MT1003 Calculus and Analytical Geometry - Fall 2022
BSDS D

Semester Project

The problem statement is for BDS D.

1. Problem Statements

Problem 1

a. When we cough, the trachea (windpipe) contracts to increase the velocity of the air going out. This raises the questions of how much it should contract to maximize the velocity and whether it really contracts that much when we cough.

Under reasonable assumptions about the elasticity of the tracheal wall and about how the air near the wall is slowed by friction, the average flow velocity y can be modeled by the equation $y = c(r_0 - r)r^2 \frac{cm}{sec}, \frac{r_0}{2} < r < r_0$, where r_0 is the rest radius of the trachea in centimeters and c is a positive constant whose value depends in part on the length of the trachea. Show that y is greatest when $r = (2/3)r_0$ that is, when the trachea is about 33% contracted. The remarkable fact is that X−ray photographs confirm that the trachea contracts about this much during a cough.

b. Take r_0 to be 0.5 and c to be 1 and graph y over the interval $0 < r < 0.5$. Compare what you see with the claim that y is at a maximum when $r = (2/3)r_0$.

Problem 2

Procedure for Scientific Graphing $y = f(x)$.

1. Identify the domain of f and any symmetries the curve may have.
2. Find the derivatives y' and y''.
3. Find the critical points of f, if any, and identify the function's behavior at each one.
4. Find where the curve is increasing and where it is decreasing.
5. Find the points of inflection, if any occur, and determine the concavity of the curve.
6. Identify any asymptotes that may exist.
7. Plot key points, such as the intercepts and the points found in Steps 3–5, and sketch the curve together with any asymptotes that exist.

$$y = -\frac{8x}{x^2 - 4}.$$

Problem 3

Procedure for Scientific Graphing $y = f(x)$.

1. Identify the domain of f and any symmetries the curve may have.
2. Find the derivatives y' and y''.
3. Find the critical points of f, if any, and identify the function's behavior at each one.

4. Find where the curve is increasing and where it is decreasing.
5. Find the points of inflection, if any occur, and determine the concavity of the curve.
6. Identify any asymptotes that may exist.
7. Plot key points, such as the intercepts and the points found in Steps 3–5, and sketch the curve together with any asymptotes that exist.

$$y = -\sin 2x\,, \qquad 0 \le x \le \pi\,.$$

2. Report Requirement

Students are required to submit a complete report of the project prepared in MS Word in their own words. A report is written in third person, i.e., use of I, We, Us, are not used to write the report. The contents of the report must include:

Sr. No	Deliverable(s)
1.	**Objectives and Introduction** Objectives and introduction of the problem. In this section briefly introduce the problem and the methodology that will be adopted by you to solve the problem.
2.	**Analytical Solution** A step-by-step analytical solution (by hand solution). Clearly state the assumptions and values that you use for the solution.
3.	**MATLAB Code (In Case of Preference)** Complete and well commented MATLAB code. This section must include the explanation of the commands, functions, and toolboxes used.
4.	**Computing Software Solution and Results** Step-by-step example demonstrating the computing software solution. Clear retraceable steps should be listed to obtain the presented solution. Also, present detailed results and discussion in this section. Do not just paste the graphs or screenshot of the command window. Compare your by hand and computing software solutions, and present physical interpretation of your results and graphs.
5.	**Flowchart** Flowchart of the solution methodology.
6.	**Conclusions** In this section, include conclusions related to this assignment. The conclusion section stands independently from the report and gives the reader a comprehensive idea of the project; thus, the conclusion section should briefly explain the problem, solution methodology, results, and analysis. The conclusion section is not very large and typically consists of 1-2 paragraphs. The conclusions section can also include bullet points.

7.	**Contribution** In this section clearly state the contribution of each group member. Generic statements such as 'each group member contributed equally' are not acceptable answers. In this section include difficulties that you faced during this assignment and how you overcame those difficulties.

Marks Distribution

Sr. No	Deliverable	Marks
1.	Each page should be numbered.	03
2.	Contribution from each group member must be highlighted.	02
3.	You can use Mathematica/MATLAB/Maple/GeoGebra or any software. Using aforementioned tools, solve these problems.	20
4.	By hand calculations for solution are necessary.	20
5.	Detailed explanation of each command/code.	10
6.	Compare results with the results obtained by hand calculations.	10
7.	Difficulties faced during this project and how you overcame them.	05

Each report element should be documented under a separate heading. Report must not exceed 12 A4 size pages including table of contents as well as a single title page with project title, student names, ids, section, and name of the course. 3 marks will be deducted from obtained marks for every extra page. Each page should be numbered. The report should be written in Calibri or Times New Roman typeface only. The size of the font should be 12. The size of first and second level of headings should be 14 bold, and 12 bold, respectively. The alignment of the report should be justified, while pictures and tables should be center aligned with relevant captions. The option to align the text left, right, center, and justify can be found under paragraph options on Home tab. Line and paragraph spacing should be set as 1.5.

3. Project Submission Guidelines

This project is an open-ended problem designed to demonstrate the application of calculus in real life. The open-ended nature of the problem means that this problem can be solved in more than one way using various techniques and methodologies, some of these techniques have been covered in this course. You are free to adopt any technique and solution methodology to solve this problem. Solution techniques and methodologies that are not part of the course outline can also be used to solve the problem. However, you are required to take approval of such a solution technique before starting the project. You will have to do extensive research to completely solve the problem. Project guidelines are summarized below:

- This is a group assignment and carries 70 marks.
- A group can have maximum of 3 students. One of the aims of this grand assignment is to enable students to work effectively in a team. If a student wishes to work individually, he/she can submit individual project.
- Plagiarized work (from internet or fellow students) will result in zero marks.

- Deadline for complete assignment submission on **google classroom** (one MS Word file and one pdf of the same Word file including all the codes and by-hand solutions) is **December 5, 2022,** latest by **4:00PM**. Do not submit your project in a .zip or .rar format. You can submit additional files such as .m files, however, the single PDF and MS Word file must also include all these files.
- Name of your report file must be as per following format: ID1_ID2_ID3_ MT1003_Project_Section.
- Do not submit your assignment via email, it will not be considered. Late submissions will not be considered.