Alexandria University
Faculty of Engineering
Engineering Mathematics & Physics Dept.

Computational Mathematics
EMP219 & EMP215
Term Project

# Computational Mathematics
## Term Project

## Part I: Applications of Linear Algebra:

Principal Component Analysis (PCA) is an important tool in many engineering applications. It uses eigenvalues and eigenvectors to compress or to extract certain features from given data. For this part, you are required to first understand how PCA works, then choose one of the following topics as an application of PCA:

- **Topic A**: Facial Recongnition

- **Topic B**: Image Compression

- **Topic C**: Biomedical Sample Identification

- **Topic D**: Electrocardiography (ECG) signal processing

- 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.

Alexandria University
Faculty of Engineering
Engineering Mathematics & Physics Dept.

Computational Mathematics
EMP219 & EMP215
Term Project

**Rules:**

1. Form a group/team of 6 to 8 members.

2. The project is divided into two parts:

   (a) For Part I (Linear Algebra), prepare a presentation on the selected topic, explaining how PCA works and how it is implemented in the application of your choice. 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. ALL team members are required to speak during the presentation (do not present yourself before speaking, just put the name of each team member on their assigned slides).

   (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.

   <span style="color:red">The PDF files should include a list of all the team members: names (in Arabic) and university ID number.</span>

4. The duration of the presentation <span style="color:red">**should NOT exceed 15 minutes**</span> under any circumstances (this includes the bonus parts).

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/toAGmhKR4Eaeiutt8`

7. Copied reports and/or codes will not receive any marks.

8. Bonus marks will be awarded if you do one or more of the following (and include it in your video/presentation):

   - You write codes for ALL the numerical methods mentioned in the report (choices A to D). $\rightarrow$ **+1**
   - You include a GUI for the linear regression code that includes the linear model and all the linearized models you studied. $\rightarrow$ **+2** (depending on the GUI)

   NOTE: Doing both (all methods + linear regression GUI) will earn you +3 bonus points.

9. Deadline: 20/5/2022 (the form will not accept responses starting 12:00 AM on 21/5/2022)

   Good luck!
   Dr. Sara Hassan Kamel