The University of New South Wales

**SAMPLE** Final Examination

Semester 1, 2016

**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

\[ \frac{(A1+C1)}{A1+B1} \]

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) \( \text{=AVERAGE(D6:D11)} \)  
B) \( \text{=AVERAGE(A$1:B4; D2:$E$5)} \)  
C) \( \text{=AVERAGE(A2:10D)} \)  
D) \( \text{=AVERAGE(A2)} \)

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?

\[ \text{=IF(AND(B2<0;C2>100);"Error"; IF(B2<50;"Fail";"Pass"))} \]

A) Error  
B) Fail  
C) Pass  
D) none of the above
A4. Consider the following portion of an OpenOffice Calc worksheet.

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
<td>5</td>
<td>2</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>8</td>
<td>2</td>
<td>1</td>
<td>9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>6</td>
<td>8</td>
<td>7</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>2</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Suppose that cell E4 contains the formula \( =B2+C3 \) 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.

Suppose that cell C1 contains the formula \( =IF(B1>35;"Hot";"Cool") \) 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.

\[
\begin{align*}
x &= 0; y = 0 \\
\text{While } x < 5 \\
& \quad x = x + 1 \\
& \quad y = x + y \\
\text{Wend}
\end{align*}
\]

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  
\[
\text{Not (blnA Or Not blnB)}
\]

A) Not blnA Or Not blnB  
B) Not blnA Or blnB  
C) 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.

<table>
<thead>
<tr>
<th>Operator</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>()</td>
<td></td>
</tr>
<tr>
<td>+  -</td>
<td>unary: sign</td>
</tr>
<tr>
<td>^</td>
<td></td>
</tr>
<tr>
<td>*  /</td>
<td></td>
</tr>
<tr>
<td>\</td>
<td></td>
</tr>
<tr>
<td>Mod</td>
<td></td>
</tr>
<tr>
<td>+  -</td>
<td>binary: add, subtract</td>
</tr>
</tbody>
</table>

What is the value of this constant expression?

\[ 4 \times 3 - (-4)^2 \]

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?

```basic
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
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\(^{nd}\), 4\(^{th}\), 6\(^{th}\), 8\(^{th}\) and 10\(^{th}\) 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

   \[ v1(1) * v2(1) + v1(2) * v2(2) + \ldots + v1(N) * v2(N) \]

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

   A) \( s = \text{sum}(v1 * v2); \)
   B) \( s = \text{sum}(v1 .* v2); \)
   C) \( s = v1 \backslash v2; \)
   D) \( s = \text{prod}(v1 + v2); \)
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) \( \text{find}((v < U) \& (v > L)); \)
B) \( v((v < U) \&\& (v > L)); \)
C) \( v(\text{find}((v < U) \& (v > L))); \)
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) \( \text{sum}(	ext{all}(M,2)); \)
B) \( \text{sum}(	ext{any}(M,2)); \)
C) \( \text{size}(M,1)-\text{sum}(	ext{all}(M,2)); \)
D) \( \text{size}(M,1)-\text{sum}(	ext{any}(M,2)); \)

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) \( \text{min}(v > 5); \)
B) \( \text{max}(v(v > 5)); \)
C) \( \text{min}(v(v > 5)); \)
D) \( \text{min}(\text{find}(v > 5)); \)

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.

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

(a) The Date type in OO Basic uses days as its unit of measure, for both dates and time. Write a complete function that accepts integer parameters hr, min and sec and returns the equivalent time representation. Assume constants MINSHR and SECSMIN are defined.

(b) The inverse cosine (arccos) can be calculated using the inverse tangent function, which is a Basic built-in (ATN) rather than a worksheet function. The identity is

\[
\tan(\arccos(x)) = \frac{\sqrt{1 - x^2}}{x}
\]

The range of ATN is $-\pi$ to $\pi$ radians.

Write a function that calculates arccos($x$) using this rule, returning the answer in degrees between 0 and CIRCLE (360). Assume the constant PI is available.

Function Arccos(x As Double, altQuad As Boolean) As Double

If altQuad is False, the answer should be return in bearing quadrants 1 or 2 (0 to 180). Otherwise the angle should be returned in bearing quadrants 3 or 4 using the same rule as applied in the SolarAzimuth function in assignment 1.

If the angle can’t be calculated, return UNDEF_ANGLE. Note that arccos(0) is well defined.

(c) You have been provided with a function that calculates solar azimuth in degrees on a certain day and Southern hemisphere location given the time in minutes since midnight.

Function Azimuth(timeMinutes As Long) As Double

The active sheet contains named cells called Sunrise and Morning. The first contains the sunrise time in minutes since midnight. Write a subprogram that obtains the sunrise time from the sheet, and calculates the solar azimuth at each ten minute period after that. When it finds the first azimuth value that is less than MORN_AZIMUTH, it writes the corresponding time to the Morning cell.
**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

\[
\text{Function ClassifyData}(x \text{ As Double}, y \text{ As Double}) \text{ As String}
\]

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 \( x \ast y > 10 \)
   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) Write a Matlab function edgeswap that returns a matrix with either the first and last rows exchanged, or the first and last columns exchanged.

```
>> m = transpose(reshape(1:15,3,5))
m =
   1  2  3
   4  5  6
   7  8  9
  10 11 12
  13 14 15
>> edgeswap(m,true)
ans =
   13  14  15
   4   5   6
   7   8   9
  10  11  12
   1   2   3
>> edgeswap(m,false)
ans =
    3   2   1
    6   5   4
    9   8   7
  12  11  10
  15  14  13
```

You may use the following header

```
function [retval] = edgeswap(mat, swapRows)
% EDGESWAP - exchange the first and last rows or columns of mat
```

(continued next page...
(b) Write a Matlab function that is given a traffic grid as used in Assignment 2, and a logical array (blocked) the same size as the grid, marking the positions of blocked cars. We are only interested in the elements of the grid where the blocked array is true. The function returns two integers:

- The number of blocked RED cars
- The number of blocked BLUE cars

For example,

```matlab
>> space = [0 2 3 2 3; 2 3 0 3 0; 2 3 2 3 3; 3 3 2 0 2; 2 3 2 3 2]
space =
    0 2 3 2 3
    2 3 0 3 0
    2 3 2 3 3
    3 3 2 0 2
    2 3 2 3 2
>> blocked = logical([1 1 0 1 1; 0 0 0 0 1; 1 1 1 1 1; 1 0 1 0 1; 1 1 0 0 0])
blocked =
    1 1 0 1 1
    0 0 0 0 1
    1 1 1 1 1
    1 0 1 0 1
    1 1 0 0 0
>> [r,b] = countblockedcars(space, blocked)
r =
    7
b =
    6
```

Do not use loops in your answer.
**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

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

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 \( \text{isPropertySatisfied} \) 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:

\[
\text{boo} = \text{isPropertySatisfied}(M(k,:));
\]

The variable \( \text{boo} \) has a value 1 if the \( k \)-th row of \( M \) satisfies the property, otherwise \( \text{boo} \) 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

\[
\text{function} \ \text{rowsWithProperty} = \text{findLastTwoOccurrences}(M)
\]

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 \( M \).
Selected Matlab Operators and Symbols

<table>
<thead>
<tr>
<th>Matrix operators:</th>
<th>Colon range:</th>
<th>Array operators:</th>
<th>Literal strings:</th>
<th>Transpose (suffix):</th>
<th>Line continuation:</th>
<th>Array construction:</th>
<th>Equal, not equal:</th>
<th>Row separator:</th>
<th>Boolean and, or, not:</th>
<th>Element separator:</th>
<th>Output suppression:</th>
</tr>
</thead>
<tbody>
<tr>
<td>* / \</td>
<td>min : incr : max</td>
<td>.* ./* .\ .^</td>
<td>'text'</td>
<td>'</td>
<td>...</td>
<td>[ ]</td>
<td>== ~</td>
<td>;</td>
<td>&amp; &amp;</td>
<td></td>
<td>~</td>
</tr>
</tbody>
</table>

Matlab Control Structures

```
if booleanexpr
  statements
end

if booleanexpr
  statements
else
  statements
end

if booleanexpr
  statements
elseif booleanexpr
  statements
... else
  statements
end

while booleanexpr
  statements
end

for variable = vector
  statements
end
```

Selected Matlab Functions

All accept arrays except where noted.

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

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

### Selected OpenOffice Calc Basic Object (VBA Compatible)

<table>
<thead>
<tr>
<th>Object</th>
<th>Refers to...</th>
</tr>
</thead>
<tbody>
<tr>
<td>ActiveCell</td>
<td>The active cell, unique</td>
</tr>
<tr>
<td>ActiveSheet.Cells(row, col)</td>
<td>Cell at given row and column</td>
</tr>
<tr>
<td>ActiveSheet.Range(str)</td>
<td>Cell or range with address or name str</td>
</tr>
<tr>
<td>ActiveSheet.Rows(row)</td>
<td>Complete row</td>
</tr>
<tr>
<td>ActiveSheet.Columns(col)</td>
<td>Complete column</td>
</tr>
</tbody>
</table>

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

### Control structure

```plaintext
While booleanexpr
  statements
Wend

If booleanexpr Then
  statements
ElseIf booleanexpr Then
  statements
Else
  statements
End If
```

For variable = num1 To num2 Step num3
  statements
Next variable

END OF PAPER