

# EECS 10: Computational Methods in Electrical and Computer Engineering

## Lecture 4

Rainer Dömer

doemer@uci.edu

The Henry Samueli School of Engineering  
Electrical Engineering and Computer Science  
University of California, Irvine

## Lecture 4: Overview

- Review Quiz
- Floating-point Example
  - Cosine approximation
  - Example `Cosine.c`
- Type Conversion
  - explicit
  - implicit
- Types in Expressions
- Arithmetic Computation
  - Example `Arithmetic.c`

## Quiz: Question 6

- Which of the following constructs is a valid arithmetic operator in C?  
(Check all that apply!)
  - a) /
  - b) %
  - c) !
  - d) @
  - e) >>

EECS10: Computational Methods in ECE, Lecture 4

(c) 2019 R. Doemer

3

## Quiz: Question 6

- Which of the following constructs is a valid arithmetic operator in C?  
(Check all that apply!)
  - a) /
  - b) %
  - c) !
  - d) @
  - e) >>

EECS10: Computational Methods in ECE, Lecture 4

(c) 2019 R. Doemer

4

## Quiz: Question 7

- What is the value of the integer  $x$  after the following statement?


```
x = 11 / 3 + 11 % 3;
```

- a) 1
- b) 2
- c) 3
- d) 4
- e) 5

## Quiz: Question 7

- What is the value of the integer  $x$  after the following statement?

```
x = 11 / 3 + 11 % 3;
```

- a) 1
- b) 2
- c) 3
- d) 4
-  e) 5

## Quiz: Question 8

- What is the value of the integer  $x$  after the following statement?


```
x = (10 - (3 - (20 - -10)));
```

- a) 7
- b) 17
- c) 27
- d) 37
- e) 77

## Quiz: Question 8

- What is the value of the integer  $x$  after the following statement?

```
x = (10 - (3 - (20 - -10)));
```

- a) 7
- b) 17
- c) 27
-  d) 37
- e) 77

## Quiz: Question 9


- Which of the following format strings will print an `unsigned int` value in decimal format when used with `printf()`?
  - a) `"%u"`
  - b) `"%ud"`
  - c) `"%d"`
  - d) `"%lu"`
  - e) `"%ui"`

EECS10: Computational Methods in ECE, Lecture 4

(c) 2019 R. Doemer

9

## Quiz: Question 9

- Which of the following format strings will print an `unsigned int` value in decimal format when used with `printf()`?
  -  a) `"%u"`
  - b) `"%ud"`
  - c) `"%d"`
  - d) `"%lu"`
  - e) `"%ui"`

EECS10: Computational Methods in ECE, Lecture 4

(c) 2019 R. Doemer

10

## Quiz: Question 10


- Which of the following statements will correctly read a decimal value from `stdin` into a variable `x` of type `signed int`?
  - a) `stdin("%x", &u);`
  - b) `stdin("%u", x);`
  - c) `scanf("%d", &x);`
  - d) `scanf("&x", %u);`
  - e) `scanf("&x", %d);`

EECS10: Computational Methods in ECE, Lecture 4

(c) 2019 R. Doemer

11

## Quiz: Question 10

- Which of the following statements will correctly read a decimal value from `stdin` into a variable `x` of type `signed int`?
  - a) `stdin("%x", &u);`
  - b) `stdin("%u", x);`
  -  c) `scanf("%d", &x);`
  - d) `scanf("&x", %u);`
  - e) `scanf("&x", %d);`

EECS10: Computational Methods in ECE, Lecture 4

(c) 2019 R. Doemer

12

## Example Program

- Cosine function approximation
  - Task
    - Design a program to compute the cosine function!
    - In your program, use only the four basic operations addition, subtraction, multiplication, and division.
  - Approach
    - The cosine function can be algebraically approximated using an infinite sum

$$\cos x = \sum_{n=0}^{\infty} \frac{(-1)^n x^{2n}}{(2n)!} \approx 1 - \frac{x^2}{2!} + \frac{x^4}{4!} - \frac{x^6}{6!} + \dots$$

## Example Program

- Program example: `Cosine.c` (part 1/2)

```

/* Cosine.c: cosine function approximation */
/*                                          */
/* author: Rainer Doemer                  */
/*                                          */
/* modifications:                         */
/* 10/02/05 RD initial version           */
#include <stdio.h>

/* main function */
int main(void)
{
    /* variable definitions */
    double x, y;

    /* input section */
    printf("Please enter real value x: ");
    scanf("%lf", &x);
    ...

```

## Example Program

- Program example: `Cosine.c` (part 2/2)

```

...

/* computation section */
y = 1 - (x*x)/(2.0*1.0)
    + (x*x*x*x)/(4.0*3.0*2.0*1.0)
    - (x*x*x*x*x*x)/(6.0*5.0*4.0*3.0*2.0*1.0);

/* output section */
printf("cos(%f) is approximately %f\n", x, y);

/* exit */
return 0;
} /* end of main */

/* EOF */

```

## Example Program

- Example session: `Cosine.c`

```

% vi Cosine.c
% gcc -Wall -ansi Cosine.c -o Cosine
% ./Cosine
Please enter real value x: 0.0
cos(0.000000) is approximately 1.000000
% ./Cosine
Please enter real value x: 0.1
cos(0.100000) is approximately 0.995004
% ./Cosine
Please enter real value x: 1.57079
cos(1.570790) is approximately -0.000888
% ./Cosine
Please enter real value x: 3.1415927
cos(3.141593) is approximately -1.211353
%

```



## Review: Basic Types in C

- Integer types
  - **char**                   Character, e.g. `'a'`, `'b'`, `'1'`, `'*'`
    - typical range [-128,127]
  - **short int**           Short integer, e.g. -7, 0, 42
    - typical range [-32768,32767]
  - **int**                   Integer, e.g. -7, 0, 42
    - typical range [-2147483648,2147483647]
  - **long int**           Long integer, e.g. -99L, 9L, 123L
    - typical range [-2147483648,2147483647]
  - **long long int**   Very long integer, e.g. 12345LL
    - typical range [-9223372036854775808,9223372036854775807]
- Integer types can be
  - **signed**           negative and positive values (incl. 0)
  - **unsigned**       positive values only (incl. 0)

EECS10: Computational Methods in ECE, Lecture 4

(c) 2019 R. Doemer

17

## Review: Basic Types in C

- Floating point types
  - **float**               Floating point with single precision
    - Example 3.5f, -0.234f, 10e8f
  - **double**           Floating point with double precision
    - Example 3.5, -0.23456789012, 10e88
  - **long double**   Floating point with high precision
    - Example 12345678.123456e123L
- Floating point values are in many cases *approximations* only!
  - Storage size of floating point values is fixed
  - Many values can only be represented as approximations
  - Example:  $1.0/3.0 = .333333$

EECS10: Computational Methods in ECE, Lecture 4

(c) 2019 R. Doemer

18

## Type Conversion

- Explicit Type Conversion
  - types can be explicitly converted to other types, by use of the type cast operator: `(type) expression`
  - the target type is named explicitly in parentheses before the source expression
  - Examples:
    - `Float = (float) LongInt`
      - converts the `long int` value into a `float` value
    - `Integer = (int) Double`
      - converts the `double` value into an `int` value
      - any fractional part is truncated!
    - `Char = (char) LongLongInt`
      - converts the `long long int` value into a `char` value
      - any out-of-range values are silently cut off!

EECS10: Computational Methods in ECE, Lecture 4

(c) 2019 R. Doemer

19

## Type Conversion

- Implicit Type Conversion
  - Type promotion
    - integral promotion
      - `unsigned` or `signed char` is promoted to `unsigned` or `signed int` before any operation
      - `unsigned` or `signed short` is promoted to `unsigned` or `signed int` before any operation
    - binary arithmetic operators are defined only for same types
      - the smaller type is converted to the larger type (before operation)
      - Examples:
        - » `ShortInt * LongInt` results in a `long int` type
        - » `LongDouble * Float` results in a `long double` type
  - Type coercion
    - most types are automatically converted to expected types
    - Example: `Double = Float`, or `Char = LongInt`

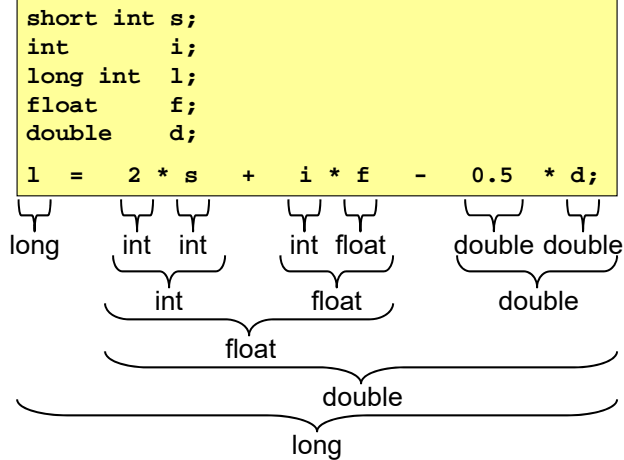
EECS10: Computational Methods in ECE, Lecture 4

(c) 2019 R. Doemer

20

## Types in Expressions

- Expressions are composed of constants, variables and operators, each of which has an associated type
- Example:



EECS10: Computational Methods in ECE, Lecture 4

(c) 2019 R. Doemer

21

## Example Program

- Program example:
  - Task: Write a C program that exercises arithmetic computation by use of different types and operators!
  - The program should compute the following equations:

- Polynomial:

$$p = 2x^2 - 3x + 5$$

- Quotient of sums:

$$q = \frac{a + b}{c + d}$$

- Remainder:

$$r = \text{rem}(2^n / 7)$$

- Assume that  $a$ ,  $b$ ,  $c$ ,  $d$ , and  $n$  are whole numbers.

EECS10: Computational Methods in ECE, Lecture 4

(c) 2019 R. Doemer

22

## Example Program

- Program example: `Arithmetic.c` (part 1/3)

```

/* Arithmetic.c: arithmetic expresions          */
/*                                              */
/* author: Rainer Doemer                      */
/*                                              */
/* modifications:                             */
/* 10/06/04 RD initial version                */

#include <stdio.h>

/* main function */

int main(void)
{
    /* variable definitions */
    int    a, b, c, d, n;
    double p, q, r, x;

    ...

```

## Example Program

- Program example: `Arithmetic.c` (part 2/3)

```

...

/* input section */
printf("Please enter the value for real x:  ");
scanf("%lf", &x);
printf("Please enter the value for integer a: ");
scanf("%d", &a);
printf("Please enter the value for integer b: ");
scanf("%d", &b);
printf("Please enter the value for integer c: ");
scanf("%d", &c);
printf("Please enter the value for integer d: ");
scanf("%d", &d);
printf("Please enter the value for integer n: ");
scanf("%d", &n);

...

```

## Example Program

- Program example: `Arithmetic.c` (part 3/3)

```

...

/* computation section */
p = 2.0*x*x - 3.0*x + 5.0;
q = ((double)(a + b)) / ((double)(c + d));
r = (1<n) % 7;

/* output section */
printf("The value for the polynomial p is %f.\n", p);
printf("The value for the quotient q is %f.\n", q);
printf("The value for the remainder r is %f.\n", r);

/* exit */
return 0;
} /* end of main */

/* EOF */

```

## Example Program

- Example session: `Arithmetic.c`

```

% vi Arithmetic.c
% gcc Arithmetic.c -Wall -ansi -o Arithmetic
% ls -l
total 20
-rwx----- 1 doemer  faculty    7344 Oct  6 08:42 Arithmetic*
-rw----- 1 doemer  faculty    1154 Oct  6 08:37 Arithmetic.c
% ./Arithmetic
Please enter the value for real x:    3.1415927
Please enter the value for integer a: 5
Please enter the value for integer b: 6
Please enter the value for integer c: 7
Please enter the value for integer d: 8
Please enter the value for integer n: 9
The value for the polynomial p is 15.314431.
The value for the quotient q is 0.733333.
The value for the remainder r is 1.000000.
%

```