to $\pm 3.402e38$

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Question 2

- A. Analyze the following code:

```
char r = 0, s = 1, t = 2;
char *p1 = &s;
char *p2 = &t;
char **pp3 = &p1;
```

```
*p1 = 10;
**pp3 = 15;
*p2 = 30;
*pp3 = &r;
**pp3 = 5;
*p1 = 25;
```

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Question 2 (answer)

- A. Analyze the following code:

```
char r = 0, s = 1, t = 2;
char *p1 = &s;
char *p2 = &t;
char **pp3 = &p1;
```

```
*p1 = 10;           // s = 10
**pp3 = 15;         // s = 15
*p2 = 30;           // t = 30
*pp3 = &r;          // p1 = &r
**pp3 = 5;          // r = 5
*p1 = 25;           // r = 25
```

r	s	t
0	1	2
0	10	2
0	15	2
0	15	30
0	15	30
5	15	30
25	15	30

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Question 3a

- When is the condition of the following if statement true?

```
if ((x = 3) || (x & 1)) {
    // do something
}
```

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Question 3a (answer)

- When is the condition of the following if statement true?

```
if ((x = 3) || (x & 1)) {
    // do something
}
```

- The statement is always true. Know the difference between the assignment operator (=) and the equality operator (==).
 - The value on the left (x = 3) is always true, as the value of an assignment is the value that was assigned. This allows programmers to have compound assignments.

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Question 3b

- When is the condition of the following **if** statement true?

```
if ((x == 3) || (x & 1)) {
    // do something
}
```

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Question 3b (answer)

- When is the condition of the following **if** statement true?

```
if ((x == 3) || (x & 1)) {
    // do something
}
```

- The statement is true if **x** is either equal to 3 or bit 0 is set.

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Question 4a

- When is the condition of the following **if** statement true?

```
if (x & 0x08 == 0x08) {
    // do something
}
```

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Question 4a (answer)

- When is the condition of the following **if** statement true?

```
if (x & 0x08 == 0x08) {
    // do something
}
```

- The statement is true if bit 0 of **x** is 1. Operator precedence evaluates the == operator before the bitwise AND (&).

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Question 4b

- When is the condition of the following **if** statement true?

```
if ((x & 0x08) == 0x08) {
    // do something
}
```

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Question 4b (answer)

- When is the condition of the following **if** statement true?

```
if ((x & 0x08) == 0x08) {
    // do something
}
```

- The statement is true if bit3 of **x** is set.
 - $x = 0b00001000$; condition is TRUE
 - $x = 0b01001110$; condition is TRUE
 - $x = 0b00101001$; condition is TRUE
 - $x = 0b00000000$; condition is FALSE
 - $x = 0b11100000$; condition is FALSE

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Question 6a

- What are the values of c1, c2, c3, and c4 after the following code executes?

```
char myarray[3] = {1, 2, 3};
char *ptr = myarray;

char c1 = *ptr++;
char c2 = *ptr;
char c3 = myarray[0];
char c4 = myarray[1];
```

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Question 6a (answer)

```
char myarray[3] = {1, 2, 3};
char *ptr = myarray;
```

- Postfix increment has higher precedence than dereference operator

```
char c1 = *ptr++;
char c2 = *ptr;
char c3 = myarray[0];
char c4 = myarray[1];
```

- c1 is 1
- c2 is 2
- c3 is 1
- c4 is 2

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Question 6b

- What are the values of c1, c2, c3, and c4 after the following code executes?

```
char myarray[3] = {1, 2, 3};
char *ptr = myarray;

char c1 = (*ptr)++;
char c2 = *ptr;
char c3 = myarray[0];
char c4 = myarray[1];
```

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Question 6b (answer)

```
char myarray[3] = {1, 2, 3};
char *ptr = myarray;
```

- c1 is 1
- c2 is 2
- c3 is 2
- c4 is 2

```
char c1 = (*ptr)++;
char c2 = *ptr;
char c3 = myarray[0];
char c4 = myarray[1];
```

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Question 7

```
/**
 * Returns the first index of occurrence of a given
 * character inside a string. If not found, return -1.
 *
 * @param needle, the character to find in haystack
 * @param haystack, the string which is searched
 */
int find(char *haystack, char needle);
```

- Given this function signature, implement the function

```
void main() {
    find("hello world", 'c'); // returns -1
    find("hello world", 'h'); // returns 0
    find("hello world", 'o'); // returns 4
    find("hello world", 'w'); // returns 6
}
```

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Question 7 (answer)

```
int find(char *haystack, char needle) {
    for (int i=0; haystack[i]; i++) {
        if (haystack[i] == needle)
            return i;
    }

    return -1;
}
```

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