ASSIGNMENT NO.1, (Part 1: Take-Home) BRIEF

HTU Course No: 00103101	HTU Course Name: STEM 1 LAB
BTEC UNIT No: N/A	BTEC UNIT Name: N/A

Version: 1

Assignment Brief

Student Name/ID Number/Section	
BTEC Unit Number and Title	N/A
HTU Course Number and Title	00103101: STEM 1 Lab
Academic Year	Fall 2021/2022
Assignment Author	Rasha Shaheen, Mohammad AL-Fayyad
Course Tutor	Rasha Shaheen, Mohammad AL-Fayyad, Nadia AL-Saad, Heba Jaradat
Assignment Title	Manipulating, processing, and visualizing data using computer software and Mathematical Modelling
Assignment Ref No	1, Part 1: Take-Home
Issue Date	December 4, 2021
Formative Assessment dates	December 4 to December 18, 2021
Submission Date	December 18, 2021
IV Name & Date	Dr. Mohammad Abdel-Rahman

Submission Format

This is the assignment#1-part one of STEM I Lab which is a take-home assignment. The submission should be provided by **uploading a compressed folder to eLearning**, the folder should include the following:

1. A well-organized report following the technical report style in pdf. The answers need to follow clear and coherent steps. Final answers without detailed steps are not accepted.
2. One MATLAB file for all tasks (.m file)
3. One Simulink file (.slx)
4. One Excel file.

There might be a selective oral session with your assessor as part of the evaluation.

General Guidelines

- If plagiarism is detected, the students' mark will be "Unclassified".
- The soft-copy of the assignment must be in pdf format.
- The report should be typed using a computer, not handwritten.
- Your report should be neat and organized in orderly manner, with proper page numbering and task numbering.

Final report requirements:
1. Your final submitted report should be a **single file in PDF format**.

2. The front page should include the course name, your section, assignment name, your name and student ID, HTU LOGO, and your tutor name.

3. Whenever you are asked to write a MATLAB code, make sure that you include your code in the report, comment your code to show your steps, and explain them.

4. The font for the code must be courier new; readable and the comments coloured in green.

5. The final report should be concise **(15 pages maximum).**

6. Remember, the objective of the assignment is to assess understanding rather than the ability to simply reproduce analytical procedures and this requires you to explain the steps in your analysis.

7. Whenever plots are required, make sure to include them within your report, assure that all your figures/plots are well labelled and numbered in the report.

8. The soft-copy of the assignment must be included in the compressed file and submitted on Moodle, the pdf file name must be as follows: AhmadAlShabali_17120024.pdf.

Unit Learning Outcomes

LO1 Manipulating, processing, and visualizing data using computer software.

LO2 Mathematically modelling STEM problems.

Assignment Brief and Guidance

Task I:

You have been invited for a job interview in a company for applied engineering modelling and simulation. The administrator has asked you to do the following task using MATLAB and Simulink to test your programming skills:

If you have the following mathematical equation:

$$X = (8 - 1 - 2)^2 * 2/5 + 4^2 * 2/8$$

a) Use MATLAB to write a code that apply the mathematical operation and find the value of X.

b) Use Simulink to apply the mathematical operation using the appropriate block diagrams and find the value of X.

c) If the mathematical operation is modified by removing the parenthesis as follows:

$$Y = 8 - 1 - 2^2 * 2/5 + 4^2 * 2/8$$

Repeat part b). Compare the values of Y and X. Is there a difference? Justify your answer.

جامعة الحسين التقنية
Al Hussein Technical University

Task II:

Suppose you will be working at Al Hussein Technical University (HTU) as a part-time teaching assistant during the fall semester in year 2026. At that semester, your students got accumulative grades (out of 100) for three courses as shown in Table 1. Your supervisor asked you to examine the students' performance by analyzing and evaluating their grades in this semester. To automatize the process, you have to perform the following task using MATLAB:

Table 1

| Student ID | Course | | |
	STEM 1	Functional MATH	Functional Physics
1	89	91	95
2	45	69	71
3	50	48	51
4	85	80	84
5	80	56	77
6	56	45	88

a) Create a matrix, A, that represents the six students' grades in the three courses where each row is defined for one student and each column is for a course. What will be the dimensions of A?

b) Store the 2nd, 3rd, and 4th students' Functional Math grades in a row vector, b. (Hint: Use Accessing Elements).

c) Using matrix A, define a column vector c, such that the ith element in c represents the sum of the grades of student i. (Hint: Use sum () function)

d) Using matrix A, define a column vector d, such that the ith element in d represents the average grade of student i, averaged over his/her courses.

e) If the pass grade in each course is 50, modify the matrix A by adding 5 points to each grade that is below 50.

f) Modify the matrix A by adding 5 points to all students in the Functional Math course.

g) Modify the matrix A by keeping the Functional Math and Physics grades, while replacing STEM 1 grades with zeros (Hint: Use element by element multiplication).

h) Plot three curves using MATLAB on the same graph, where the x-axis is the student ID. The y-axis of the first curve is STEM 1 grades. The y-axis of the second curve is Functional math grades. The y-axis of the third curve is Functional Physics grades. All curves should be with different colors and use different markers. Use legends to distinguish different curves. Label all axes, add grid lines, and title your graph.

Task III:

You are working in the data analysis and design department in a game design studio. You are asked to design a simple racing game using MATLAB and you have the following case to analyze:

Samir tests his new car by racing with Ahmad. Ahmad was driving with a constant velocity of 10 m/s. Samir leaves the starting line 2.00 s after Ahmad. Samir moves with a constant velocity of 50.0 m/s. Knowing that the position as a function of time for the particle under constant velocity model is given by:

$$x_f = x_i + v * t$$

Where:

x_f: Final position (m). v: Velocity(m/s).

x_i: Intial position (m). t: Time(s).

(Hint: Consider x_i for Ahmad 20 m and x_i for Samir 0 m)

a) Write the equation of the final position of Ahmad.

b) Write the equation of the final position of Samir.

c) Write the equations derived in parts a and b above in the form $Ax = b$, where $x = \begin{bmatrix} x_f \\ t \end{bmatrix}$.

d) By calculations discover if Samir will catch Ahmad or not. If yes find at what time (t) and the final position (x_f) for both.

e) Write down the coefficient matrix A.

f) Write down the constant matrix b.

g) Write a MATLAB code to calculate the determinant of matrix A.

h) Based on your result in (g), is it possible to find the inverse of matrix A? If yes, calculate and display the inverse of A.

i) Using the matrix method, discover if Samir will catch Ahmad or not. If yes find at what time (t) and the final position (x_f) for both.

j) If Samir decreased his velocity to 10 m/s. Repeat the steps from (a) to (i) to discover if Samir could catch Ahmad or not. Then explain why. Show all details.

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Task IV:

You are working as a design engineer in Royal Scientific Society (RSS). Your manager asked you to do the following task as a part of rockets experiment analysis:

Suppose that the height of two rockets that were launched to the sky is represented by the following functions:

$$y_1 = 3t^3 - 26t$$

$$y_2 = -20t^2 + 350t + 5$$

where y is the rocket height in meter(m) and t is the time in seconds(s).

Answer the following:

a) Use MATLAB to plot the two functions versus time on the same graph. All curves should be with different colors and use different markers. Use legends to distinguish different curves. Label all axes, add grid lines, and title your graph. (Use the following increment t = 0:0.05:10).

b) Use Excel to plot the two functions versus time on the same graph. All curves should be with different colors and use different markers. Use legends to distinguish different curves. Label all axes, add grid lines, and title your graph. (Use the following increment t=0:0.5:10).

Task V:

You are working in the cyber security department at a certain company. For security purposes, a password is required to access the system. You are asked to find the first 3 digits of this password based on the following information:

- 1st digit (D_1) plus twice of the 2nd digit (D_2) plus the 3rd digit (D_3) is equal to 26.

- Triple of the 1st digit (D_1) plus the 2nd digit (D_2) plus the 3rd digit (D_3) is equal to 25.
- 1st digit (D_1) plus the 2nd digit (D_2) plus triple of the 3rd digit (D_3) is equal to 28.

a) Express the three rules above as equations.

b) Rearrange the equations so that they are in the form Ax=b, where $x = \begin{bmatrix} D_1 \\ D_2 \\ D_3 \end{bmatrix}$.

c) Define the coefficient matrix A and the constant matrix b.

d) Use the matrix method to find the password digits (D_1, D_2, and D_3). (Hint: Round the password digits (D_1, D_2, and D_3) to the nearest integer)

Task VI:

You are working in the fluid mechanics system engineering department at a firm. You have a task to determine flow rates of different valves that used to fill a tank. The tank is 2000 L that is fed by three valves with different flow rates. The flow rates (in L/min) of the three valves are x, y, and z. The three valves can be used to fill the tank in 3 scenarios. In the first scenario the three valves will fill the tank as follows, valve x will be opened for 10 mins, valve y for 4 mins, and valve z for 40 mins. Second scenario, the valve x opens for 15 mins, valve y for 2 mins, and valve z for 20 mins. Third scenario, valve x opens for 12 mins, valve y for 10 mins, and valve z for 15 mins.
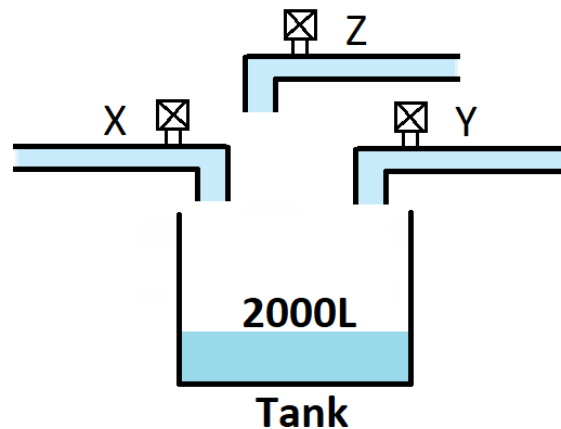
Knowing that the tank's volume (v=2000L) as a function of three valves' flow rate is given by:

$$x * C + y * D + z * E = 2000 \text{ L}$$

Where x, y and z represent the 1st, 2nd, and 3rd valve flow rates (L/min), C is the opening time for x valve (min), D is the opening time for y valve (min), E is the opening time for z valve (min).

a) For each scenario, write an equation that relates the tank volume to the three valves flow rates.

b) Rearrange the equations so that they are in the form Ax=b, where $x = \begin{bmatrix} x \\ y \\ z \end{bmatrix}$.

c) Define the coefficient matrix A and the constant matrix b.

d) Use the matrix method to find x, y, and z flow rates.

Task VII:

You are working as Former Architect at Arabtech Jardaneh. Your returning client asking for a special design for his home that require the following specifications:

- The house has three bedrooms, one of them is a master bedroom, two bathrooms, one kitchen, one living room, and one balcony.
- The area of bedroom 1, bedroom 2, master bedroom, and living room is identical (equal to A_1).
- The area of bathroom 1, and balcony is identical (equal to A_2).
- The area of the kitchen is A_3.
- The area of bathroom2 is A_4.
- The total area of the house should be 120 m² (1).
- The area of the balcony and bedroom 1 is 28 m² (2).
- The area of the kitchen and bathroom 2 is 24 m² (3).
- The area of balcony and kitchen is 22 m² (4).

a) Express the four area rules above as equations.

b) Rearrange the equations so that they are in the form Ax=b, where $x = \begin{bmatrix} A_1 \\ A_2 \\ A_3 \\ A_4 \end{bmatrix}$.

c) Define the coefficient matrix A and the constant matrix b.

d) Use the matrix method to find A_1, A_2, A_3 , A_4.

Task VIII:

You are working in a computer graphics company that designs images using computers. That is a very important technology in digital photography, film, video games, cell phone and computer display, and many specialized applications. You have been asked to design a logo for a game. An approximation for this logo is shown in Figure 1:
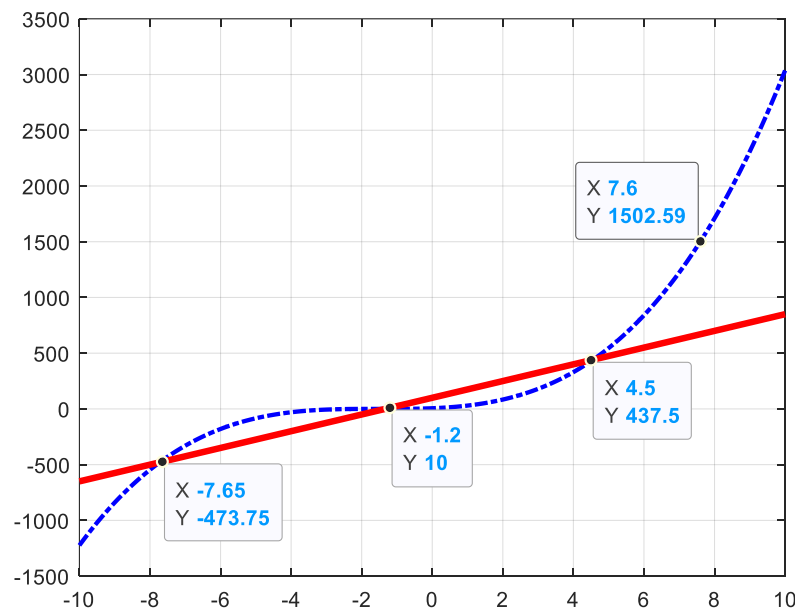

Figure 1

Knowing that the blue curve is a cubic curve with the following formula:

$$y_1 = ax^3 + bx^2 + cx + d$$

The formula for the red line is as follows:

$$y_2 = qx + p$$

Use MATLAB to do the following:

a) Use the matrix method to find the unknowns a, b, c, and d.

b) Use the matrix method to find the unknowns q and p.

c) Using the obtained formulas in a) and b). Reproduce the logo using plot() function. The curves should be with the same format (color and shape) that is shown in Figure 1. Add a legend to identify each. Label all axes, add grid lines, and title your graph. (Use the following increment x= -10:0.05:10).

Learning Outcomes and Assessment Criteria			
Learning Outcome	**Pass**	**Merit**	**Distinction**
LO1 Manipulating, processing, and visualizing data using computer software	**P1** Apply basic algebraic operations on input data using computer software **P2** Visualize data appropriately using computer software (as plots, charts, etc.)	**M1** Process input data using vectors and matrices	**D1** Build block diagrams for data processing using tools such as MATLAB Simulink
LO2 Mathematically modelling STEM problems	**P3** Model simple STEM problems	**M2** Model a range of STEM problems	**D2** Model complex STEM problems

STUDENT ASSESSMENT SUBMISSION AND DECLARATION

When submitting evidence for assessment, each student must sign a declaration confirming that the work is their own.

Student name and No.:		Assessor name:
Issue date: **4/12/2021**	Submission date: **18/12/2021**	Submitted on: **18/12/2021**
Programme:		
BTEC Course Number and Title**: NA** HTU Course Number and Title: 00103101: STEM 1 Lab		
Assignment number and title: Assignment #1-Part One: Manipulating, processing, and visualizing data using computer software and Mathematical Modelling		

Plagiarism

Plagiarism is a particular form of cheating. Plagiarism must be avoided at all costs and students who break the rules, however innocently, may be penalised. It is your responsibility to ensure that you understand correct referencing practices. As a university level student, you are expected to use appropriate references throughout and keep carefully detailed notes of all your sources of materials for material you have used in your work, including any material downloaded from the Internet. Please consult the relevant unit lecturer or your course tutor if you need any further advice.

Student Declaration

Student declaration

I certify that the assignment submission is entirely my own work and I fully understand the consequences of plagiarism. I understand that making a false declaration is a form of malpractice.

Student signature: **Date:**