College of Science
School of Engineering

Time Constrained Assessment

Module Title	**Data Modelling & Simulation**
Module Code	**EGR2010**
Module Coordinator	Seong-Ho Jin
Duration of Assessment	**4 hours**
Date	**17/01/2024**
Release Time	**13:30 - British Summer Time (BST)**
Submission Time	**17:30 - British Summer Time (BST)**

General Instructions to Candidates.
1. You **must** submit your answers to TurnItIn on Blackboard **before** the submission time: failure to do so will be classified as misconduct in examinations. It is strongly recommended you submit at least 15 minutes prior to the deadline.
2. You **must** also send a copy of your work to: soesubmissions@lincoln.ac.uk at the same time. You must place the Module Code and your Student ID in the Subject Field of the Mail.
3. For students who choose to word process their answers, hand-written notes or diagrams **must** be photographed (preferably using Microsoft Lens which is available as part of your Office 365 package) and inserted into the Word Document as an image.
4. This assessment is an open resource format: you may use online resources, lecture and seminar notes, text books and journals. All sources must be correctly attributed or referenced.
5. All work will be subject to plagiarism and academic integrity checks. In submitting your assessment, you are certifying that this is entirely your own work, without input from either commercial or non-commercial writers or editors, or advanced technologies such as Artificial Intelligence services. If standard checks suggest otherwise, Academic Misconduct Regulations will be applied.
6. The duration of the Time Constrained Assessment will vary for those students with Personalised Academic Study Support (PASS) plan. Extensions do not apply, but Extenuating Circumstances can be applied for in the normal way.

Module Specific Instructions to Candidates
1. Answer **FOUR questions**. All questions carry equal marks.
2. **No marks** will be awarded **if only the final answers are provided**. If you carry out the calculation **by hand**, please **explain the derivation step by step**.

Question 1

Consider the function $f(x) = x^2 + |x|$ defined for $-1 < x < 1$.

a) Compute the Fourier series for the function f(x) which is even. Show all necessary steps and provide the final expression for the Fourier series.

[13 marks]

b) Evaluate the value of following series

[12 marks]

$$S = \sum_{n=1}^{n=\infty} \frac{1 - 3\cos(n\pi)}{n^2}$$

Question 2

Determine the value of $y(0.3)$ using three different numerical methods for the initial value problem $y' = x + y$ and initial condition $y_0 = 1, x_0 = 1$:

a) The Euler method

[10 marks]

b) The Runge-Kutta method

[15 marks]

Question 3

For the linear system which is $AX = \lambda X$ where $A = \begin{pmatrix} 4 & 3 \\ -4 & -4 \end{pmatrix}$

    a) Find the eigenvalues of matrix A.

                                              [13 marks]

    b) Find the eigenvectors of matrix A.

                                              [12 marks]

Question 4

    a) Determine whether the following equations are linear or nonlinear.

    1. $y''' + y'' = \sin(x)$

    2. $2xy'' + 5y' = 0$

    3. $x^2 y'' + 5y' = 0$

                                              [6 marks]

b) For the following equation (second order ode)

$$y'' + 5y' + 2y = 0$$

1. write the system as 1st order differential equations by change variable method.

[12 marks]

2. Write the first order ode equations of previous part (part 1) in matrix form.

[7 marks]

Question 5

a) Solve the differential equation $\frac{\partial^2 u}{\partial x \partial y} = \sqrt{x+y} + \cos y$ *given the boundary*
    conditions that at $y = \frac{\pi}{2}$, $\frac{\partial u}{\partial x} = \pi$ *and at* $x = 0$, $u = 0$

[15 marks]

b) Find the particular solution of the following equation with the given initial
    condition:

$$y' + 2\sin(3\pi x) = 0 \, , y(0) = \frac{1}{\pi}$$

[10 marks]

[End of Time Constrained Assessment]