Daffodil InternationalUniversity

Department of Computer Science and Engineering(CSE)
Course Outline

Course Code:	CSE 226		
Course Title:	Numerical Methods		
Program:	B.Sc. in Computer Science and Engineering		
Faculty:	Faculty of Science and Information Technology (FSIT)		
Semester:	Fall	**Year:**	2024
Credit:	3.0	**Contact Hour:**	2.5 Hrs/Week
Course Level:	L2T2	**Prerequisite:**	MAT102, MAT211
Course Category:	Core Engineering		
Instructor's Name:	Dr. Bimal Chandra Das		
Designation:	Associate Dean & Associate Professor		
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Office Address:	Room# 738, Knowledge Tower		

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	Course Content (as summary)	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*

Knowledge Profile
K1: *Natural Sciences*
K2: *Mathematics*

CEP Attributes
EP1: *Depth of knowledge required.*
EP3: *Depth of analysis required.*

CEA Attributes

Course Delivery Plan/ Lesson Delivery Plan:

Week/Lesson(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)]	Brainstorming sessions, Classroom discussion, Voice over PPT, Lecture video, Lecture note, Open discussion	CO1, PO-1	Class Test, Assignment, Midterm
	Lesson 2: Error Analysis. [Textbook 3, Chapter-1, Page (17-41)]	Brainstorming sessions, Classroom discussion, Voice over PPT, Lecture video, Lecture note, Open discussion		
Week-2 Lesson 1 & 2 [3 Hours]	**Lesson 1:** Error Analysis. [Textbook, Chapter-1, Page (17-41)]	Brainstorming sessions, Classroom discussion, Voice over PPT, Lecture video, Lecture note, Open discussion	CO1 PO-1	Class Test, Assignment, Midterm
	Lesson 2: Error Analysis. [Textbook, Chapter-1, Page (17-41)]	Brainstorming sessions, Classroom discussion, Voice over PPT, Lecture video, Lecture		

		note, Open discussion		
Week-3 Lesson 1 & 2 [3 Hours]	**Lesson 1:** Method of iteration, Bisection method [Textbook-2, Chapter-1, Page (23-28)]	Brainstorming sessions, Classroom discussion, Voice over PPT, Lecture video, Lecture note, Open discussion	CO2 PO-2	Class Test, Assignment, Midterm
	Lesson 2: Newton–Raphson method. [Textbook-2, Chapter-1, Page (38-43)]	Brainstorming sessions, Classroom discussion, Voice over PPT, Lecture video, Lecture note, Open discussion		
Week-4 Lesson 1 & 2 [3 Hours]	**Lesson 1:** False position method [Textbook-2, Chapter-1, Page (28-31)]	Brainstorming sessions, Classroom discussion, Voice over PPT, Lecture video, Lecture note, Open discussion	CO2 PO-2	Class Test, Assignment, Midterm
	Lesson 2: Secant method [Textbook -2, Chapter-1, Page (49-53)]	Brainstorming sessions, Classroom discussion, Voice over PPT, Lecture video, Lecture note, Open discussion		
Week-5 Lesson 1 & 2 [3 Hours]	**Lesson 1:** Fixed point method [Textbook-2, Chapter-1, Page (31-37)]	Brainstorming sessions, Classroom discussion, Voice over PPT, Lecture video, Lecture	CO2, CO3 PO-2, PO-3	Class Test, Assignment, Midterm

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

		note, Open discussion		
Week-8 Lesson 1 & 2 [3 Hours]	**Lesson 1:** Gaussian elimination by pivoting, [Textbook-2, Chapter-1, Page (265-266)]	Brainstorming sessions, Classroom discussion, Voice over PPT, Lecture video, Lecture note, Open discussion	CO3 PO-3	Class Test, Assignment, Final Exam
	Lesson 2: LU decomposition, Cholesky's method [Textbook, Chapter-1, Page (271-274)]	Brainstorming sessions, Classroom discussion, Voice over PPT, Lecture video, Lecture note, Open discussion		
Week-9 Lesson 1 & 2 [3 Hours]	**Lesson 1:** Triangular systems and back substitution [Textbook-2, Chapter-1, Page (275-279)]	Brainstorming sessions, Classroom discussion, Voice over PPT, Lecture video, Lecture note, Open discussion	CO3 PO-3	Class Test, Presentation, Final Exam
	Lesson 2: Gauss-Jordan method. [Textbook-2, Chapter-1, Page (266-270)]	Brainstorming sessions, Classroom discussion, Voice over PPT, Lecture video, Lecture note, Open discussion		
Week-10 Lesson 1 & 2 [3 Hours]	**Lesson 1:** Jacob and Gauss-Seidel [Textbook-2, Chapter-1, Page (279-283)]	Brainstorming sessions, Classroom discussion, Voice over PPT, Lecture video, Lecture	CO3 PO-3	Class Test, Presentation, Final Exam

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

		note, Open discussion		
Week-13 Lesson 1 & 2 [3 Hours]	**Lesson 1:** Weddle's method [Textbook-2, Chapter-1, Page (1-16)]	Brainstorming sessions, Classroom discussion, Voice over PPT, Lecture video, Lecture note, Open discussion	CO3 PO-3	Class Test, Presentation , Final Exam
	Lesson 2: Rhomberg rule with error [Textbook-2, Chapter-1, Page (222-225)]	Brainstorming sessions, Classroom discussion, Voice over PPT, Lecture video, Lecture note, Open discussion		
Week-14 Lesson 1 & 2 [3 Hours]	**Lesson 1:** Min-Max value of tabulated functions [Textbook, Chapter-1, Page (217-219)]	Brainstorming sessions, Classroom discussion, Voice over PPT, Lecture video, Lecture note, Open discussion	CO3 PO-3	Class Test, Presentation , Final Exam
	Lesson 2: Euler method, Modified Euler's method [Textbook, Chapter-1, Page (307-315)]	Brainstorming sessions, Classroom discussion, Voice over PPT, Lecture video, Lecture note, Open discussion		
Week-15 Lesson 1 & 2 [3 Hours]	**Lesson 1:** Taylors series methods [Textbook, Chapter-1, Page (303-307)]	Brainstorming sessions, Classroom discussion, Voice over PPT, Lecture video, Lecture	CO3 PO-3	Class Test, Presentation , Final Exam

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

Assessment Pattern:

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

Presentation	--	--	--	8
Midterm Examination	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 https://www.youtube.com/watch?v=1_Hfi1EV0-k
3. Numerical methods blog.