THE UNIVERSITY of ADELAIDE

Primary Examination, Semester 1, 2019

109759	**Programming (MATLAB & C)** **ENG 1002, 1002UAC**

Course Coordinator: Dr Cheryl Pope

Official Reading Time:	10 mins
Writing Time:	120 mins
Total Duration:	130 mins

Questions	Time	Marks
Answer all 11 questions	120 mins	120 marks
		120 Total

Instructions for Candidates

- Begin each answer on a new page
- Examination material must not be removed from the examination room

Permitted Materials

- 1 Blue book
- General or translation dictionary is permitted

DO NOT COMMENCE WRITING UNTIL INSTRUCTED TO DO SO

Programming Structures: All Code Questions in this Section must be answered in MATLAB

Question 1

Variables and Operators

(a) Explain why it is important to initialise variables and give an example of initialising a variable.

[2 marks]

(b) What will be the value of the variable a after the following MATLAB statement?
a = 5 + 3 / 1 * 2;

[2 marks]

[Total for Question 1: 4 marks]

Question 2

Iteration

(a) Write a MATLAB script, using either a single or nested for-loop, that will print the factorials for the numbers between 1 and 100 (inclusive). The factorial of n (n!) is the product of the positive integers less than or equal to n. For example: 3! = 3 * 2 * 1. For this question you cannot use the built-in MATLAB factorial function, but you can use other MATLAB functions if you wish.

[6 marks]

(b) Write a MATLAB while-loop that iteratively decrements a variable called counter by 1 until counter becomes negative.

[3 marks]

(c) You are writing a control program that checks a temperature sensor's values until the reading reaches 100C. Would you use a for-loop or while-loop for this application? Explain why.

[3 marks]

[Total for Question 2: 12 marks]

Question 3

Selection

(a) Write a MATLAB if-statement that captures the following logic:
Given a variable called `waterTemp`, display 'gas', 'liquid' or 'solid' indicating the current state of the water based on the value of `waterTemp`. Water becomes a gas at 100C and a solid at 0C.

[3 marks]

(b) Use && || and $\sim$ operators to write an if-condition that is true if a given number, n, is an even number that is less than 1 or greater than 100 (inclusive)

[3 marks]

(c) Write a MATLAB switch-statement that is equivalent to the following if-statement:

```
if number == 1 || number == 100
   disp("Extreme value");
elseif number == 50
   disp("Mean value");
else
   disp("Invalid number");
end
```

[4 marks]

[Total for Question 3: 10 marks]

Question 4

Input and Output

(a) Write MATLAB code to read in a floating point number and then print the entered number with two digits after the decimal point. For example, if the user enters 5.627, the code should print 5.62

[2 marks]

(b) Explain what the following code will print? You are not required to give the exact value that will be printed, a description is acceptable.

```
initial = 'C';
fprintf('%d', initial);
```

[2 marks]

[Total for Question 4: 4 marks]

Question 5

Functions

(a) A function is called with the following code:

```
[res1, res2] = myFunction(num1, num2, num3);
```

i. How many values are returned by this function?

[1 mark]

ii. How many parameters does the function take?

[1 mark]

iii. Write the function declaration (ie write the function but you don't have to put any code inside the function)

[2 marks]

(b) Explain the purpose of functions giving advantages of using functions over writing all code in a single script.

[3 marks]

[Total for Question 5: 7 marks]

Question 6

Code Style

The code below contains several program style problems. Correct the style.

```
s = input('numbers?: ');
numbers = [];
for i = 1:s
v = input('number: ');
n = [n, v];
end
```

[5 marks]

[Total for Question 6: 5 marks]

Question 7

Libraries

During the course we wrote a program to generate all the permutations of an array of characters. For example, given 'part', our script printed the permutations: tarp, trap, prat, etc. MATLAB has a library function perms. Typing: `help perms` gives the following output:

```
>> help perms
 perms  All possible permutations.
    perms(1:N), or perms(V) where V is a vector of length N, creates a
    matrix with N! rows and N columns containing all possible
    permutations of the N elements.

    This function is only practical for situations where N is less
    than about 10 (for N=11, the output takes over 3 gigabytes).

    Class support for input V:
       float: double, single
       integer: uint8, int8, uint16, int16, uint32, int32, uint64, int64
       logical, char

    See also nchoosek, randperm, permute.

    Reference page for perms
```

Given an array of characters `word = 'hello';` write the MATLAB code needed to generate and display all of the permutations of word using the perms function.

[3 marks]

[Total for Question 7: 3 marks]

Question 8

Data Structures - arrays, matrices and strings

(a) Write a MATLAB script that will copy all of the negative values in a matrix, M, to a new vector, N.

[7 marks]

(b) Write a MATLAB script that reads in two strings from the user and compares them, printing `'same'` if they are the same or the indexes of the characters which differ if they are different. For example, if the user typed in 'car' and 'cat', the script would print 'the words differ in characters: 3'. For this question, you can assume the two strings entered are of the same length.

[6 marks]

[Total for Question 8: 13 marks]

Question 9

Problem Solving, Design, Implementation and Testing in MATLAB

(a) Write a function `isPrime(n)` that takes an integer `n` and returns true if the number is prime or false if it is not. Your function must not use the isPrime built in function, but you can use whatever other MATLAB functions you want. A number, n, is not prime if any number between 2 and n/2 divides the number without any remainder.

[8 marks]

(b) For the `isPrime` function above, give three test cases that will test a range of outcomes. For each test case explain what types of inputs that case is testing and give the expected output.

[4 marks]

[Total for Question 9: 12 marks]

All Questions in this Section must be answered in C

Question 10

Defensive Programming in C - fundamental C programming structures

(a) What will be the value of counter printed when the following code runs? Explain your answer

```
int increment(int counter) {
    counter++;

    return 0;
}
int main(void) {
    int counter = 4;

    if (counter > 0) {
        int counter = increment(counter);
    } else {
        increment(counter);
    }
    printf("%d\n", counter);
}
```

[3 marks]

(b) Write a C program that asks the user to enter up to 20 characters and then prints the characters the user entered in reverse. The program should stop accepting characters when the user enters a non-alphabetic character (ie anything other than a, b, c .... z or A, B, C .... Z)

[10 marks]

(c) Explain two risks to running C programs and defensive programming techniques you can use to mitigate them in your code.

[4 marks]

[Total for Question 10: 17 marks]

Question 11

Memory & Data Representation in C

(a) Explain the types of values that each of the following C data types store, your answer must explain the advantage provided by each type: char, unsigned int, long int, float, double.

[5 marks]

(b) Explain how C represents strings.

[2 marks]

(c) Write C code that reads in two strings of up to 10 characters and prints out the longer of the two strings.
For example, the output of a run of the program might look like:

Enter word 1: hello
Enter word 2: universe
The longer word is universe

[4 marks]

(d) The following C function takes two doubles: `min` and `max`. The function should update the passed values, placing the smallest of the two values in `min` and the largest in `max`. It does not currently work correctly.

```
void order(double min, double max) {
    if (max < min) {
        double temp = min;
        min = max;
        max = temp;
    }
}
```

i. What will the following code output using the version of the order function given above?

```
int main(void) {
    double num1 = 6;
    double num2 = 5;
    order(num1, num2);
    printf("small %lf, large %lf \n", num1, num2);

    return 0;
}
```

[2 marks]

ii. Write the correct C code for the function so that it behaves as expected.

[5 marks]

iii. Correct the call in `main` to the `order` function.

[2 marks]

(e) Write a C function, `identity`, that takes two arguments: `rows, cols` and creates a new rows x cols identity matrix. An identity matrix is a matrix with ones on the main diagonal and zeros elsewhere.

[13 marks]

[Total for Question 11: 33 marks]

End of exam