

## EECS 10 Midterm Examination 1

- Please...
  - ... seat yourself with space around you
  - ... have a valid photo ID ready for inspection
- Rules
  - 50 minutes time
  - No books, no notes, no devices
  - No questions
  - If in doubt, state all assumptions clearly
- Good Luck!

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## EECS 10: Computational Methods in Electrical and Computer Engineering

### Lecture 4

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## Lecture 4.1: Overview

- Formatted Input
  - Format specifiers for `scanf()`
  - Detailed formatting of integral values
  - Detailed formatting of floating-point values
- Formatted Output
  - Format specifiers for `printf()`
  - Detailed formatting of integral values
  - Detailed formatting of floating-point values
- Example `Formatting.c`

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## Formatted Input

- Formatted input using `scanf()`
  - standard format specifier for integral values
    - (unsigned) long long    `%llu`    `%lld`
    - (unsigned) long        `%lu`     `%ld`
    - (unsigned) int         `%u`      `%d`
    - (unsigned) short       `%hu`     `%hd`
    - (unsigned) char        `%c` (reads a character)
  - standard format specifier for floating point values
    - long double            `%Lf`
    - double                 `%lf`
    - float                  `%f`

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## Formatted Output

- Formatted output using `printf()`
  - standard format specifier for integral values
    - (unsigned) long long    `%llu`    `%lld`
    - (unsigned) long        `%lu`     `%ld`
    - (unsigned) int         `%u`      `%d`
    - (unsigned) short      `%hu`    `%hd`
    - (unsigned) char        `%c` (prints a character)
  - standard format specifier for floating point values
    - long double            `%Lf`
    - double                 `%f`
    - float                  `%f`

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## Formatted Output

- Detailed formatting sequence for integral values
  - `% flags width length conversion`
  - **flags**
    - (none)    standard formatting (right-justified)
    - -         left-justified output
    - +         leading plus-sign for positive values
    - 0         leading zeros
  - field **width**
    - (none)    minimum number of characters needed
    - integer    width of field to be filled with output
  - **length** modifier
    - (none)    `int` type
    - `h`        `short int` type
    - `l`        `long int` type
    - `ll`       `long long int` type
  - **conversion** specifier
    - `d`        signed decimal value
    - `u`        unsigned decimal value
    - `o`        (unsigned) octal value
    - `x`        (unsigned) hexadecimal value using characters `0-9, a-f`
    - `X`        (unsigned) hexadecimal value using characters `0-9, A-F`

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## Formatted Output

- Detailed formatting sequence for floating-point values
  - *% flags width precision length conversion*
  - **flags**
    - (none) standard formatting (right-justified)
    - - left-justified output
    - + leading plus-sign for positive values
    - 0 leading zeros
  - **field width**
    - (none) minimum number of characters needed
    - integer width of field to be filled with output
  - **precision**
    - (none) default precision (e.g. 6)
    - .int number of digits after decimal point (for **f**, **e**, or **E**), maximum number of significant digits (for **g**, or **G**)
  - **length modifier**
    - (none) **float** or **double** type
    - **L** **long double** type
  - **conversion specifier**
    - **f** standard floating-point notation (fixed-point)
    - **e** or **E** exponential notation (using **e** or **E**)
    - **g** or **G** standard or exponential notation (using **e** or **E**)

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## Formatted Output

- Program example: **Formatting.c** (part 1/2)

```

/* Formatting.c: formatted output demo          */
/* author: Rainer Doemer                       */
/* modifications:                              */
/* 10/19/04 RD initial version                 */

#include <stdio.h>

/* main function */

int main(void)
{
    /* output section */
    printf("42 formatted as |%d|:   |%d|\n", 42);
    printf("42 formatted as |%8d|:  |%8d|\n", 42);
    printf("42 formatted as |%-8d|: |%-8d|\n", 42);
    printf("42 formatted as |%+8d|: |%+8d|\n", 42);
    printf("42 formatted as |%08d|: |%08d|\n", 42);
    printf("42 formatted as |%x|:   |%x|\n", 42);
    printf("42 formatted as |%o|:   |%o|\n", 42);
    ...
}

```

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## Formatted Output

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

```

...
printf("\n");
printf("123.456 formatted as |%f|:      |%f|\n", 123.456);
printf("123.456 formatted as |%e|:      |%e|\n", 123.456);
printf("123.456 formatted as |%g|:      |%g|\n", 123.456);
printf("123.456 formatted as |%12.4f|:  |%12.4f|\n",
      123.456);
printf("123.456 formatted as |%12.4e|:  |%12.4e|\n",
      123.456);
printf("123.456 formatted as |%12.4g|:  |%12.4g|\n",
      123.456);

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

/* EOF */

```

## Formatted Output

- Example session: `Formatting.c`

```

% vi Formatting.c
% gcc Formatting.c -o Formatting -Wall -ansi
% Formatting
42 formatted as |%d|:      |42|
42 formatted as |%8d|:      |      42|
42 formatted as |%-8d|:     |42      |
42 formatted as |%+8d|:     |      +42|
42 formatted as |%08d|:     |00000042|
42 formatted as |%x|:      |2a|
42 formatted as |%o|:      |52|

123.456 formatted as |%f|:      |123.456000|
123.456 formatted as |%e|:      |1.234560e+02|
123.456 formatted as |%g|:      |123.456|
123.456 formatted as |%12.4f|:  |      123.4560|
123.456 formatted as |%12.4e|:  |  1.2346e+02|
123.456 formatted as |%12.4g|:  |      123.5|
%

```

## Lecture 4.2: Overview

- Programming Principles
  - Algorithm and control flow
- Structured Programming
  - Control flow chart
  - Sequential execution
  - Conditional execution
    - `if` statement
    - `if-else` statement
    - `switch` statement
  - Structured Program Composition
  - Examples `Grade.c`, `Grade2.c`

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## Programming Principles

- Thorough *understanding* of the problem
- *Problem definition*
  - Input data
  - Output data
- *Algorithm*: Procedure to solve the problem
  - Detailed set of *actions* to perform
  - Specification of *order* in which to perform the actions
  - Termination after a *finite* number of steps
- *Pseudo code*: Planning a program
  - Informal (English) description of steps in an algorithm
  - Example: Cake baking recipe
- *Control flow*
  - Detailed execution order of steps in the program
- *Program*: Instructions for the computer
  - Formal description in programming language
    - Statements (steps, actions)
    - Control structures (flow of control)

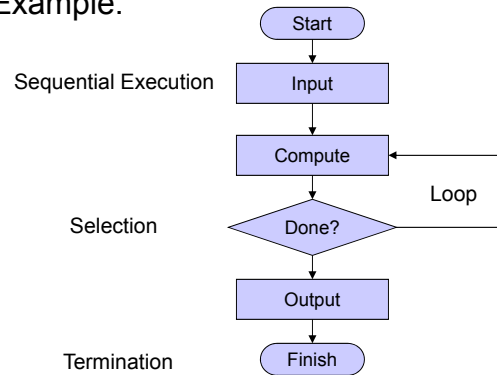
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## Structured Programming

- Control Flow Chart
  - Graphical representation of program control flow
  - Example:



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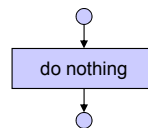
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## Structured Programming

- Empty statement blocks
    - empty compound statement
    - does nothing (no operation, no-op)
    - Example:
- Flow chart:

```
{
  /* nothing */
}
```



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## Structured Programming

- Sequential execution in C
  - Statement blocks: *Compound statements*
  - Sequence of statements grouped by braces: { }
- Example:

```
{
  /* statement 1 */

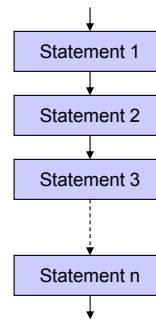
  /* statement 2 */

  /* statement 3 */

  /* ... */

  /* statement n */
}
```

Flow chart:



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## Structured Programming

- Sequential execution in C
  - Statement blocks: *Compound statements*
  - Sequence of statements grouped by braces: { }
- *Indentation* increases readability of the code
  - proper indentation is highly recommended!
- Example:

```
/* some statements... */
if (x < 0) {
  printf("%d is negative!", x);
  /* handle negative values of x... */
  if (x < -100) {
    printf("%d is too small!", x);
    /* handle the problem... */
  } /* fi */
} /* fi */
if (x > 0) {
  printf("%d is positive!", x);
  /* handle positive values of x... */
} /* fi */
/* more statements... */
```

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## Structured Programming

- Sequential execution in C
  - Statement blocks: *Compound statements*
  - Sequence of statements grouped by braces: { }
- *Indentation* increases readability of the code
  - proper indentation is highly recommended!

• Example:

```

/* some statements... */
indentation level 0 if (x < 0) {
    printf("%d is negative!", x);
    indentation level 1 → /* handle negative values of x... */
    if (x < -100) {
        printf("%d is too small!", x);
        indentation level 2 → → /* handle the problem... */
    } /* fi */
    indentation level 1 → } /* fi */
indentation level 0 if (x > 0) {
    printf("%d is positive!", x);
    indentation level 1 → /* handle positive values of x... */
    } /* fi */
indentation level 0 /* more statements... */
  
```

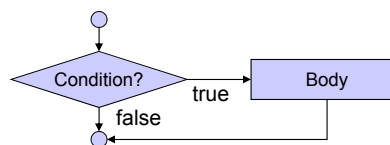
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## Structured Programming

- Selection: **if** statement
  - Flow chart:



- Example:

```

if (grade >= 60)
{ printf("You passed.");
} /* fi */
  
```

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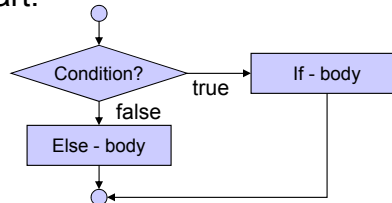
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## Structured Programming

- Selection: **if-else** statement

– Flow chart:



– Example:

```

if (grade >= 60)
{ printf("You passed.");
} /* fi */
else
{ printf("You failed.");
} /* esle */
  
```

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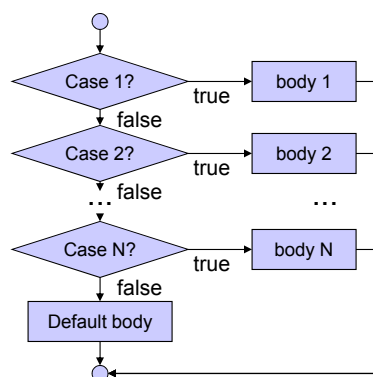
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## Structured Programming

- Selection: **switch** statement

– Flow chart:



Example:

```

switch(LetterGrade)
{ case 'A':
  { printf("Excellent!");
    break; }
  case 'B':
  case 'C':
  case 'D':
  { printf("Passed.");
    break; }
  case 'F':
  { printf("Failed!");
    break; }
  default:
  { printf("Invalid grade!");
    break; }
} /* hctiws */
  
```

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## Structured Program Composition

- Initial flow chart
  - Start
  - Program body
  - Finish
- Statement sequences
  - Statement blocks can be concatenated
  - Sequential execution
- Nested control structures
  - control structures can be placed wherever statement blocks can be placed in the code

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## Structured Program Composition

- Example:
  - Initial flow chart

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## Structured Program Composition

- Example:
  - Sequential composition

```

graph TD
  Start([Start]) --> P1[ ]
  P1 --> P2[ ]
  P2 --> End([End])
  subgraph Box [ ]
    P1
    P2
  end
  
```

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## Structured Program Composition

- Example:
  - insertion of another sequential statement

```

graph TD
  Start([Start]) --> P1[ ]
  P1 --> P2[ ]
  P2 --> P3[ ]
  P3 --> End([End])
  subgraph Box [ ]
    P1
    P2
  end
  
```

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## Structured Program Composition

- Example:
  - insertion of **if - else** statement

The flowchart shows a sequence of operations starting from a start node (oval), followed by a process node (rectangle), then a decision node (diamond). A dashed box encloses the decision node and a process node to its right. An arrow from the decision node points to the process node, and another arrow from the process node loops back to the decision node, representing an if-else loop. Below the dashed box is another process node, followed by a final end node (oval).

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## Structured Program Composition

- Example:
  - insertion of **sequential** statement

The flowchart shows a sequence of operations starting from a start node (oval), followed by a process node (rectangle), then a decision node (diamond). A dashed box encloses two process nodes stacked vertically to the right of the decision node. An arrow from the decision node points to the top process node, and another arrow from the bottom process node loops back to the decision node, representing a sequential loop. Below the dashed box is another process node, followed by a final end node (oval).

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## Structured Program Composition

- Example:
  - insertion of **if - else** statement

The flowchart shows a sequence of operations starting from a start node (oval), followed by a process node (rectangle), a decision node (diamond), and another process node. A dashed box highlights a section where a decision node is inserted. This decision node has two paths: one leading to a process node and another leading to another process node. Both paths then merge back into the main flow before the final process node and end node (oval).

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## Structured Program Composition

- Example:
  - insertion of **sequential** statement

The flowchart shows a sequence of operations starting from a start node (oval), followed by a process node, a decision node, and another process node. A dashed box highlights a section where a sequential block of two process nodes is inserted. The flow enters the dashed box from the top, passes through the two process nodes in sequence, and then exits to merge back into the main flow before the final process node and end node (oval).

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## Structured Program Composition

- Example:
  - insertion of sequential statement (twice)

The flowchart shows a sequence of operations starting from a start node (oval). It proceeds through a process box, a decision diamond, another process box, and a third decision diamond. From the second decision diamond, the flow branches into two parallel paths, each containing a process box. These paths then merge back into a single path that goes through a final process box and ends at a stop node (oval). A dashed box highlights the two parallel paths, indicating the insertion of sequential statements.

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## Structured Program Composition

- Example:
  - insertion of **switch** statement
  - etc. ...

The flowchart shows a sequence of operations starting from a start node (oval). It proceeds through a process box, a decision diamond, another process box, and a third decision diamond. From the second decision diamond, the flow branches into two parallel paths, each containing a process box. These paths then merge back into a single path that goes through a final process box and ends at a stop node (oval). A dashed box highlights a section of the flowchart where a single decision diamond branches into three parallel paths, each containing a process box, before merging back into a single path. This represents the insertion of a switch statement.

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## Example Program

- Grade calculation: `Grade.c` (part 1/3)

```

/* Grade.c: convert score into letter grade */
/* author: Rainer Doemer */
/* modifications: */
/* 10/17/04 RD initial version */

#include <stdio.h>

/* main function */
int main(void)
{
    /* variable definitions */
    int score = 0;
    char grade;

    /* input section */
    while (score < 1 || score > 100)
    { printf("Please enter your score (1-100): ");
      scanf("%d", &score);
    } /* elihw */

    ...

```

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## Example Program

- Grade calculation: `Grade.c` (part 2/3)

```

...
/* computation section */
if (score >= 90)
{ grade = 'A'; }
else
{ if (score >= 80)
  { grade = 'B'; }
  else
  { if (score >= 70)
    { grade = 'C'; }
    else
    { if (score >= 60)
      { grade = 'D'; }
      else
      { grade = 'F'; }
    } /* esle */
  } /* esle */
} /* esle */
...

```

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## Example Program

- Grade calculation: `Grade.c` (part 3/3)

```
...  
  
/* output section */  
printf("Your letter grade is %c.\n", grade);  
  
/* exit */  
return 0;  
} /* end of main */  
  
/* EOF */
```

## Example Program

- Example session: `Grade.c`

```
% vi Grade.c  
% gcc Grade.c -o Grade -Wall -ansi  
% Grade  
Please enter your score (1-100): 111  
Please enter your score (1-100): 99  
Your letter grade is A.  
% Grade  
Please enter your score (1-100): 85  
Your letter grade is B.  
% Grade  
Please enter your score (1-100): 71  
Your letter grade is C.  
% Grade  
Please enter your score (1-100): 69  
Your letter grade is D.  
% Grade  
Please enter your score (1-100): 55  
Your letter grade is F.  
%
```

## Example Program

- Grade calculation: `Grade2.c` (part 1/3)

```

/* Grade2.c: convert score into letter grade */
/* author: Rainer Doemer */
/* modifications: */
/* 10/18/04 RD use 'switch' statement */
/* 10/17/04 RD initial version */

#include <stdio.h>

/* main function */

int main(void)
{
    /* variable definitions */
    int score = 0;
    char grade;

    /* input section */
    while (score < 1 || score > 100)
    { printf("Please enter your score (1-100): ");
      scanf("%d", &score);
    } /* elihw */

```

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## Example Program

- Grade calculation: `Grade2.c` (part 2/3)

```

.../* computation section */
switch (score / 10)
{ case 10:
  case 9:
    { grade = 'A';
      break; }
  case 8:
    { grade = 'B';
      break; }
  case 7:
    { grade = 'C';
      break; }
  case 6:
    { grade = 'D';
      break; }
  default:
    { grade = 'F';
      break; }
} /* hctiws */

```

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## Example Program

- Grade calculation: `Grade2.c` (part 3/3)

```
...  
  
/* output section */  
printf("Your letter grade is %c.\n", grade);  
  
/* exit */  
return 0;  
} /* end of main */  
  
/* EOF */
```

## Example Program

- Example session: `Grade2.c`

```
% cp Grade.c Grade2.c  
% vi Grade2.c  
% gcc Grade2.c -o Grade2 -Wall -ansi  
% Grade2  
Please enter your score (1-100): 111  
Please enter your score (1-100): 99  
Your letter grade is A.  
% Grade2  
Please enter your score (1-100): 85  
Your letter grade is B.  
% Grade2  
Please enter your score (1-100): 71  
Your letter grade is C.  
% Grade2  
Please enter your score (1-100): 69  
Your letter grade is D.  
% Grade2  
Please enter your score (1-100): 55  
Your letter grade is F.  
%
```