Semester Project

(This problem statement is only for students of section A)

Problem Statement

Your software house has picked up an assignment that requires background in differential equations and their solution methodologies. The client requires final solution in form of a MATLAB algorithm, however, complete documentation including the analytical solution is also required to show the basis of the algorithm. Complete details of the requirements are provided by the client in the next sections. You have been tasked by the manager of your software house to pick at least one and maximum two members for your team to work on this assignment. The details of the task are as follows:

The Rockwell Collins Satellite Transportable Terminal (STT) is a combat-proven, transportable earth terminal designed to establish secure voice, video, and data communications virtually anywhere. Designed to withstand challenging conditions and demanding operations. These rugged, trailer-based earth terminals deliver up to 56 Mbps (megabytes per second) throughput - and they can be towed anywhere a HMMWV (High Mobility Multipurpose Wheeled Vehicle) can go. Rockwell Collins has built more than 800 STT units since the program's inception in 2004. Due to recent budget cuts, more economical parts must be used in the production of STTs. The client has tasked you with comparing feasible options for the suspension systems of the STTs. The suspension system can be modeled as a simplified mass, spring, and a damper system. The suspension system for the STTs needs to be fitted with cost effective shocks that are reliable and protect the satellite while being loaded and transported. There are three shocks available:

Sr. No.	Type of Shocks	Spring Constant k (N=m)	Damping Coefficient β (N · s/m)
1	Air Coasters	220	100
2	Cloud Riders	59	1050
3	Extreme Shocks	170	1110

1. Model the suspension system of a STT Trailor while it is loaded with a satellite. The trailer of a STT at rest will be loaded with a satellite with a mass of 1800 kg. Assuming that the loaded trailer is at equilibrium, the displacement of the shocks before the trailer is loaded is 3 cm.
2. Analytically (by-hand) solve the problem for first type of shock with the given damping and spring constant value.
3. Plot the analytical solution of the model using MATLAB.

4. Find the solution to the problem using MATLAB for first type of shock.
5. Compare the analytical and MATLAB solution for the first type of shock.
6. Find the MATLAB solution of the problem for remaining shock types.
7. Compare the solutions of the three types of shocks that you have obtained using MATLAB. From your analysis, decide which shock is best for the STT suspension system for loading.

Program requirements

1. On every run, the program must display the name of your software house, and your team along with student ids.
2. At this stage, a message should be displayed to press any key to continue.
3. After the input from user, the program must solve the problem and display the results.
4. At this stage, the program must ask the user if they wish to run another query or terminate the program. Based on user input, the program must act accordingly.

Report Requirements

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 the following headings:

Sr. No.	Deliverable	Marks
1.	**Objectives and Introduction:** Objectives and introduction of the problem. In this section briefly introduce the problem and the methodology that you have adopted to solve the problem. In this section include flowchart of the solution methodology or the program.	10
2.	**Analytical Solution:** A step-by-step analytical solution (by-hand solution). Clearly state the assumptions (if any) and values that you use for the solution.	20
3.	**MATLAB Code:** Complete and well commented MATLAB code. This section must include the explanation of the commands, functions, and toolboxes used.	15
4.	**MATLAB Solution and Results:** Step-by-step example demonstrating the MATLAB 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 MATLAB solutions, and present physical interpretation of your results and graphs.	20
5.	**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.	5
6.	**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.	5

Each report element should be documented under a separate heading. Each page should be numbered. The report should be written in Calibri or Times New Roman typeface only. The font size 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. Optimally utilize the available space on each page, do not leave blank space on a page unnecessarily. Include a proper title page and table of contents at the start.

Submission Guidelines

This project is an open-ended problem designed to demonstrate the applications of differential equations 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 use any technique and solution methodology to solve this problem. You may have to do extensive research to completely solve the problem. If you have any confusion, you can discuss your query via email. General guidelines are summarized below:

- This is a group assignment and carries 70 marks. The weightage of this assignment is 7% (7 absolute marks).
- A group can have a maximum of 3 students. One of the aims of this project is to enable students to work effectively in a team. Therefore, this assignment cannot be done individually.
- Plagiarized work (from internet or fellow students) will result in zero marks.
- Deadline for 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 **04:30pm on Wednesday 03 May 2023**. Do not submit your assignment 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_MT1006_Project_Section**.
  (e.g., 123456_654321_987654_MT1006_Project_A)
- Do not submit your assignment via email, it will not be considered.
- Late submissions will not be considered.