Module Code & Title: (EGR2010-2223) - Data Modelling and Simulation

Contribution to Final Module Mark (module weighting): XX Total Marks: 100

Coursework Title: Mock Test

Coursework Issue Date: 04/05/2023

Coursework Submission Date & Time: 04/05/2023

Coursework Feedback Date:

Learning Outcomes Assessed:

LO1 Use mathematical techniques and models to generate data and show how understanding, analysis and hence design of engineering systems are informed by the underpinning maths.

- To be able to understand the concept of matrices and evaluate eigen values and eigen vectors
- Understanding the statistical methods of solving ODEs (Euler's Method, Runge-Kutta)
- To be able to implement various optimisation functions.
- Understand the essential elements of Fourier Series Analysis.

LO2 Design and write structured programmes in a high-level language and use them to solve familiar real world engineering problems

- To be able to understand the concept of Ordinary Differential Equations (ODEs) and obtaining mathematical and MATLAB-based solutions.
- Develop skills connecting modelling, simulation and testing
- Demonstrate a systematic approach to solving real-world control problems

LO3 Work and learn independently and communicate results effectively

Knowledge & Skills Assessed:

Subject Specific Knowledge, Skills and Understanding, Professional Graduate Skills.

Assessment Submission Instructions:

This submission is: ☒ Individual work.

☐ Group work.

You are required to submit your assessment in Portable Document Format (PDF) file format using the turnitin online assessment submission facility on the module Blackboard site.

All work should be submitted by the deadline stated above. Any late submissions will be subject to a lateness penalty in line with the University policy.

The method of submission described above should be used in the first instance however, in cases of technical issues please email your assessment to: soesubmissions@lincoln.ac.uk by the above deadline. Please include the module code and coursework title in the email subject.

All work will be subject to plagiarism and academic integrity checks. In submitting your assessment you are claiming that it is your own original work; if standard checks suggest otherwise, Academic Misconduct Regulations will be applied.

(10 marks)

Question 1

What is a Matrix? Explain the intuitive concept using a 2x2 matrix. (Page limit: 1 and can include figures or sketches).

(10 marks)

Question 2

What are Eigen values and Eigen vectors? Explain on the significance of computing Eigenvalues and Eigen vectors? Explain the intuitive concept using a 2x2 matrix. (Page limit: 1 and can include figures or sketches)

(10 marks)

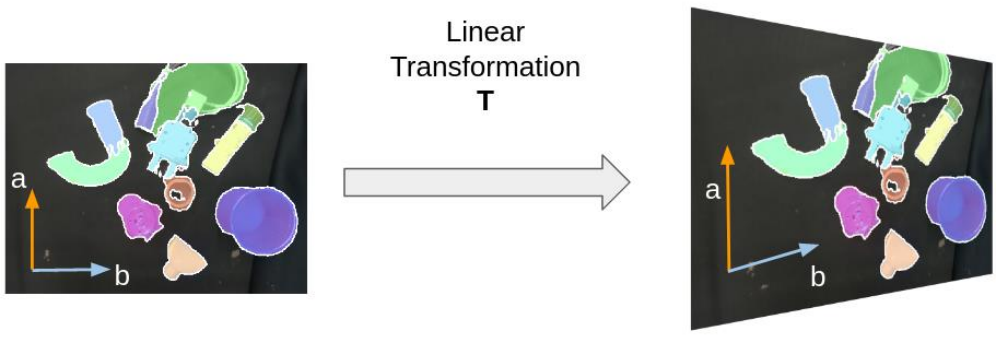
Question 3

3 marks

a. Write down the steps to solve the eigenvalue problem for an n x n matrix.

3 marks

b. Two vectors 'a' and 'b' were drawn on the image below. The picture then underwent a linear transformation T and is shown on the right. Answer the following



i. Which are eigenvectors and why?
ii. Which are not eigenvectors and why?
iii. From the image comment on eigenvalues of eigenvectors

4 marks

c. Check whether **V is an eigenvector** with the corresponding λ=0 for the matrix **A** ?

$$V = \begin{bmatrix} 1 \\ -2 \end{bmatrix} A = \begin{bmatrix} 6 & 3 \\ -2 & -1 \end{bmatrix}$$

(2+4+4 marks)

Question 4

Find Eigenvalue and Eigenvectors of given matrices.

a. A= $\begin{bmatrix} -1 & 2 \\ 0 & -1 \end{bmatrix}$

b. B= $\begin{bmatrix} 7 & 0 & -3 \\ -9 & -2 & 3 \\ 18 & 0 & -8 \end{bmatrix}$

c. C = $\begin{bmatrix} 1 & 1 & -2 \\ -1 & 0 & 1 \\ -2 & 1 & 1 \end{bmatrix}$

Verify (a), (b) and (c) using MATLAB?

(8+2 marks)

Question 5

Optimization matlab

$$y(x) = 2x^2 + 20x - 22$$

a. Find for what values of x the function achieves its minimum value (Use fminbnd command)
b. What is the minimum value?

(2+3 marks)

Question 6

Find Fast Fourier Transform of

a. Sine Wave (Amplitude =1, Duration = 1s) OR Cosine Wave (Amplitude = 1, Duration = 1s)
b. Square Wave (Amplitude = 1, Duration = 1s)

(10 marks)

Question 7

Fast Fourier Transform of a .wav signal:

a. Record a music for duration 10 seconds
b. Save the file in wav format
c. Upload wav data to MATLAB
d. Obtain time and frequency response (use fft command)

(7 + 8 marks)

Question 8

Solve the system of first order ordinary differential equations using (a) Euler Method and (b) Runge-Kutta method in MATLAB:

$$\frac{\mathrm{d}x}{\mathrm{d}t} = -5x + 5y; \frac{\mathrm{d}y}{\mathrm{d}t} = 14x - 2y - xz; \frac{\mathrm{d}z}{\mathrm{d}t} = -3z + xy$$

- Time Period - 0:5
- Initial Conditions - x(0)=1, y(0)=1, z(0)=1
- Step Size - 0.001

Question 9

10 marks

Obtain a numerical solution of the differential equation:

$$\frac{1}{x}\frac{\mathrm{d}y}{\mathrm{d}x} + 2y = 1$$

given the initial conditions that x = 0 when y = 1, in the range x = 0(0.2)1.0

Question 10

10 marks

Apply the Runge–Kutta method to solve the differential equation:

$$\frac{\mathrm{d}y}{\mathrm{d}x} = 3 - \frac{y}{x}$$

for the range 1.0(0.1)1.5, given the initial conditions that x = 1 when y = 2