ECE 120 Midterm 1

HKN Review Session

Time: 8:30-10:00 pm (Arrive at 8:15 pm)
Location: Your Room on Compass
What to bring: iCard, pens/pencils, Cheat sheet (Handwritten)

Overview of Review

- Binary
- IEEE floating point
- Hex & ASCII
- Operators
- Bitmasks
- C programming
- Practice Exam

Binary Representation

- Unsigned - k bits can represent [0, 2^k) values
  - Can only represent non-negative integers
  - Overflow Condition: If the most significant bit has a carry out
  - Zero Extended - pad the front with zeros when moving to larger data type
  - (10101) = (16+4+1) = 21
- Signed Magnitude - (- 2^(k-1), 2^(k-1)) values
  - First bit determines sign of number (1 = negative, 0 = positive)
  - (10101) = (-1) x (4+1) = -5

Binary Representation - Part II

- 2’s Complement - k bits represents [-2^(k-1), 2^(k-1) - 1]
  - Sign Extended - pad the front of the number with the sign bit when moving to larger data type
  - Overflow Condition: if adding numbers of the same sign yields a result of the opposite sign
  - If signed bit is 0, magnitude is same as if the number were treated as unsigned
  - If signed bit is 1, to determine the magnitude, bitwise NOT the bits, and add 1 before finding magnitude
  - 2’s complement provides a greater range of values and cleaner binary arithmetic operations
    - ie. the same logic circuit used to add binary unsigned and 2’s complement numbers

iEEE 754 Floating Point Representation

- Great for approximations & expressing very large/very small decimal values
- 1st bit is sign bit, 0 for positive and 1 for negative
- 2nd through 9th bit is exponent
  - Special Cases: When exponent is 0 or 255, then denormalized or NAN/inf forms respectively.
  - Denormalized format has normal sign, and magnitude: 0.mantissa * 2^(-126)
  - NAN/inf form is NAN when mantissa is non-zero, and infinity (inf) when mantissa is all zeros
- 10th through 32nd bit is 23 bit mantissa
- Normal Form has magnitude of 1.mantissa * 2 ^ (exponent - 127)
- (-1)^sign * 1.fraction * 2^(exponent - 127)

Hexadecimal & ASCII Representations

- 7-bit ASCII table will be provided if necessary
- Although 7 bits, chars in C are 1 byte of memory and allocate 8 bits per character anyway
- Hexadecimal is base 16 number system (0-9 & A-F)
- All numbering systems that have a power of 2 base can have individual characters mapped to binary strings
- A=1010 B=1011 C=1100 D=1101 E=1110 F=1111
- converting 76 (01001100) to hex = 0x4C
- 0111010, 0110011, 0101001 converting to ASCII -

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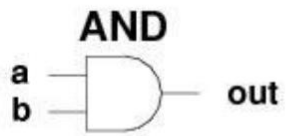
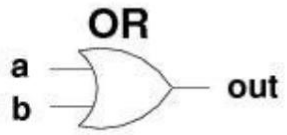
- 0111010, 0110011, 0101001 converting to ASCII -
- 0x3A 0x33 0x29
- :3)

Operators

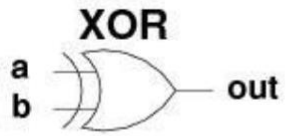
- AND
  - Returns 1 if both inputs are 1
- OR
  - Returns 1 if any of the inputs are 1
- XOR
  - Returns 1 if either a or b is 1, not both
- NOT
  - Returns opposite of input (0->1 , vice versa)



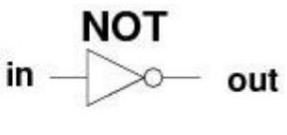
a	b	out
0	0	0
0	1	0
1	0	0
1	1	1



a	b	out
0	0	0
0	1	1
1	0	1
1	1	1



a	b	out
0	0	0
0	1	1
1	0	1
1	1	0



in	out
0	1
1	0

Bitmasks

- Great for looking at only certain bits
- A bitmask using AND as the bitwise operator will selectively mask bits to 0
- A bitmask using OR as the bitwise operator will selectively mask bits to 1

C programming

- Variables
  - Double, Long (8 bytes)
  - Int, Float (4 bytes)
    - Int may be 2 bytes on some systems
  - Short (2 bytes)
  - Char (1 byte)

```c
#include <stdio.h>
#define PI = 3.1415926;

int main(){

    int r = 12;

    float area;

    area = (PI * r * r);

    return 0;
}

```

Format Specifiers and Escape Sequences

Format Specifiers:

%c char single character
%d (%i) int signed integer
%e (%E) float or double exponential format
%f float or double signed decimal
%g (%G) float or double use %f or %e as required
%o int unsigned octal value
%p pointer address stored in pointer
%s array of char sequence of characters
%u int unsigned decimal
%x (%X) int unsigned hex value

Escape Sequences:

\n - new line character
\b - backspace character
\t - horizontal tab
\' - allows for storing and printing of ' ASCII value in string
\\ - allows for storing and printing of \ ASCII value in string
\" - allows for storing and printing of " ASCII value in string
\? - allows for storing and printing of ? ASCII value in string
Ie. char x = '\'; (those are 2 single quotes)
will store the data byte associated with ' into x

Format Specifier Example

```
int integer = 5;

float decimal = 2.5;

printf(“This is an integer: %d\nThis is a float: %f\n”,
integer, decimal);
```

Format Specifier Example

```
int integer = 5;

float decimal = 2.5;

printf(“This is an integer: %d\nThis is a float: %f\n”,
integer, decimal);
```

Prints:

This is an integer: 5

This is a float: 2.50000

C - operators

- Order of precedence
  - * , / , % , then + , - (Note, Modular Arithmetic (%) is not defined for floating point numbers)
- Assignment operator
  - = (takes a variable on the left and a value/expression on the right side)
  - Sets the variable on the left equal to the expression on the right
    - IE, you can't do 5 = x; as 5 is not a variable (you can't assign a value to 5!)
- Relational
  - ==, !=, <, >, <=, >=
  - Returns 1 for true, 0 for false
- Bitwise
  - &, |, ~, ^ (AND, OR, NOT, XOR)
- Logical
  - !, &&, || (NOT, AND, OR)

C operators - bitwise examples

```c
int a = 12;
int b = 20;
int c;

c = (a|b);
```

```c
int a = 13;
int b = 6;
int c = 17;
int d;

d = (((a|b)&c) | b);
```

```c
int a = 7;
int b = 16;
int c = 21;
int d = 12;
int e;

e = (((a^b)&c) & ((d^a)|b));
```

C operators - bitwise examples

```c
int a = 12;
int b = 20;
int c;

c = (a|b);
```

c = 28

```c
int a = 13;
int b = 6;
int c = 17;
int d;

d = (((a|b)&c) | b);
```

e = 17

```c
int a = 7;
int b = 16;
int c = 21;
int d = 12;
int e;

e = (((a^b)&c) & ((d^a)|b));
```

d = 7

Basic Input / Output

```c
float i = 2.15;
int j;

scanf("%d", &j);

printf("%d and %f", j, i);
```

Conditional Constructs

```c
int a = 4;

if (a < 10){
    printf("a is less than 10");
}
```

```c
int a = 4;
int b = 8;

if (a < 10){
    printf("a is less than 10");
}else if (b < 20){
    printf("b is less than 20");
}else{
    printf("b is greater than 20");
}
```

Conditional Constructs - Example

```c
int a = 20;
int b = 13;
int c = 6;

if ( (a-b > 10) || ((c*a)%10 == 0)){
    if(b+c < a){
        printf("a = %d", a);
    }else{
        printf("Error");
    }
}else{
    printf("b = %d", b);
}
```

Iterative Constructs

```c
int i = 0;

do {
    /* do things */
} while(i < 10);
```

```c
int i;

for(i = 0; i<=10; i++){
    printf("%d", i);
}
```

```c
int i = 0;

while (i < 10){
    /* do things*/
}
```

Iterative - Example

```
int i;

for(i = 0; i<=10; i++){
    if (i%3 == 0){
        printf("%d\n", i);
    }
}
```

HW2.9

HW2.9. Masking Bits

Define X NAND Y = NOT(X AND Y) and X NOR Y = NOT(X OR Y).

Select a logical operation and enter a bitmask that convert the following input bit strings to the corresponding output bit strings.

$00100101 \rightarrow 00111101$

$11001010 \rightarrow 11111110$

$10111011 \rightarrow 10111111$

Logical operation

- AND
- OR
- NAND
- NOR

Bitmask (8 bits) [ ]

Past Exam Review

- https://wiki.illinois.edu/wiki/display/ece120/Midterm+1
- Fall 2016, Midterm 1
- Solutions available