



OLLSCOIL NA GAILLIMHE
UNIVERSITY OF GALWAY

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Exam Code(s) 2BCT/2BSE
Exam(s) 2nd BSc (CS&IT), 2nd BE ESE

Module Code(s) CT248
Module(s) Introduction to Modelling

Paper No. I

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Instructions:

Answer any 3 questions. All questions have the same number of marks.

Duration 2hrs
No. of Pages 5 (Including Cover Page)
Discipline Computer Science
Course Co-ordinator Dr. Colm O’Riordan

Requirements:

Release in Exam Venue	No <input type="checkbox"/>	Yes <input checked="" type="checkbox"/>
MCQ Answer sheet	No <input checked="" type="checkbox"/>	Yes <input type="checkbox"/>
Handout	No <input checked="" type="checkbox"/>	Yes <input type="checkbox"/>
Formulae & Tables*	No <input type="checkbox"/>	Yes <input checked="" type="checkbox"/>
Cambridge Tables 2 nd Edition**	No <input checked="" type="checkbox"/>	Yes <input type="checkbox"/>
Graph Paper**** A4 Graph Paper 1mm 0.1cm Squared (Standard)	No <input type="checkbox"/>	Yes <input checked="" type="checkbox"/>
Other Materials	No <input checked="" type="checkbox"/>	Yes <input type="checkbox"/>
Graphic material in colour	No <input type="checkbox"/>	Yes <input checked="" type="checkbox"/>

1. (a) Explain the workings of a logical vector in MATLAB, and describe its use in filtering vector values.

Write a function `odd(v)` which returns the odd values of a vector. A sample test run of the function is shown below.

```
>> v
```

```
v =
```

```
3 6 5 3 2 3 1 2 5 1
```

```
>> v1 = odd(v)
```

```
v1 =
```

```
3 5 3 3 1 5 1
```

[10 marks]

- (b) Given the following matrices A and B, calculate results for the following operations in MATLAB, and explain the basis for your results.

$$A = \begin{pmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{pmatrix} \quad B = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

`A * B;`

`A .^ B;`

[8 marks]

- (c) Given the following two vectors:

```
x = 1:20;
```

```
y = 11:30;
```

Write MATLAB code (not using loops) to generate the following.

$$ans = \sum_i (x_i - y_i)^2$$

[7 marks]

PTO

2. (a) Show the general form of a function in MATLAB.

Explain the workings of **subfunctions**.

How might a subfunction be made visible to code outside of the function?

[8 marks]

- (b) Write a function (m file) that takes a 2-dimensional array and an input number. It should then create an output 2-dimensional array that contains only those values of the 2-dimensional array that are less than the input number. For example, if the input number is 4, and the input array (A) is:

```
A =  
    1    2    3  
    4    5    6  
    7    8    9
```

Then the function output should be.

```
ans =  
    1    2    3  
    0    0    0  
    0    0    0
```

[10 marks]

- (c) Explain what is happening in the following MATLAB code, and determine the values (and type) of the output.

```
f = @(x) [sum(x); min(x); max(x)]
```

```
f(1:5)
```

[7 marks]

PTO

3. (a) What is a table in MATLAB, and how does it differ from an array?

[5 marks]

- (b) Consider the following dataset (first 5 rows shown).

```
>> w
```

```
w =
```

```
5×6 table
```

station	month	day	hour	temp	rain
{ 'DUBLIN AIRPORT' }	1	1	0	5.3	0.9
{ 'DUBLIN AIRPORT' }	1	1	1	4.9	0.2
{ 'DUBLIN AIRPORT' }	1	1	2	5	0.1
{ 'DUBLIN AIRPORT' }	1	1	3	4.2	0
{ 'DUBLIN AIRPORT' }	1	1	4	3.6	0

Write the following queries on this data set.

- Select all observations where the temperature drops below 4 degrees
- Find the minimum temperature for Dublin Airport
- Count the number of observations where the rainfall was greater than 0.

[10 marks]

- (c) Using the following example (10 records), explain (using a diagram) how the **splitapply** process works. Assume you want to get the average *displ* for the models “corolla” and “gti”. Show the **splitapply** code as part of your solution.

```
10×5 table
```

manufacturer	model	class	displ	cty
"toyota"	"corolla"	"compact"	1.8	24
"toyota"	"corolla"	"compact"	1.8	24
"toyota"	"corolla"	"compact"	1.8	26
"toyota"	"corolla"	"compact"	1.8	28
"toyota"	"corolla"	"compact"	1.8	26
"volkswagen"	"gti"	"compact"	2	21
"volkswagen"	"gti"	"compact"	2	19
"volkswagen"	"gti"	"compact"	2	21
"volkswagen"	"gti"	"compact"	2	22
"volkswagen"	"gti"	"compact"	2.8	17

[10 marks]

PTO

4. (a) Build an anonymous function to model the following set of differential equations that model the consumer adoption of a product. The function should accept values for the parameter a . Show how this function can be invoked from the MATLAB function `ode45()`.

$$\frac{dP}{dt} = -a P$$

$$\frac{dA}{dt} = a P$$

Where:

- P represents the number in the population who have not adopted the product (i.e. they are potential adopters). The rate at which people leave the population P is determined by the parameter a .
- A represents the number of adopters. The rate at which people adopt is determined by the parameter a

Note, at all times, the sum of P and A will be constant.

[15 marks]

- (b) Consider the following differential equation that models the number of customers (C) in a company, where:

- p is the fractional rate of customers who join ($p = 0.10$)
- q is the fractional rate of customers who leave ($q = 0.02$)

$$\frac{dC}{dt} = pC - qC$$

Write a MATLAB script (using an anonymous function) that models the number of customers in the company from 2018 to 2030. Assume that there are 10000 initial customers, and that the two parameters (p and q) are passed into the anonymous function. Make use of the MATLAB function `ode45()`.

[10 marks]

END