	<b>Daffodil Intern</b> Department of Computer S Cours	DIUCSE				
Course Code:	CSE 226					
Course Title:	Numerical Methods					
Program:	B.Sc. in Computer Science an	B.Sc. in Computer Science and Engineering				
Faculty:	Faculty of Science and Inform	nation Technology	(FSIT)			
Semester:	Fall	Year:	2024			
Credit:	3.0	<b>Contact Hour:</b>	2.5 Hrs/Week			
Course Level:	L2T2	Prerequisite:	MAT102, MA	Т211		
Course	Core Engineering					
Category:						
Instructor's	Dr. Bimal Chandra Das					
Name:						
Designation:	Associate Dean & Associate Professor					
Email:	bcdas@daffodilvarsity.edu.bd					
Office Address:	Room# 738, Knowledge Tow	ver				

### **Course Content (from syllabus):**

**Numbers and Errors:** Introduction, Accuracy and errors, Significant digits, Absolute and relative error, rounding error in functional evaluation, Propagation of error in arithmetic processand Truncation errors.

**Solution of Non-linear Equation:** Method of iteration, Bisection method,Newton–Raphson method, False position method, Secant method, Fixed point method.

**Interpolation:** Lagrange interpolation, Difference tables, Newton's forward and backward interpolation formula, Spline interpolation.

**Solution of Linear Equations**: Gaussian elimination, Gaussian elimination by pivoting, LU decomposition, Cholesky method, Triangular systems and back substitution, Gauss-Jordan method, Iteration method of Jacob and Gauss-Seidel.

**Curve Fitting:** Linear and polynomial regression, Fitting exponential and Trigonometric functions, Chebyshev polynomial.

**Numerical Integration & Differentiation:** Trapezoidal rule, Simpson's 1/3 rule, Simpson's 3/8 rule, Boole's rule, Weddle method and Rhomberg rule with error, Min-Max values of tabulated functions.

**Solution of Ordinary Differential Equations:** Runge-kutta method, Euler and modified Euler's method, Picard'smethod, Milne's method, Taylor's series methods.

#### **Course Description/Rationale:**

Numerical analysis is an area of mathematics and computer science that creates, analyzes, and implements algorithms for obtaining numerical solutions to problems involving continuous variables. Such problems arise throughout the natural sciences, social sciences, engineering, medicine, and business. Since the mid-20th century, the growth in power and availability of

digital computers have led to the increasing use of realistic mathematical models in science and engineering, and numerical analysis of increasing sophistication is needed to solve these more detailed models of the world. The formal academic area of numerical analysis ranges from quite theoretical mathematical studies to computer science issues. With the increasing availability of computers, the new discipline of scientific computing, or computational science, emerged during the 1980s and 1990s. The discipline combines numerical analysis, symbolic mathematical computations, computer graphics, and other areas of computer science to make it easier to set up, solve, and interpret complicated mathematical models of the real world.

### **Course Objective:**

This course aims to teach the students different numerical methods which are essential in many areas of modern life. This course will develop their programming knowledge and analytical ability of the underlying mathematics in popular software packages. From this course, students will learn:

- Computing integrals and derivatives.
- Solving differential equations.
- Building models based on data, be it through interpolation, Least Square, or othermethods.
- Root finding and numerical optimization.
- Estimating the solution to a set of linear and nonlinear equations.
- Computational geometry.

### Course Outcome (CO): (at the end of the course, students will be able to do :)

CO1	Demonstrate an understanding of common numerical methods and how they are
	used to obtain approximate solutions to otherwise intractable mathematical problems
	estimate errors in the calculation of various methods.
CO2	Apply numerical methods to obtain approximate solutions to mathematical problems
	from linear and non-linear equations.
CO3	Evaluate the accuracy of numerical methods for various mathematical operations and
	tasks, such as interpolation, differentiation, integration, the solution of linear and
	nonlinear equations, and the solution of differential equations.

#### **Content of the course:**

SL	<b>Course Content (as summary)</b>	Hrs	CO's
1	Numbers and Errors	6.0	CO1
2	Solution of Non-linear Equation	7.5	CO2

3	Solution of Linear Equations	6.0	CO2
4	Interpolation	9.0	CO3
5	Curve fitting	4.5	CO3
6	Numerical Integration & Differentiation	7.5	CO3
7	Solution of Ordinary Differential Equations	7.5	CO3

Mapping of CO with PO's, TLA's, Blooms Domain, KP's, EP's and EA's:

COs	POs	Teaching Learning Activity	Assessment Strategy	Blooms Taxonomy Domains and Levels	Knowledge Profile (WK)	Complex Engineering Problem (EP)	Complex Engineering Activity (EA)
CO1	PO1	Lecture, Group Study, Discussion, Exercise, Blended Learning	Quiz, Question answer, Midterm, Assignment	C2	K1	EP1, EP3	-
CO2	PO2	Lecture, Group Study, Discussion, Exercise, Blended Learning	Quiz, Question answer, Midterm, Final Assignment	C3	K2	EP1, EP3	-
CO3	PO3	Lecture, Group Study, Discussion, Exercise, Blended Learning	Quiz, Question answer, Final, Assignment	C5	K2	EP1, EP3	-

Bloom's Taxonomy Cognitive Domain C2: Understand C3: Apply C5: Evaluate

**Course Delivery Plan/ Lesson Delivery Plan:** 

Knowledge Profile K1: Natural Sciences K2: Mathematics **CEP Attributes** *EP1: Depth of knowledge required. EP3: Depth of analysis required.* 

# **CEA** Attributes

Week/Lesso n(hour)	Discussion Topic and Book Refer	Student Activities during Online and Onsite and TLA [course teacher will decide based on the type of the contents]	Mapping with CO and PO	Assessment Plan
Week-1 Lesson 1 & 2 [3 Hours]	Lesson 1: Overview of Numerical Methods. [Textbook 3, Chapter-1, Page (1-16)] Lesson 2: Error Analysis. [Textbook 3, Chapter-1, Page (17-41)]	Brainstorming sessions, Classroom discussion, Voice over PPT, Lecture video, Lecture note, Open discussion Brainstorming sessions, Classroom discussion, Voice over PPT, Lecture video, Lecture note, Open discussion	CO1, PO-1	Class Test, Assignment , Midterm
Week-2 Lesson 1 & 2 [3 Hours]	Lesson 1: Error Analysis. [Textbook, Chapter-1, Page (17-41)] Lesson 2: Error Analysis. [Textbook, Chapter-1, Page (17-41)]	Brainstorming sessions, Classroom discussion, Voice over PPT, Lecture video, Lecture note, Open discussion Brainstorming sessions, Classroom discussion, Voice over PPT, Lecture video, Lecture	CO1 PO-1	Class Test, Assignment , Midterm

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[Textbook -2, Chapter-1, Page (49-53)]sessions, Classroom discussion, Voice over PPT, Lecture video, Lecture note, Open discussionImage (49-53)Week-5Lesson 1: Fixed point methodBrainstorming sessions, ClassroomImage (2000) ClassroomLesson 1 & 2 [3 Hours][Textbook-2, Chapter-1, Page (31-37)]Brainstorming over PPT, Lecture over PPT, LectureCO2, Class Test, Assignment PO-2, PO-3	[3 Hours]		e	<b>PO-</b> 2	-
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Week-5Lesson 1: Fixed point methodBrainstorming sessions, ClassroomCO2, CC3Class Test, Assignment[3 Hours][Textbook-2, Chapter-1, Page (31-37)]discussion, Voice over PPT, LecturePO-2, PO-3, Midterm		Page (49-53)]			
Week-5Lesson 1: Fixed point methodBrainstorming sessions, ClassroomCO2, CO3Class Test, Assignment PO-2, , MidtermLesson 1 & 2 [3 Hours][Textbook-2, Chapter-1, Page (31-37)]discussion, Voice over PPT, LecturePO-2, PO-3, Midterm					
Week-5Lesson 1: Fixed point methodBrainstorming sessions, ClassroomCO2, CO3Class Test, Assignment[3 Hours][Textbook-2, Chapter-1, Page (31-37)]discussion, Voice over PPT, LecturePO-2, PO-3, Midterm			over PPT, Lecture		
Week-5Lesson 1: Fixed point methodBrainstorming sessions, ClassroomCO2, CO3Class Test, AssignmentLesson 1 & 2 [3 Hours][Textbook-2, Chapter-1, Page (31-37)]discussion, Voice over PPT, LecturePO-2, PO-3, Midterm			video, Lecture		
Week-5Lesson 1: Fixed point methodBrainstorming sessions, ClassroomCO2, Class Test, CO3Class Test, AssignmentLesson 1 & 2 [3 Hours][Textbook-2, Chapter-1, Page (31-37)]discussion, Voice over PPT, LecturePO-2, PO-3, Midterm			note, Open		
Week-Smethodsessions, ClassroomCO2, Class Test, CO3Class Test, AssignmentLesson 1 & 2 [3 Hours][Textbook-2, Chapter-1, Page (31-37)]discussion, Voice over PPT, LecturePO-2, PO-3, Midterm			discussion		
Lesson 1 & 2 [3 Hours]methodsessions, ClassroomCO2, Class Test, AssignmentClass Test, Assignment[3 Hours][Textbook-2, Chapter-1, Page (31-37)]discussion, Voice over PPT, LecturePO-2, PO-3, Midterm	Wook 5	Lesson 1: Fixed point	Brainstorming		
Lesson 1 & 2 [3 Hours][Textbook-2, Chapter-1, Page (31-37)]Classroom discussion, Voice over PPT, LectureCO3 PO-2, PO-3Assignment , Midterm	** CCR=J	method	sessions,	$CO^{2}$	Class Test
[3 Hours] [Textbook-2, Chapter-1, Page (31-37)] discussion, Voice over PPT, Lecture PO-2, PO-3, Midterm	Lasson 1 & 2		Classroom	,	
Page (31-37)] over PPT, Lecture PO-3		[Textbook-2, Chapter-1,	discussion, Voice		-
P()-3	[3 Hours]	Page (31-37)]	over PPT, Lecture		, whaterm
video, Lecture			video, Lecture	PO-3	

		noto Oncr		
		note, Open		
		discussion		
	Lesson 2: Lagrange	Brainstorming		
	interpolation	sessions,		
		Classroom		
	[Textbook-2, Chapter-1,	discussion, Voice		
	Page (101-107)]	over PPT, Lecture		
		video, Lecture		
		note, Open		
		discussion		
	Lesson 1: Difference tables	Brainstorming		
		sessions,		
	[Textbook-2, Chapter-1,	Classroom		
	Page (111-113)]	discussion, Voice		
		over PPT, Lecture		
Week-6		video, Lecture		
WEEK-U		note, Open		Class Test
Lesson 1 & 2		discussion	CO3	Class Test,
	Lesson 2: Newton's forward	Brainstorming	PO-3	Assignment Midterm
[3 Hours]	and backward interpolation	sessions,		, Midterm
	formula	Classroom		
		discussion, Voice		
	[Textbook-2, Chapter-1,	over PPT, Lecture		
	Page (75-90)]	video, Lecture		
		note, Open		
		discussion		
	Lesson 1: Spline	Brainstorming		
	interpolation	sessions,		
		Classroom		
	[Textbook-2, Chapter-1,	discussion, Voice		
	Page (182-193)]	over PPT, Lecture		
Week-7		video, Lecture		Class Test,
		note, Open	CO3	Assignment
Lesson 1 & 2		discussion	PO-3	
[3 Hours]	Lesson 2: Gaussian	Brainstorming		, Final Exam
	elimination	sessions,		
		Classroom		
	[Textbook-2, Chapter-1,	discussion, Voice		
	Page (263-265)]	over PPT, Lecture		
	1 460 (200 200)]	video, Lecture		

		note, Open		
		discussion		
	Lesson 1: Gaussian	Brainstorming		
	elimination by pivoting,	sessions,		
	chimitation by proting,	Classroom		
	[Textbook-2, Chapter-1,	discussion, Voice		
	Page (265-266)]	over PPT, Lecture		
	r age (203-200)]	video, Lecture		
Week-8				Class Test,
		note, Open discussion	CO3	· · · · ·
Lesson 1 & 2				Assignment
[3 Hours]	Lesson 2: LU	Brainstorming	PO-3	, F' 1 F
	decomposition, Cholesky's	sessions,		Final Exam
	method	Classroom		
		discussion, Voice		
	[Textbook, Chapter-1, Page	over PPT, Lecture		
	(271-274)]	video, Lecture		
		note, Open		
		discussion		
	Lesson 1: Triangular	Brainstorming		
	systems and back	sessions,		
	substitution	Classroom		
		discussion, Voice		
	[Textbook-2, Chapter-1,	over PPT, Lecture		
Week-9	Page (275-279)]	video, Lecture		
WEEK-9		note, Open		Class Test,
Lagar 1 & 2		discussion	CO3	Presentation
Lesson 1 & 2	Lesson 2: Gauss-Jordan	Brainstorming	PO-3	,
[3 Hours]	method.	sessions,		Final Exam
		Classroom		
	[Textbook-2, Chapter-1,	discussion, Voice		
	Page (266-270)]	over PPT, Lecture		
		video, Lecture		
		note, Open		
		discussion		
	Lesson 1: Jacob and	Brainstorming		
Week-10	Gauss-Seidel	sessions,		Class Test,
_		Classroom	CO3	Presentation
Lesson 1 & 2	[Textbook-2, Chapter-1,	discussion, Voice	PO-3	
[3 Hours]	Page (279-283)]	over PPT, Lecture		, Final Exam
	1 460 (217 200)]			i mui DAum
		video, Lecture		

		note, Open		
		discussion		
	Lesson 2: Linear and			
		Brainstorming		
	polynomial regression	sessions,		
		Classroom		
	[Textbook-2, Chapter-1,	discussion, Voice		
	Page (127-133)]	over PPT, Lecture		
		video, Lecture		
		note, Open		
		discussion		
	Lesson 1: Exponential and	Brainstorming		
	Trigonometric functions	sessions,		
		Classroom		
	[Textbook-2, Chapter-1,	discussion, Voice		
	Page (135-139)]	over PPT, Lecture		
Week-11		video, Lecture		
WEEK II		note, Open		Class Test,
Lesson 1 & 2		discussion	CO3	Presentation
[3 Hours]	Lesson 2: Chebyshev	Brainstorming	PO-3	,
[5 110015]	polynomial	sessions,		Final Exam
		Classroom		
	[Textbook-2, Chapter-1,	discussion, Voice		
	Page (149-151)]	over PPT, Lecture		
		video, Lecture		
		note, Open		
		discussion		
	Lesson 1: Trapezoidal rule,	Brainstorming		
	Simpson's 1/3 rule,	sessions,		
	Simpson's 3/8 rule.	Classroom		
	-	discussion, Voice		
	[Textbook-2, Chapter-1,	over PPT, Lecture		
Week-12	Page (219-22)]	video, Lecture		Class Test,
		note, Open	CO3	Presentation
Lesson 1 & 2		discussion	PO-3	
[3 Hours]	Lesson 2: Boole's rule	Brainstorming		Final Exam
		sessions,		
	[Textbook-2, Chapter-1,	Classroom		
	Page (222-225)]	discussion, Voice		
		over PPT, Lecture		
		video, Lecture		
		viueo, Lecture		

		note, Open		
		discussion		
	<b>T 1</b> - W/ - 1			
	Lesson 1: Weddle's method	Brainstorming		
		sessions,		
	[Textbook-2, Chapter-1,	Classroom		
	Page (1-16)]	discussion, Voice		
		over PPT, Lecture		
Week-13		video, Lecture		
Week 15		note, Open		Class Test,
Lesson 1 & 2		discussion	CO3	Presentation
[3 Hours]	Lesson 2: Rhomberg rule	Brainstorming	PO-3	,
	with error	sessions,		Final Exam
		Classroom		
	[Textbook-2, Chapter-1,	discussion, Voice		
	Page (222-225)]	over PPT, Lecture		
	-	video, Lecture		
		note, Open		
		discussion		
	Lesson 1: Min-Max value of	Brainstorming		
	tabulated functions	sessions,		
		Classroom		
	[Textbook, Chapter-1, Page	discussion, Voice		
	(217-219)]	over PPT, Lecture		
		video, Lecture		
Week-14		note, Open		Class Test,
		discussion	CO3	Presentation
Lesson 1 & 2	Lesson 2: Euler method,	Brainstorming	PO-3	
[3 Hours]	Modified Euler's method	sessions,	100	, Final Exam
		Classroom		
	[Textbook, Chapter-1, Page	discussion, Voice		
	(307-315)]	over PPT, Lecture		
	(507-515)]	video, Lecture		
		note, Open		
		discussion		
	Logon 1. Toylors series			
Week-15	Lesson 1: Taylors series	Brainstorming		Class Test
	methods	sessions,	$CO^{2}$	Class Test,
Lesson 1 & 2		Classroom	CO3	Presentation
[3 Hours]	[Textbook, Chapter-1, Page	discussion, Voice	PO-3	,
	(303-307)]	over PPT, Lecture		Final Exam
		video, Lecture		

		2		1
		note, Open		
		discussion		
	Lesson 2: Picard's method,	Brainstorming		
	Milne's method.	sessions,		
		Classroom		
	[Textbook, Chapter-1, Page	discussion, Voice		
	(305-320)]	over PPT, Lecture		
		video, Lecture		
		note, Open		
		discussion		
	Lesson 1: Runge-kutta	Brainstorming		
	method	sessions,		
		Classroom		
	[Textbook-2, Chapter-1,	discussion, Voice		
	Page (310-314)]	over PPT, Lecture		
Week-16		video, Lecture		
vveek-10		note, Open		Class Test,
Lesson 1 & 2		discussion	CO3	Presentation
[3 Hours]	Lesson 2: Review class	Brainstorming	PO-3	,
		sessions,		Final Exam
	[Textbook, Chapter-1, Page	Classroom		
	(17-64)]	discussion, Voice		
		over PPT, Lecture		
		video, Lecture		
		note, Open		
		discussion		

# **Assessment Pattern:**

Assessment Task	CO's			Mark (Total=100)
	CO1	CO2	CO3	(2000 200)
Attendance				7
Class Test (CT1, CT2, CT3)				15
Assignmentt				5

Presentation				8
Midterm Examinatio n	5	10	10	25
Semester Final Examination	0	20	20	40
CO-wise Total Mark	5	30	30	100

## CIE – Breakup (Theory) [60 marks]

Bloom's Criteria	Attendance (07)	Class Test (15)	Assignment (05)	Presentation (08)	Mid Exam (25)
Remember					02
Understand		05		02	03
Apply		05	03	03	10
Analyze					00
Evaluate		05	02	03	10

# SEE – Semester End Examination [40 marks] {Theory}

Bloom Criteria	Score for the Test		
Remember	-		
Understand	-		
Apply	20		
Analyze	-		
Evaluate	20		

## **Learning Materials:**

### **Textbook/Recommended Readings:**

- 1. Burden, R. L., and Faires, J. D., Numerical Analysis, Sixth Edition, Brooks/Cole Publishing Company, 1997.
- 2. Gerald, G. F., and Wheatley, P. O., Applied Numerical Analysis, Fourth Edition, Addison Wesley Publishing Company, 1989.
- 3. Introductory methods of numerical analysis by S.S. Sastry, Fifth Edition.

## **Reference Books/ Supplementary Readings:**

- 1. An Introduction to Numerical Analysis by Kendall E. Atkinson.
- 2. Numerical Methods for Mathematics, Science and Engineering by John H. Mathews.
- 3. Elementary Numerical Analysis: An Algorithmic Approachby S. D. Conte, Carl de Boo.
- 4. Fundamentals of Numerical Analysis Book by Augustus H. Fox.

# **Other Readings:**

- **1.** Form BLC Course Blog.
- 2. Different supporting tutorials from <u>https://www.youtube.com/watch?v=1\_Hfi1EV0-k</u>
- 3. <u>Numerical methods blog.</u>