

Family Name: _____

Given Names: _____

Student Number: _____

Signature: _____

B

The University of New South Wales

SAMPLE Final Examination

Semester 2, 2017

ENGG1811 Computing for Engineers

Time allowed: **2 hours**

Reading time: **10 minutes**

Total number of questions: **29, in 3 Sections**

Total number of marks: **100**

No examination materials permitted

Calculators may **not** be used

Questions are **not** worth equal marks

Answer **all** questions

Tables of Matlab and OpenOffice Basic functions and operators are included

This paper may **not** be retained by the candidate

Answers must be written in ink. Except where they are expressly required, pencils may be used only for drawing, sketching or graphical work.

Section A: Multiple Choice Questions

Answer the questions in this section on the answer sheet provided, NOT on this paper.

Each question has four alternatives. Once you have chosen an alternative, fill in the selected letter (e.g., "B") against the question number on the multiple-choice sheet. Be careful that you fill each answer in on the correct row of the multiple-choice sheet, and erase any stray marks.

This section is worth 30 marks and contains 24 questions. Each question is worth 1.25 marks. There is no additional penalty for answering a question incorrectly. It is recommended that you spend no more than 30 minutes on this section.

A1. Suppose that in an OpenOffice Calc spreadsheet cells A1, B1 and C1 contain the values 2, 3, and 4 respectively. What value will be displayed in a cell containing the formula

`=(A1+C$1)/$A$1+B1`

- A) 2
- B) 4
- C) 6
- D) the formula is invalid

A2. Which of the following is not a valid formula when typed into the cell L5 in an OpenOffice Calc worksheet?

- A) `=AVERAGE(D6:D11)`
- B) `=AVERAGE(A$1:B4; D2:$E$5)`
- C) `=AVERAGE(A2:10D)`
- D) `=AVERAGE(A2)`

A3. Suppose that in an OpenOffice Calc spreadsheet, cell B2 contains the value 115, and cell C2 contains the value 34. What value will be displayed in a cell containing the following formula?

`=IF(AND(B2<0;C2>100);"Error"; IF(B2<50;"Fail";"Pass"))`

- A) Error
- B) Fail
- C) Pass
- D) none of the above

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A4. Consider the following portion of an OpenOffice Calc worksheet.

	A	B	C	D	E	F
1	10	5	2	4		
2	8	2	1	9		
3	6	8	7	5		
4	2	4	6	2	9	
5						
6						
7						

Suppose that cell E4 contains the formula $=\$B2+C\3 and that this cell is now copied to cell D5. What value will be shown in cell D5?

- A) 9
- B) 10
- C) 14
- D) 16

A5. Consider the following portion of an OpenOffice Calc worksheet.

	A	B	C	D
1		42	Hot	
2		18		
3		22		
4		39		
5		10		

Suppose that cell C1 contains the formula $=IF(\$B\$1>35;"Hot";"Cool")$ and that this cell is now copied to cell C2. What value will be shown in cell C2?

- A) Hot
- B) Cool
- C) Error
- D) None of the above

A6. In OpenOffice Calc, the Correlation tool can be used to:

- A) calculate the strength of linear relationship between two or more variables
- B) calculate a frequency distribution
- C) display Trendlines
- D) calculate an optimal solution

A7. Suppose that you want to use the Solver tool in OpenOffice Calc to solve an optimisation problem. For the optimisation problem, you are given a number of locations and the decision variables are the number of sensors to be placed at each location. The objective is to minimise the sensor placement cost. Which of the following is the most appropriate option to use?

- A) Assume variables as integer
- B) Assume variables as non-negative
- C) Both of A) and B)
- D) None of A) and B)

A8. Which one of the following statements about names in Calc is true?

- A) Names can only be applied to a single cell
- B) Names can only be used on the sheet where they are defined
- C) Names used in formulas must be quoted
- D) Names such as A1 are invalid because they look like cell addresses

A9. What are the values of x and y after this **while** loop terminates? x and y are variables of type **Integer**.

```
x = 0: y = 0
While x < 5
    x = x + 1
    y = x + y
Wend
```

- A) $x = 4, y = 10$
- B) $x = 5, y = 10$
- C) $x = 5, y = 15$
- D) $x = 6, y = 21$

A10. If blnA and blnB are Boolean variables, which expression is equivalent to

$\text{Not} (\text{blnA Or Not blnB})$

- A) $\text{Not blnA Or Not blnB}$
- B) Not blnA Or blnB
- C) $\text{Not blnA And Not blnB}$
- D) Not blnA And blnB

A11. The following table lists the arithmetic operators used in OpenOffice Basic in decreasing order of precedence.

()
+ - (unary: sign)
^
* /
\
Mod
+ - (binary: add, subtract)

What is the value of this constant expression?

$$4 * 3 - -4^2$$

- A) 76
- B) 28
- C) -4
- D) -52

A12. Which of the following statements about the **Step** keyword in OpenOffice Basic is *false*?

- A) **Step** is only used with **For** statements.
- B) **Step** indicates how much a loop control variable changes at the end of each iteration.
- C) **Step** must have a positive step amount.
- D) If **Step** and the amount are omitted, the step amount is assumed to be one.

A13. If x is 25, what is the value of y after the following block of code has been executed?

```

If x > 40 Then
    y = 1
Elseif x < 30 Then
    y = 2
Elseif x > 20 Then
    y = 3
Elseif x < 10 Then
    y = 4
End If
    
```

- A) $y = 1$
- B) $y = 2$
- C) $y = 3$
- D) $y = 4$

A14. In the program below, what are the values of x and y displayed by the MsgBox command?

```

Sub A13
    Dim x As Integer
    Dim y As Integer
    Dim z As Integer

    x = 1
    y = 2
    z = ZFunc(x,y)

    MsgBox "x = " & x & "y = " & y

End Sub

Function ZFunc(ByVal xCopy As Integer,ByRef yCopy As Integer) As Integer

    xCopy = 3*xCopy
    yCopy = 4*yCopy
    ZFunc = xCopy + yCopy

End Function
    
```

- A) x = 1, y = 2
- B) x = 3, y = 2
- C) x = 1, y = 8
- D) x = 3, y = 8

A15. In the program below, what is the value of z at the end of the program?

```

Sub A15
    Dim x as Double
    Dim y as Integer
    Dim z as Variant

    x = 1.7
    y = 3.2

    z = x + y

    MsgBox "z = " & z

End Sub
    
```

- A) z = 4
- B) z = 4.7
- C) z = 5
- D) z = 5.9

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A16. Which of the following would not cause an error when used as an OpenOffice Basic identifier:

- A) 2Difficult
- B) Cat-Tail
- C) IAm18YearsYoung
- D) End

A17. Which of the following is equivalent to the Matlab expression `linspace(0,5,11)`?

- A) `0: 5/11: 5`
- B) `0: 0.5 : 5`
- C) `0: 5 : 0.5`
- D) `0: 0.5 : 11`

A18. Which Matlab statements do not produce the same result as the following:

`y = [1 , 2 , 3 ; 4 , 5 , 6];`

- A) `y = [[1,4]', [2,5]', [3 6]']`;
- B) `y = [[1,4]'; [2,5]'; [3 6]']`;
- C) `x1 = 1:3; x2 = 4:6; y = [x1 ; x2]`;
- D) `z = 1:6; y = [z(1:3) ; z(4:end)]`;

A19. Given a Matlab matrix `M` with 10 rows and 20 columns. You would like to extract a submatrix containing the 2nd, 4th, 6th, 8th and 10th rows of the `M`. Which of the following is *not* true:

- A) You can use `M(2:2:end,:)`
- B) You can use `M(2:2:length(M),:)`
- C) You can use `M(2:2:size(M,1),:)`
- D) You can use any of the expressions in the above three choices

A20. Given two Matlab vectors `v1` and `v2` that have the same dimension, the Matlab built-in function `dot(v1, v2)` forms the dot product of two vectors `v1` and `v2`, that is, the sum of the product of the corresponding elements

$$v1(1) * v2(1) + v1(2) * v2(2) + \dots + v1(N) * v2(N)$$

where `N` is the number of elements in each vector. Which of the following produces the same result as `s = dot(v1,v2)`?

- A) `s = sum(v1 * v2)`;
- B) `s = sum(v1 .* v2)`;
- C) `s = v1 \ v2`;
- D) `s = prod(v1 + v2)`;

- A21. Given a vector v . You want to obtain a sub-vector of v , which contains all the numbers in v that are less than U and greater than L . Which of the statements below can you use?
- A) `find((v < U) & (v > L));`
 - B) `v((v < U) && (v > L));`
 - C) `v(find((v < U) & (v > L)));`
 - D) `(v < U) && (v > L);`
- A22. Given a matrix M , you want to find the number of rows in M that have all zeros in the row. Which of the following Matlab statement allows you to do that?
- A) `sum(all(M,2));`
 - B) `sum(any(M,2));`
 - C) `size(M,1)-sum(all(M,2));`
 - D) `size(M,1)-sum(any(M,2));`
- A23. Given a vector v , which of the following Matlab statement can you use to find the smallest of all those numbers in v that are bigger than 5?
- A) `min(v > 5);`
 - B) `max(v(v > 5));`
 - C) `min(v(v > 5));`
 - D) `min(find(v > 5));`
- A24. The Matlab vector $v1$ has a dimension of n -by-1 and the vector $v2$ has a dimension of 1-by- n , which of the following is true?
- A) The operation `v1 * v2` does not return an error
 - B) The operation `v2 * v1` does not return an error
 - C) The operation `v1 .* v2` does not return an error
 - D) None of the above

Section B: OpenOffice Basic

Answer the questions in this section in the answer book provided.

This section contains **2 questions**. Answer **both** questions. Each question is worth 15 marks.

Question B1 (15 marks) *(This question is related to Assignment 1.)*

In Assignment 1, you were given a data series and a pattern, and the aim was to determine whether the pattern was found in the data series, and if yes, where the pattern was located. You did that by first computing a similarity measure between each segment of the data series and the pattern. After that, you scanned through the similarity measures to determine whether the pattern could be found and where it was.

The setting of this question is similar except that the task for this question is to write *a block of code* to determine the *value* of the **second largest** similarity measure.

You can assume the following in your code:

- The similarity measures are stored in a column whose index is given by a constant called `SIM_COL`
- The first similarity measure is stored in row `SIM_ROW_START` which is a defined constant
- The last similarity measure is stored in row `rowSimLast`
- There are at least two similarity measures in the column `SIM_COL`
- All the similarity measures in the column `SIM_COL` are distinct, i.e. no two similarity measures are equal.
- Note that the above assumptions together mean the second largest similarity measure **exists** and is **unique**.
- The value and row number of the largest similarity measure have been found. The value of the largest similarity measure is stored in a variable with the name `valueSimMax`. The row number at which the largest similarity measure is located is in the variable `rowSimMax`.

	A	B	C	D
1	Index	Data series		Similarity measures (Pattern 1)
2	1	-3.4		10
3	2	41.0		490
4	3	38.0		1210
5	4	22.0		2330
6	5	10.0		3320
7	6	18.0		2370
8	7	-4.0		1190
9	8	-2.0		
10	9	40.2		
11	10	40.4		
12	11	40.0		
13	12	30.8		
14	13	20.0		
15	14	10.9		
16				

```
SIM_COL = 4
SIM_ROW_START = 2
rowSimLast = 8
valueSimMax = 3320
rowSimMax = 6
```

Your subprogram should find `valueSecondMax`, in this example it would be 2370

You can use any of the above constants and variables in your block of code. You should define any additional constants and variables that you need in your program.

Note that you are only required to determine the **value** of the **second largest** similarity measure.

Your sub program may look like below. **Important:** DO NOT write your solution on this pink paper, write your solution in the answer booklet provided, along with the following lines.

```
'Given Constants
Const SIM_COL=4   'for column D
Const SIM_ROW_START=2

Sub findSecondLargestValue

    ' The question assumes that the following have been found
    Dim rowSimLast As Double    'Last row of data
    Dim rowSimMax As Double     'The row where the maximum is found
    Dim valueSimMax As Double   'The value of the maximum

    Dim valueSecondMax As Double 'Value of the second largest maximum

    ' START - Solution to the Question below
    ' you can assume that variables rowSimLast, rowSimMax and
    ' valueSimMax have been found

    ' ... your solution here to find value of valueSecondMax ...

End Sub
```

Question B2 (15 Marks)

Your task for this question is to write a function that classifies two given data points x and y . The function has the prototype

`Function ClassifyData(x As Double, y As Double) As String`

The function is required to perform the following:

1. Check that the data are valid. The data are valid if both x and y are (strictly) positive. If the data is invalid, then the function should return “Invalid data”. The function should only proceed to classification if the data are valid.
2. If the data are valid, then the function should classify the data into 3 classes. The function should return a string with the name of the class in which the data belong. The classification rules are:
 - a. The data belong to the class “Normal” if $x * y > 10$
 - b. The data belong to the class “Fault1” if they do not belong to “Normal” and $x > y$
 - c. The data belong to the class “Fault2” if they do not belong to “Normal” and $x \leq y$

You should define any constants and variables that you need in your program.

END OF SECTION B

Section C: Matlab

Answer the questions in this section in the answer book provided.

This section contains 3 questions. Answer all 3 questions. Questions C1 and C3 are worth 15 marks each. Question C2 is worth 10 marks.

Question C1 (15 Marks) *(This question is related to Assignment 2.)*

(a) In Assignment 2, you did a simulation with a time vector which is equally spaced. In general, it is possible to do simulation with a *non-equally spaced* time vector.

Assuming that you want to use simulation to determine the amount of bacteria. You are given a Matlab vector `vecTime`

$$\text{vecTime} = [\text{vecTime}(1), \text{vecTime}(2), \dots, \text{vecTime}(n)],$$

with n elements but the elements in `vecTime` are not equally spaced. You are also given a Matlab function `rate` that returns the rate of change in the amount of bacteria. For example, if you write

$$\text{rate}(\text{vecTime}(k))$$

in Matlab, the value returned by the function is the rate of change of the amount of bacteria at time `vecTime(k)`, i.e. the k -th element of the vector `vecTime`. Your aim is to use simulation to obtain the amount of bacteria at the time instances given in the vector `vecTime`. These amounts are to be stored in a Matlab vector called `vecAmount`. The initial amount of bacteria is in the Matlab variable `initAmount`. If you do not use iteration, these are the $(n-1)$ Matlab statements you would use to do this simulation

```
vecAmount(2) = vecAmount(1) + (vecTime(2) - vecTime(1)) * rate(vecTime(1));
vecAmount(3) = vecAmount (2) + (vecTime(3) - vecTime(2)) * rate(vecTime(2));
vecAmount(4) = vecAmount (3) + (vecTime(4) - vecTime(3)) * rate(vecTime(3));
% To be continued until
vecAmount(n)=vecAmount(n-1) + (vecTime(n) - vecTime(n-1))*rate(vecTime(n-1));
```

(To be continued on the next page.)

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Your task is to write a Matlab function `simulateBacteriaAmount` which takes two inputs

- The vector `vecTime`
- Initial amount of bacteria `initAmount`

And returns the vector `vecAmount` as its output.

(b) Given a vector `v`, you want to compute the value of `m1-m2` where

- `m1` is the largest value of `v`
- `m2` is the second largest value of `v`

Show how you can compute `m1-m2` using vectorisation in Matlab, i.e. loops must not be used. You can assume that all values in the vector `v` are distinct and finite.

Question C2 (10 Marks)

This question contains 2 parts: (a) and (b). Each part is worth 5 marks.

Each part of this question describes a task that you need to do in Matlab. Each task can be achieved **without** using any loops. You should provide the Matlab code and a short explanation of how you achieve the task. You must **not** use any loops in your answer.

- a) Given two vectors x and y which have the same dimension. Both x and y have length n . You want to compute the vector z , which has a length of $n-1$. The k -th element of z , i.e. $z(k)$, is given by

$$z(k) = (x(k)^2 + y(k)) / (x(k+1)^2 + y(k+1)) \text{ where } k = 1, 2, \dots, n-1$$

Show how you can obtain z from x and y .

- b) Given

- A vector w ,
- 2 scalars L and U such that $U > L$
- A scalar M

You want to obtain a vector v that has the same dimension as w , such that the k -th element of v and the k -element of w are related by:

- $v(k) = 0$ if $w(k) \leq L$
- $v(k) = M$ if $w(k) \geq U$
- $v(k) = w(k)$ otherwise

Show how you can compute vector v from vector w .

Question C3 (15 Marks)

You have got some data stored in a Matlab matrix M . You also have a Matlab function `isPropertySatisfied` which determines whether a row of data in the matrix M satisfies a certain property or not. For example, if you want to determine whether the k -th row of the matrix M satisfies the property or not, you write:

```
boo = isPropertySatisfied(M(k,:));
```

The variable `boo` has a value `1` if the k -th row of M satisfies the property, otherwise `boo` has a value `0`. You can use this function in your answer.

Your task is to write a Matlab function to determine the **last two** occurrences in the matrix M that satisfies the property. The following examples illustrates what the expected outcomes are:

1. Assuming only rows 1, 5, 8, 21, 27 and 35 of matrix M satisfy the property, then the last two occurrences are rows 27 and 35. The function should return a row vector with 2 elements containing [35 27]. Note that the first element of the output vector should contain the last occurrence and the second element of the output vector should contain the second last occurrence.
2. Assuming only rows 7 and 21 of matrix M satisfy the property, then the expected output of the function should be [21 7].
3. Assuming there is only one row in the matrix M satisfying the property and it is located at row 5. The function should return a scalar (or a vector with only one element) containing that row number. In this case, the expected output is [5].
4. If none of the rows in M satisfies the property, then the function should return an empty vector [].

The function should have the declaration

```
function rowsWithProperty = findLastTwoOccurrences(M)
```

As a simplification, you do not need to consider error checks on M and you can assume that M is not empty and M contains many rows (far more than 2) of data. There are many methods to implement this function. Some methods are **efficient** in that they stop processing once the last two occurrences are found. Some methods are **inefficient** in that they find all the occurrences in the matrix M first and then determine the output. You can only get full marks for this question if you use an **efficient** method. The maximum mark that you can earn by using an **inefficient** method is 60% of full marks.

Note that if only 0 or 1 row in the matrix M satisfies the property, then there are no differences between efficient and inefficient methods. Efficiency can only be observed when there are 2 or more occurrences of the property in the rows of M .

END OF SECTION C

Selected Matlab Operators and Symbols

Matrix operators: * / \	Colon range: min : incr : max
Array operators: .* ./ .\ .^	Literal strings: 'text'
Transpose (suffix): '	Line continuation: ...
Array construction: []	Equal, not equal: == ~=
Row separator: ;	Boolean and, or, not: && ~
Element separator: , or space	Comment: %
Output suppression: ; (after command)	

Matlab Control Structures

<pre>if booleanexpr statements end</pre>	<pre>if booleanexpr statements else statements end</pre>	<pre>if booleanexpr statements elseif booleanexpr statements ... else statements end</pre>
<pre>while booleanexpr statements end</pre>	<pre>for variable = vector statements end</pre>	

Selected Matlab Functions

All accept arrays except where noted.

size(array)	Maximum extent of each dimension
length(array)	(scalar) equivalent to max(size(array))
disp([strings])	Display on command window
fprintf([format, values])	Formatted display
abs(v), exp(v), log(v), sqrt(v), floor(v), mod(a,b)	Mathematical: absolute value, e ^v , ln v, √, round down to integer, remainder from a/b.
sum(v), max(v), min(v), mean(v), median(v)	Aggregation, array to scalar
sin(v), cos(v), tan(v)	Trigonometry
linspace(start,finish,pts)	Equally spaced values
inv(m), det(m)	Matrix inverse, determinant
isempty(v), isnumeric(v)	Boolean tests

Table of OpenOffice Functions

Function call	Returns...
Int(num)	Largest integer \leq num
Fix(num)	num with fraction removed (truncates towards zero)
Abs(num)	Absolute value of num (same type)
Val(str)	Numeric data in str converted to Double
Round(val, dp)	val rounded to dp decimal places (Double)
CStr(num)	num as a string
CInt(arg)	arg (number or string) as an integer, fraction truncated
Sqr(num), Exp(num), Log(num)	Mathematical functions
Sin(a), Cos(a), Tan(a)	Trigonometric functions
Atn(r)	Arctangent of r (returns radians)
IsNumeric(v)	True if v can be interpreted as a number (or the empty string)
Rnd()	Next pseudo-random number between 0 and 1 (excluding 1)
WorksheetFunction.func(...)	Function func as used in Excel formulas

Selected OpenOffice Calc Basic Object (VBA Compatible)

Object	Refers to...
ActiveCell	The active cell, unique
ActiveSheet.Cells(row, col)	Cell at given row and column
ActiveSheet.Range(str)	Cell or range with address or name str
ActiveSheet.Rows(row)	Complete row
ActiveSheet.Columns(col)	Complete column

Note: row, col and str are just example variable names.

Control structure

```
While booleanexpr
  statements
Wend
```

```
For variable = num1 To num2 Step num3
  statements
Next variable
```

```
If booleanexpr Then
  statements
Elseif booleanexpr Then
  statements
Else
  statements
End If
```

END OF PAPER