Computational Mathematics
Term Project

Rules:

1. Form a group of 8 to 10 members.
2. The project is divided into two parts:
   (a) Applications of Linear Algebra: In which you are required to pick a real-life application that involves linear algebra and briefly explain how it works in light of what you studied in this course. Focus on explaining the role of linear algebra in the application. A list of topics is given on page 2. The following link directs you to a Google Drive folder where you'll find research papers related to the topics listed below, one paper for each topic. This should help you get started, but you may search for more resources to better understand the topic.
   `https://drive.google.com/drive/folders/1umgD-37UGUIjlupXPXcwY7D5bAJZ9C-5`
   For this part, prepare a presentation on the selected topic, and submit a video narrating your presentation. You should also upload the presentation itself (in PDF format). The video should be either .mp4, .wmv or Matroska (.mkv). You can also upload your video to YouTube as an **unlisted** video.
   (b) Numerical Methods: In which you are required to write MATLAB (or Octave) codes that implement some of the methods you studied. On page 2, you will find a list of choices for this part. Pick one. Prepare a report that includes screenshots of your codes and a sample run (input and output of the code, for example, screenshots of the command window and resulting figures).
3. Upload ALL your files on Google Drive in ONE folder. The folder should include:
   (a) The PDF of the presentation (linear algebra application)
   (b) The PDF of the numerical part, which includes screenshots of the codes and the examples used to test the codes (input, output and figures)
   (c) Video of the narrated presentation (if you put an unlisted YouTube video link you don't have to put the video in the folder. There's a place for the YouTube video in the form).
   (d) The code files (m-files) for the numerical part.

   The PDF files should include a list of all the team members: names (in Arabic) and university ID number.
4. The duration of the presentation **should NOT exceed 10 minutes** under any circumstances.
5. Each team should pick a representative (one of the team members). This team member will be contacted via email in case there's a problem with the submission and will be responsible for submitting the project through the form.
6. Submission Link: `https://forms.gle/3s7tYtpuGArdMkRAA`
7. Copied reports and/or codes will not receive any marks.
8. Bonus marks will be awarded if:
   - You write codes for ALL the numerical methods mentioned in the report (choices A to D)
   - You include a GUI for the linear regression code that includes the linear model and all the linearized models you studied.
9. Deadline: 15/6/2021 (the form will not accept responses starting 11:59 PM on 15/6/2021)

Part I: Applications of Linear Algebra:

Pick one of the following topics:

- **Topic A**: Image Compression using Singular Value Decomposition
- **Topic B**: Multiple Signal Classification (MUSIC) Algorithm
- **Topic C**: Tomographic Imaging
- **Topic D**: Principal Component Analysis for Biomedical Sample Identification
- An application of your choice (in which case you need approval, send your chosen topic by email to: sara.kamel@alexu.edu.eg, or in a message through Microsoft Teams)

Note that Topic A and B are applications related to communications (directed towards EMP-219 students), while C and D are biomedical applications (directed towards EMP-215 students). However, you don't have to choose the topics related to your major or your department.

Part II: Numerical Methods:

Choose one of the following method sets to implement, and use any example to verify that each of your codes work.

- **Choice A**: Linear regression + exponential model, the Newton-Raphson method, trapezoidal method.
- **Choice B**: Linear regression + growth-rate model, bisection, Simpson's 1/3 rule.
- **Choice C**: Linear regression + power model, the trapezoidal method, Euler's method.
- **Choice D**: Linear regression + power model, the Jacobi method, Heun's method.

Notes: The linear regression code should be able to plot the data points vs. the least squares solution, as well as give the values of the required coefficients and the correlation coefficient.