



UNIVERSITY
OF LONDON

BSc COMPUTER SCIENCE

CM1015 Computational Mathematics

Midterm coursework

INSTRUCTIONS TO STUDENTS:

This coursework assignment consists of **FIVE** questions. You should answer **ALL** the questions.

There are 100 marks available in this coursework assignment. The marks for each question are indicated at the end of the part in [.] brackets. **Full marks will be awarded for complete answers to a total of 5 questions. Make sure to show your work clearly in each of the questions.**

Submission requirements

Please submit **one** PDF document for this coursework assignment.

IMPORTANT: you must submit work that is properly formatted using the maths mode of your word processor. Any handwritten submissions will be subject to penalty of being capped at 40 marks.

Question 1

Show your work. Full marks will only be awarded if the workings are shown. Use your knowledge of number bases in this question.

- (a) A given number in base x can be converted to any other base y . According to the expansion method, if ***abc.de*** is any given number in base x , then write its value in base 10.

[3 marks]

- (b) Consider the binary number 10.0011

- i. Convert the above number to the decimal system
- ii. What are the place values of the digits 1 in the number $(0.0011)_2$
- iii. What is the sum of $(1+1+1+1)$ in the binary system
- iv. Calculate 101 divided by 10 using long division in base 2.

[4 marks]

- (c) Find the value of x from the following equation, if all numbers are in base 2. Express your final answer in base 2.

$$\frac{11}{x} = \frac{1000}{x + 101}$$

[4 marks]

- (d) In some base b , the following equation holds:

$$AB_b + BA_b = 121_{10}$$

Where A and B are digits ($A \neq B$). Find the base b , and the values of A and B .

[4 marks]

Question 2

Show your work. Full marks will only be awarded if the workings are shown. Use your knowledge of sequences and series in this question.

- (a) The sum culture of bacteria doubles every 3 hours. Initially, there are 200 bacteria. After 12 hours, a sterilising agent is applied that instantly kills 70% of the bacteria. The remaining bacteria continue to grow at the same rate (doubling every 3 hours). After an additional 36 hours, a second identical sterilising agent is applied, again killing 70% of the bacteria instantly. How many bacteria are present immediately after the second sterilisation?

[8 marks]

- (b) A geometric sequence has a first term of 4 and a common ratio of 3. The sum of the first n terms are 364.

- i. Find the number of terms n .
- ii. If possible, find the last term of the sequence.

[7 marks]

- (c) The 2nd, 4th, and 6th terms of a geometric progression form an arithmetic progression. If the first term is positive and the common ratio is not 1, find the possible values of the common ratio.

[8 marks]

- (d) Ben buys 10 books from an online store. The price of the first book is £3, and the price of each subsequent book doubles. However, after the 6th book, he gets a 15% discount on the price of each additional book. How much does Ben pay for all 10 books?

[7 marks]

Question 3

Show your work. Full marks will only be awarded if the workings are shown. Use your knowledge of modular arithmetic in this question.

(a) Find the smallest positive integer x that satisfies the following system:

$$\begin{cases} x \equiv 5 \pmod{6} \\ x \equiv 3 \pmod{7} \end{cases}$$

[4 marks]

(b) A 24-hour clock shows 14:00 now. What time will it show after 224 hours?

[3 marks]

(c) A number leaves a remainder 1 when divided by 2, 2 when divided by 3, and 3 when divided by 4 ... and 9 when divided by 10. What is the smallest positive integer that satisfies all these?

[4 marks]

(d) Find all integers x satisfying $6x \equiv 15 \pmod{21}$.

[4 marks]

Question 4

Show your work. Full marks will only be awarded if the workings are shown. Use your knowledge of angles, triangles, and trigonometry in this question.

(a) A triangle ABC has side lengths $a = 7$, $b = 8$, and angle $C = x$.

i. Write an equation involving x using the Law of Cosines.

ii. Solve for x if $c = 9$.

iii. Find the angle C in degrees to 2 decimal places.

[5 marks]

(b) In triangle ABC , you are given $AB = 10$, $AC = 13$, $Area = 30$.

Find angle A using the formula:

$$Area = \frac{1}{2} ab \sin C$$

[5 marks]

(c) Solve the equation $\sin 3x = \sin x$ in the interval $0^\circ \leq x \leq 360^\circ$

[5 marks]

(d) Solve for all values of $x \in [0^\circ, 360^\circ]$:

$$\sin x + \sin 2x + \sin 3x = 0$$

[5 marks]

Question 5

Show your work. Full marks will only be awarded if the workings are shown. Use your knowledge of Graph sketching and kinematics in this question.

(a)

i. An object is moving at constant speed. Which statement MUST be true? Show your work.

1. The acceleration of the object must be zero
2. The direction of the object is not changing
3. The velocity of the object is constant
4. All of the above
5. None of the above.

[2 marks]

ii. A tennis player tosses a tennis ball straight up in the air. If a is the acceleration of the ball, and v is its velocity, which statement is true when the ball reaches the highest point of its trajectory? Show your work.

1. Both v and a are zero
2. Only v is zero, and a is not
3. Only a is zero and v is not
4. Both v and a are non-zero
5. Impossible to answer without knowing the initial speed of the ball.

[2 marks]

iii. When a stone is thrown directly upwards with an initial velocity of 30.0m/s, what will be the maximum height it will reach, and when will it be? Acceleration due to gravity is 10m/s². Show your work

1. 45 m in 3 s
2. 90 m in 6 s
3. 1.5 m in 3 s
4. 90 m in 3 s
5. 45 m in 6 s.

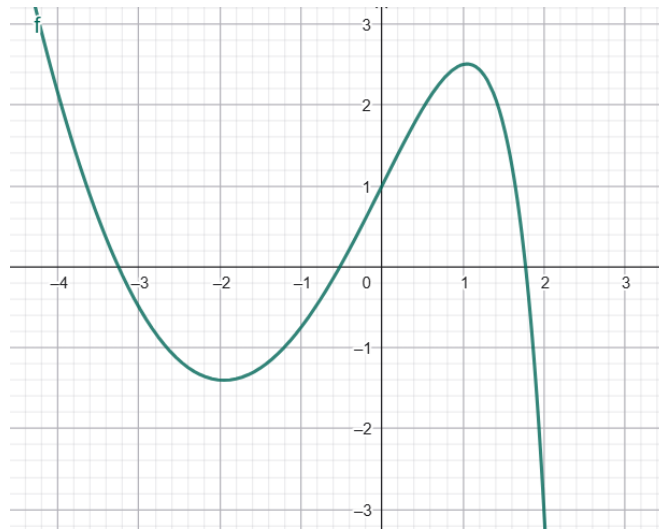
[2 marks]

(b) Consider the function given by $f(x) = \frac{x-3}{x^2+9x-22}$.

- i. State the domain of the function
- ii. State the range of the function
- iii. Plot the graph of the function.

[6 marks]

- (c) From the following plot of the function $f(x)$, say whether it is one-to-one or not. Is it onto or not? Find the domain and the range of the function.



[8 marks]

[END OF COURSEWORK ASSIGNMENT]