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**B**

The University of New South Wales

**SAMPLE** Final Examination

**Semester 1, 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.

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- 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  $\text{blnA}$  and  $\text{blnB}$  are Boolean variables, which expression is equivalent to

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

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

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

( )
+ - (unary: sign)
^
* /
\
<b>Mod</b>
+ - (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 2<sup>nd</sup>, 4<sup>th</sup>, 6<sup>th</sup>, 8<sup>th</sup> and 10<sup>th</sup> 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.)*

One learning object for Assignment 1 is that you can use a sub or function to do similar calculations. In this question, you will write a sub to do two similar tasks.

You can assume that you are given a worksheet where Column 1 is filled with data in Rows 1-12, as shown in the figure below.

	A	B	C
1	1		
2	2		
3	3		
4	4		
5	5		
6	6		
7	7		
8	8		
9	9		
10	10		
11	11		
12	12		
13			

You want to perform two different sets of calculations. In the first set of calculations, you want to calculate 6 averages and each average is computed from 2 numbers:

- Calculate the average of A1 and A7 and put the answer in B1
- Calculate the average of A2 and A8 and put the answer in B2
- Calculate the average of A3 and A9 and put the answer in B3
- Calculate the average of A4 and A10 and put the answer in B4
- Calculate the average of A5 and A11 and put the answer in B5
- Calculate the average of A6 and A12 and put the answer in B6

In the second set of calculations, you want to calculate 4 averages and each average is computed from 3 numbers:

- Calculate the average of A1, A5 and A9, and put the answer in C1
- Calculate the average of A2, A6 and A10, and put the answer in C2
- Calculate the average of A3, A7 and A11, and put the answer in C3
- Calculate the average of A4, A8 and A12, and put the answer in C4

(To be continued on the next page)

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After completing these two sets of calculations, the worksheet should look like the following:

	A	B	C
1	1	4	5
2	2	5	6
3	3	6	7
4	4	7	8
5	5	8	
6	6	9	
7	7		
8	8		
9	9		
10	10		
11	11		
12	12		
13			

You can realise these two sets of calculations by using the same sub. The definition of the sub is

```
Sub CalculateAverages(NAverages As Long, NTerms As Long, _  
                    colToFill As Long)
```

where `NAverages` is the number of averages that you want to calculate, `NTerms` is the number of terms to be averaged, and `colToFill` is the index of the column to contain the averages.

The first and second sets of calculations can be realised by calling the sub using:

```
Call CalculateAverages(6,2,2)  
Call CalculateAverages(4,3,3)
```

Your task is to write the sub `CalculateAverages`. You can assume the following constants have been defined:

```
Const ROW_START = 1      'The first row of data  
Const COL_DATA = 1      'The column containing the data
```

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

*Hints:* (1) You want to observe the patterns in computing the averages. For example, for the first set of averages. Note that there are 6 averages, and the gaps between A1 & A7, A2 and A8, ... are always the same. (2) You need two loops, one inside another, to do the work.

**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.

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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.

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

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

Assuming that you want to simulate the motion of a block of mass moving along the x-axis. You are given a Matlab vector `time`

```
time = [time(1), time(2), time(3), time(4), ..., time(n)],
```

with  $n$  elements but the elements in `time` are not equally spaced. You are also given a Matlab function `velocity` that returns the velocity of the block at the time specified in the input argument. For example, if you write

```
velocity(time(k))
```

in Matlab, the value returned by the function is the velocity of the block at `time(k)`, i.e. the  $k$ -th element of the vector `time`. Your aim is to use simulation to obtain the position of the block at time instances given in the vector `time`. These positions are to be stored in a Matlab vector called `pos`. The initial position of the block is in the matlab variable `posInit`. If you do not use iteration, these are the  $(n-1)$  Matlab statements you would use to do this simulation

```
pos(2) = pos(1) + (time(2) - time(1)) * velocity(time(1));
pos(3) = pos(2) + (time(3) - time(2)) * velocity(time(2));
pos(4) = pos(3) + (time(4) - time(3)) * velocity(time(3));
% To be continued until
pos(n) = pos(n-1) + (time(n) - time(n-1)) * velocity(time(n-1));
```

This question has two parts: (a) and (b).

(To be continued on the next page.)

(a) Write a Matlab function `simulateBlock` which takes two inputs

- The vector `time`
- Initial position `posInit`

And returns the vector `pos` as its output. You should use iteration (i.e. loops) in this function.

(b) In this part, we assume that the function `velocity` has been modified to accept a vector as the input and returns a vector of the same dimension as the output. For example, if we write

```
velocityVec = velocity(timeVec)
```

then `velocityVec` has the same dimension as `timeVec`, and the  $k$ -th element of `velocityVec`, i.e. `velocityVec(k)`, is the velocity of the block at the time at `timeVec(k)`.

Given this revised function `velocity`, you can now replace the iteration (i.e. the loop) that you use for simulation in Part (a) by using vectorisation. Show how you can use vectorisation to replace the iteration. Note that you do not need to rewrite the function, you only have to show how vectorisation can be used to replace iteration.

Hint:

`cumsum` - calculates cumulative sum.

`B = cumsum (A)` returns an array of the same size as the array `A` containing the cumulative sum. If `A` is a vector, then `cumsum (A)` returns a vector containing the cumulative sum of the elements of `A`.

For example,

```
>> B = cumsum ([4, 2, 1, 5])
```

```
B =
    4    6    7   12
>>
```

**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 <sup>v</sup> , 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