MATLAB Project

PART 1: PROGRAMMING

A) Power Method:

The Power Method is a simple iterative algorithm for finding the largest eigenvalue of a given matrix A. Write a MATLAB function with the following inputs and outputs:

- Input: matrix A, number of iterations
- Output: the largest eigenvalue of A

Use any square matrix to test your function use the MATLAB built-in function for eigenvalues **`eig`** to compare your results with the exact value.

B) Least Squares Fitting

Given a set of N points (x,y), it is required to find a straight line that best fits the given data. To determine the best fitting line $y = a_0 + a_1x$, one must determine the values of a_0 and a_1. This means that we have a set of N equations in just two unknowns, which is an overdetermined system of equations. This system has a unique solution if all N points lie on the same straight line, but in most cases, they don't, and in that case the system has no solution.

Write a MATLAB function that takes two inputs: the vectors x and y containing the coordinates of the N points, and gives two outputs: the values of a_0 and a_1, and generates a plot of both the given points and the best fitting line as shown in Fig.1.

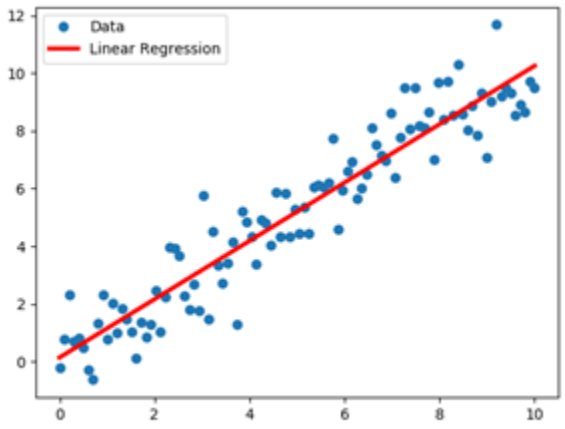

Fig.1

PART 2: SIMULINK

PID Controller

A Proportional-Integral-Derivative (PID) controller is a feedback system that aims to control the output of a process; like regulating the temperature, pressure or speed of a certain device. The PID controller calculates the error $e(t)$ between a desired setpoint (input) $r(t)$ and a measured process variable $y(t)$. The controller continuously attempts to minimize this error over time by adjusting an output variable and recalculating the error. The output of the controller $u(t)$ is

$$u(t) = K_p e(t) + K_i \int_0^t e(\tau)d\tau + K_d \frac{d}{dt} e(t)$$

where K_p, K_i and K_d are the proportional, integral and derivative constants respectively.

Create a Simulink Model for a PID Controller with the following parameters:

- $K_p = 5$, $K_i = 2$, $K_d = 1$
- Transfer function of the Process (or Plant) = $\frac{s^2+3s+9}{s^3+2s+1}$
- Input: Unit step function

Plot the input and output of the system in **one** figure (setpoint $r(t)$ and PID response $y(t)$).

BONUS: Create a GUI that can adjust the parameters K_p, K_i and K_d and plot the input and output of the system. (Hint: Use `set_param` to modify the parameters)

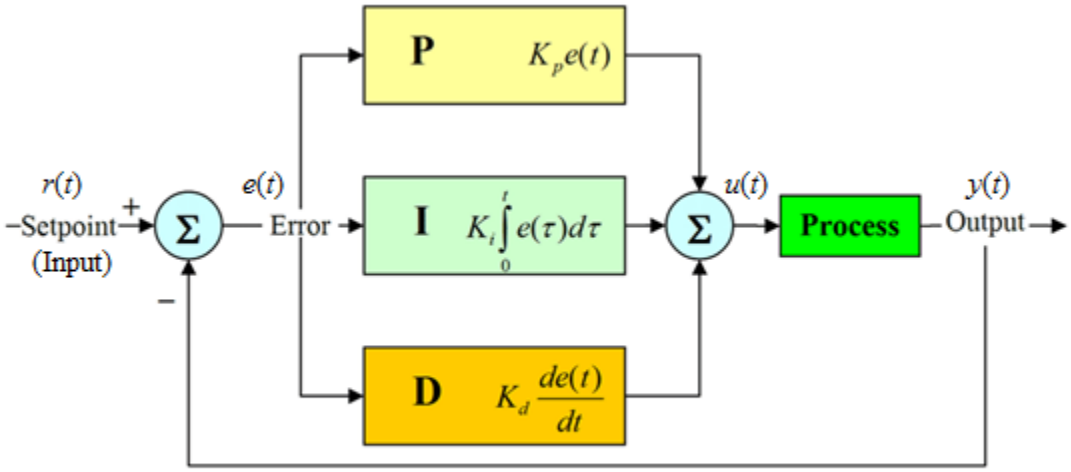

Fig.2

Project Requirements:

- This is a group project. Each group should include **6 to 8** students.
- Each group should prepare one report with the **names** of the students (in Arabic) and their **seat numbers** written on the front page.
- You are required to look up the basics of the power method, least squares fitting and the PID controller, and understand them well enough to implement them using your own MATLAB codes and models.
- **For Part 1**: Include the following in your report:
  - The MATLAB code (function m-file) of the power method
  - Test the code using any matrix and put a screenshot of the output appearing in the MATLAB workspace (of both your code and the built-in function)
  - The MATLAB code (function m-file) of the least squares method
  - A screenshot of the figure containing the input points and output line
  - A screenshot of the workspace with the values of a_0 and a_1
- **For Part 2**: Include the following in your report:
  - A screenshot of your Simulink model
  - A screenshot of the parameters of Simulink blocks that you modified. No need to include the parameters of the blocks that you did not modify.
  - A screenshot of the figure containing the input and output (transfer the output of the scope to the workspace where you can plot them).
  - For the bonus part: a screenshot of the GUI and the edited parts of the associated code (i.e. don't put the entire GUI m-file; just the parts you wrote yourself), as well as a sample run.
- The tasks should be evenly distributed among the members of the group. Copying codes from the internet or from other groups is not allowed.