Computer Aided Design (CAD)

Lecture 6

- Conditional Statements
- Loop Statements

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Schedule (Draft)

Topics	Estimated Duration (# Lectures)
Introduction	1
Introduction to Matlab Environment	1
Matlab Programing (m-files) (1)	5 (4/5)
Modeling using Matlab Simulink Tool	4
Communication Systems Simulation (Applications)	3
Midterm	8th Week
Introduction to FPGA + Review on Digital Logic/Circuits	2
VHDL Modeling Language	4
VHDL Application	2
Introduction to OPNET Network Simulator	3
Course Closeout / Feedback/ project (s) Delivery	1

The Lecture is based on :

A. **Matlab by Example: Programming Basics, Munther Gdeisat**

6 Conditional Statements in Matlab

Lesson 6.1 The Construction of an `if` Statement

The syntax for an `if` statement is

```
if (expression)
   commands are evaluated if expression is true
end
```

Example 2

Find the value of `r` in the program

```
x = 1
r = 1
if(x > 0)
        r = 2
end
```

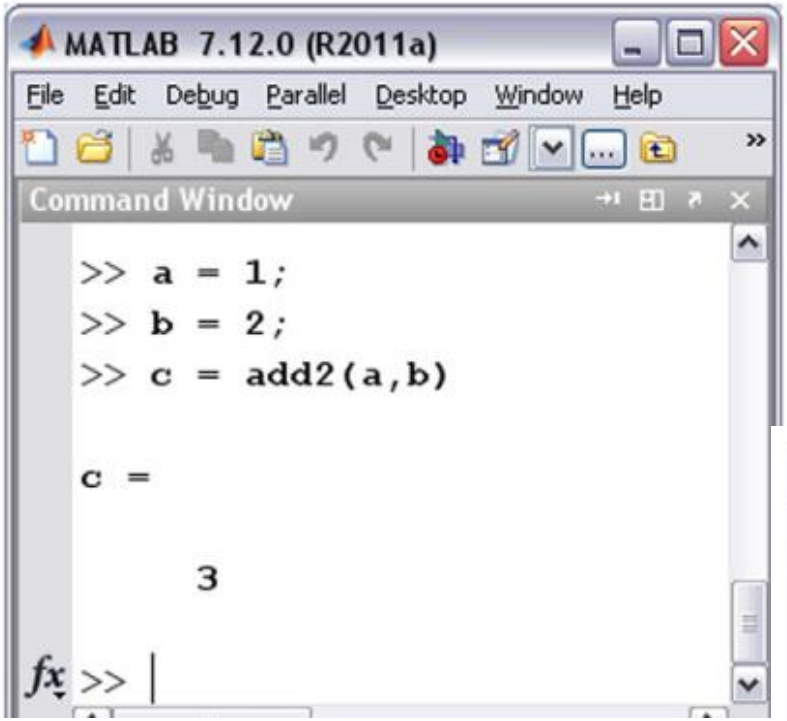
Example 3

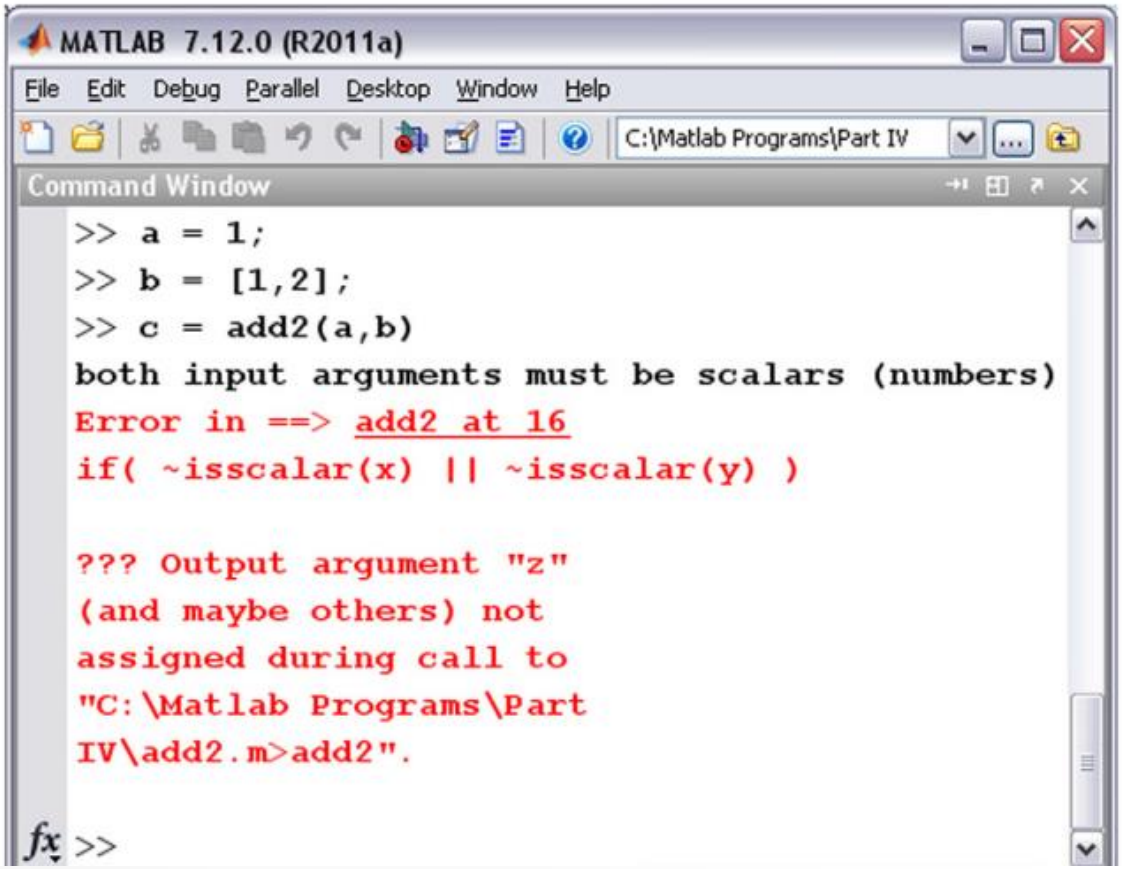
Find the values of `r` and `b` in the program

```
x = 1;
y = -4;
r = 1;
b = 0
if (x > 0 & y  < 3)
      r  = 3;
      b  =  b - 1;
end
```

- Write a function that has two arguments and returns a value which is equal to the addition of both arguments.
- This function checks whether both arguments are scalars.
  - If both arguments are scalars, the function performs the addition;
  - Otherwise, it displays a warning message and returns without attempting to perform the addition.

```
function z = add2(x,y)
%This function adds "x" to "y" and returns their addition
%This example shows how to use this function
%a = 1;
%b = 2;
%c = add2(a,b);
%This function returns "3" which is a result of adding "1" and "2"
%This function was written by Dr. Munther Gdeisat on 25/10/2011
%ensure that the both input arguments are scalars (numbers)
if(~isscalar(x) || ~isscalar(y))
  disp('both input arguments must be scalars (numbers)')
  return
end
z = x + y;
end
```


MATLAB 7.12.0 (R2011a)
File Edit Debug Parallel Desktop Window Help
Command Window
>> a = 1;
>> b = 2;
>> c = add2(a,b)
c =
3
>>


MATLAB 7.12.0 (R2011a)
File Edit Debug Parallel Desktop Window Help
C:\Matlab Programs\Part IV
Command Window
>> a = 1;
>> b = [1,2];
>> c = add2(a,b)
both input arguments must be scalars (numbers)
Error in ==> add2 at 16
if(~isscalar(x) || ~isscalar(y))
??? Output argument "z"
(and maybe others) not
assigned during call to
"C:\Matlab Programs\Part
IV\add2.m>add2".
>>

Lesson 6.2 The Construction of an `if else` Statement

The syntax for the Matlab `if else` statement is

```
if (expression)
        commands are evaluated if expression is true
else
        commands are evaluated if expression is false
end
```

Example 1

Find the value of `r` in the program

```
x = 1;
r = 1;
if (x > 0)
  r = 2;
else
  r = 3;
end
```

Example 2

Find the value of `r` in the program

```
x = 1;
r = 1;
if (x > 3)
  r = 2;
else
  r = 3;
end
```

Example 4

Find the value of r in the program

```
a = 1;
b = 2;
r = 0;
if (a > 0)
  if (b > 10)
    r = 1;
  end
  r = 2;
else
  r = 3;
end
```

This sets the value of r to 2.

Example 5

Find the value of r in the program

```
a = 1;
b = 2;
r = 0;
if (a > 0)
  if (b > 10)
    r = 1;
  else
    r = 2;
  end
  r = 3;
end
```

The value of r is now 3.

Lesson 6.4 The Construction of an `if elseif else` Statement

The syntax for the Matlab `if elseif else` statement is

```
if (expression 1)
        commands are evaluated if expression 1 is true. Then jump to end.
elseif (expression 2)
        commands are evaluated if expression 2 is true. Then jump to end.
             :
elseif (expression n)
        commands are evaluated if expression n is true. Then jump to end.
else
        commands are evaluated if all the expressions 1, 2,...n are false.
end
```

Lesson 6.4 The Construction of an `if elseif else` Statement

Example 1

Find the value of `r` in the program

```
x = 1;
y = 3;
r = 1;
if (x > 0)
   r = 2;
elseif (y < -2)
   r = 3;
else
   r = 4;
end
```

Example 2

Find the value of `r` in the program

```
x = 1;
y = -3;
r = 1;
if (x > 0)
   r = 2;
elseif (y< -2)
   r = 3;
else
   r = 4;
end
```

Note that even though the condition y <-2 is true here, the command r =3 is not executed

Quiz

Write a Matlab function that has two input arguments and returns two values. This function swaps the values of its input arguments. Name this function `swap()`.

Write a Matlab function that has one input argument and returns one value. Name this function `change_it()`. This function operates as follows:

- If the value of the input argument is greater than 0, the function returns the value 10.
- If the value of the input argument is less than or equal to 0, the function returns the value of the input argument.

- **Allowed Time: 10 Minutes**
- **Readability is an important evaluation function**

Lesson 6.5 The Construction of a `switch case` Statement

The syntax for a `switch case` statement is

```
switch (expression)
        case {expression 1}
                commands 1 are evaluated if expression 1 is true. Then jump to end.
        case {expression 2}
                commands 2 are evaluated if expression 2 is true. Then jump to end.
                :
                :
                :
        case {expression n}
                commands n are evaluated if expression n is true. Then jump to end.
        otherwise
                commands are evaluated if all the expressions 1, 2,...n are false.
end
```

The term expression here must be either an integer scalar or a string character.

Example 1

Write a Matlab program to convert a distance with units of either kilometers, meters, centimeters, or millimeters into meters.

Suppose that we could like to convert 10 centimeters to meters.

```
x = 10;
units = 'cm';
switch (units)
  case {'km'}
    y = 1000 * x
  case {'m'}
    y = x
  case {'cm'}
    y = x / 100
  case {'mm'}
    y = x / 1000
  otherwise
    disp(['Unknown Units: ', units])
end
```

According to the variable “units”, different conversion is performed

Note: conversion laws is wrong in the reference

Example 2

The code in Example 1 can be modified as follows

Answer

```
x = 10;
   units = 'cm';
   switch (units)
     case {'km', 'kilometer'}
       y = 1000 * x;
     case {'m', 'meter'}
       y = x;
     case {'cm', 'centimeter'}
       y = x / 100;
     case {'mm', 'millimeter'}
       y = x / 1000;
     otherwise
       disp(['Unknown Units: ', units])
   end
   y
```

7 Loop Statements in Matlab

Lesson 7.1 The Construction of a for Loop Statement

- This keyword is used to run a piece of code for a specific number of times

The syntax of a `for` statement is

```
for iterationVariable = initial value: increment: final value
   commands
end
```

$$\text{The number of iterations for the for loop} = \left\lfloor \frac{\text{final value} - \text{initial value}}{\text{increment}} \right\rfloor + 1$$

where $\lfloor \cdot \rfloor$ rounds down a real number toward the nearest lower integer.

- The loop stops executing the commands when the value of the iteration Variable is greater than or equal to the final value.

Examples

In the following program

```
f(1) = 0;
f(2) = 1;
for iNo = 3:1:7
    f(iNo) = f(iNo-1) + f(iNo-2);
end
```

Example 4

In the following program

```
f(1) = 0;
f(2) = 1;
for iNo = 3:7
    f(iNo) = f(iNo-1) + f(iNo-2);
end
```

The default increment for the iteration variable is 1.

the iteration variable is `iNo`.

The initial value for the iteration variable is 3.

The increment for the iteration variable is 1.

The final value for the iteration variable is 7.

The command in the `for` statement is `f(iNo) = f(iNo-1) + f(iNo-2);`

The number of iterations for the `for` loop $= \left\lfloor \frac{7-3}{1} \right\rfloor + 1 = 5$.

The values of `iNo` are 3, 4, 5, 6, and 7.

Examples

Example 5

In the following program

```
x = 1;
for ix = 0:2:10
    x = 0.9 * x;
end
```

The iteration variable is `ix`.
The initial value for the iteration variable is 0.
The increment for the iteration variable is 2.
The final value for the iteration variable is 10.

The command in the `for` statement is `x = 0.9 * x;`
The number of iterations for the `for` loop $= \left\lfloor \frac{10-0}{2} \right\rfloor + 1 = 6$.
The values of `ix` are 0, 2, 4, 6, 8, and 10.

Examples

Example 6

In the following program

```
x = 1;
for ix = 1:2:10
    x = 0.9 * x;
end
```

The iteration variable is `ix`.
The initial value for the iteration variable is 1.
The increment for the iteration variable is 2.
The final value for the iteration variable is 10.
The command in the `for` statement is `x = 0.9 * x;`
The number of iterations for the `for` loop $= \left\lfloor \frac{10-1}{2} \right\rfloor + 1 = 4 + 1 = 5.$
The values of `ix` are 1, 3, 5, 7, and 9.

Examples

Example 8

In the following program

```
x = 1;
for ix = 1:2:-3
    x = 0.9 * x
end
```

The iteration variable is `ix`.
The initial value for the iteration variable is 1.
The increment for the iteration variable is 2.
The final value for the iteration variable is -3.
The command in the `for` statement is `x = 0.9 * x;`
The number of iterations for the `for` loop $= \left|\frac{-3-1}{2}\right| + 1 = -2 + 1 = -1.$

Matlab will not execute the commands inside the loop since the number of iterations is negative.

Example 12

Write a Matlab program to calculate the factorial of an integer number n. The factorial of a number n is defined as

$$n! = n \times (n-1) \times (n-2) \times (n-3). \ldots \ldots \ldots \ldots (3) \times (2) \times (1)$$

The factorial of the number 1 is 1 by definition.
The factorial of 2 is $2 \times 1 = 2$.
The factorial of 3 is $3 \times 2 \times 1 = 6$ and so on.
The factorial 4 is $4 \times 3 \times 2 \times 1 = 24$ and so on.

Answer

This program calculates the factorial of the number $n = 4$.

```
%This program calculates the factorial of n
n = 4;
%calculate the factorial of n
factorial_of_n = 1;
for in = 2:n
    factorial_of_n = factorial_of_n * in;
end
```

7.1.3 The Construction of a Nested `for` Statement

The syntax of a `for` statement is

```
for iterationVariable1 = initial value1: increment1: final value1
  for iterationVariable2 = initial value2: increment2: final value2
    commands
  end
end
```

Example 19

Write a Matlab program to calculate the summation of an array. Your program should be able to calculate the summation of the array irrespective of its dimensions. The summation of the array is given by the following equation:

$$\text{summation} = \sum_{i=1}^{m}\sum_{j=1}^{n} V(i,j)$$

where m represents the number of rows in the array and n represents the number of columns in the array.

```
V = [1, 3, 6; 4, 9 10];
m = size(V,1);
n = size(V,2);
summation = 0;
for i = 1:m
  for j = 1:n
    summation = summation + V(i,j);
  end
end
```

Check time on matlab

7.2.2 The `continue` Keyword

- The continue keyword passes control to the next iteration of the for loop in which it appears, skipping any remaining statements in the body of the for loop.

Example 5

Write a Matlab program to calculate y according to the equation

$$y = \sum_{k=-10}^{10} \frac{1}{k^2 + 2k} \quad \text{where } k \text{ is an integer and } k \neq 0, -2$$

Answer

The following program calculates y according to the preceding equation.

```
y = 0;
for k = -10:10;
  if k == 0 || k == -2
    continue
  end
  y = y + 1 /(k^2 + 2*k);
end
```

7.2.3 The break Keyword

- The break keyword terminates the execution of for loop.
- In nested loops, break exits from the innermost loop only.

Example 7

Write a Matlab program to produce the numbers of a Fibonacci series whose values are less than 100.

```
f(1)=0;
f(2)=1;
for i=3:10000
  c=f(i-1)+f(i-2);
  if c>=100
    break
  end
  f(i)=c;
end
```

Lesson 7.3 The Construction of a `while` Loop

The syntax of a `while` loop statement is

```
while (statement)
   commands
end
```

- Matlab executes the commands inside the while loop as long as statement remains true.

Example 1

Find the value of `r` that is produced by the following program:

```
r = 2;
while (r<10)
    r = 2*r;
end
```

Iteration	r
1	4
2	8
3	16

- With r = 16 (on the third iteration), the statement (r <10) is now false.
- Matlab therefore terminates the while loop.
- The command r = 2*r in the loop body is therefore not evaluated and the final value of r remains at 16.

- The continue keyword passes control to the next iteration of the while loop in which it appears, thereby skipping any remaining statements in the body of the while loop.

Example 2

Find the value of r that is produced by the following program:

```
r = 2;
while (r<10)
  if (r == 8)
    r = r - 1
    continue
  end
  r = 2*r
end
```

Iteration	r
1	4
2	8
3	7
4	14

- When the statement (r == 8) is true, the two commands in the body of the if statement are now evaluated.
- The command r = r-1 is therefore evaluated. The new value of r is 7.
- Matlab then executes the continue command, passes control to the next iteration of the while loop, and skips the remaining commands in the body of the while loop.

- The break keyword terminates the execution of the while loop. In nested loops, break exits from the innermost loop only.

Example 3

Find the value of r that is produced by the following program:

```
r = 2;
while (r<10)
  if (r == 8)
    r = r - 1
    break
  end
  r = 2*r
end
```

Iteration	r
1	4
2	8
3	7

- When the statement (r == 8) is now true, the two commands in the body of the if statement are evaluated.
- The command r = r-1 is therefore evaluated, The new value of r is 7.
- Matlab then executes the break command, and terminates the execution of while loop.

Example 4

Write a Matlab program to produce the numbers of a Fibonacci series whose values are less than 100.

Answer

The following program produces the numbers of a Fibonacci series whose values are less than 100.

```
f(1)=0;
f(2)=1;
counter=3;
while( ( f(counter-1)+f(counter-2) )<100)
  f(counter)=f(counter-1)+f(counter-2);
  counter=counter+1;
end
```