Islamic University of Technology
Department of Computer Science and Engineering (CSE)
Course Outline and Course Plan

Name of the Teacher	**Syed Rifat Raiyan**	**Position**	**Lecturer**
Department	**CSE**	**Programme**	**B.Sc. Engg. CSE**
Course Code	**Math 4543**	**Course Title**	**Numerical Methods**
Academic Year	**2023-2024**	**Semester**	**Winter**
Contact Hours	**3.0**	**Credit Hours**	**3.0**
Textbooks and Reference books	**1. Numerical Methods with Applications 2. Introduction to Numerical Methods and Matlab Programming for Engineers**	**Authors of the books**	**1. Autar Kaw and Egwu K. Kalu 2. Todd Young and Martin Mohlenkamp**
Prerequisites (If any)	**1. Math 4141: Geometry and Differential Calculus 2. Math 4241: Integral Calculus and Differential Equations 3. Math 4341: Linear Algebra**		
Google Classroom link	https://classroom.google.com/c/NzEwMjQzNjA1NTgy?cjc=hjqlnji		
Teaching Methods/ Approaches	☐ **Lecture ✔** ☐ **Group discussion** ☐ **Demonstration** ☐ **Problem solving ✔** ☐ **Project** ☐ **Others: Tutorial classes ✔**		
Teaching aids	**Multi-media ✔** **OHP** **Board and Marker ✔** **Others**		

Course Assessment Method								
Attendance (10%)	**Quiz 15% of Total Marks (Best 3 out of 4)**						**Mid Semester (25%)**	**Semester Final (50%)**
	1st Quiz	**2nd Quiz**	**3rd Quiz**	**4th Quiz**	**Others**		**Week/Date**	**Week/Date**
	Week/Date	**Week/Date**	**Week/Date**	**Week/Date**	**Assignment**	**Homework**		
	4th Week	**6th Week**	**10th Week**	**13th Week**	**1 Assignment**	**Will be given time to time**	**8th Week**	**15th Week**

Grading Policy					
Marks out of 100	**Letter Grade**	**Grade Point**	**Marks out of 100**	**Letter Grade**	**Grade Point**
80 - 100	A+	4.00	55 - 59	B-	2.75
75 - 79	A	3.75	50 - 54	C+	2.50
70 - 74	A-	3.50	45 - 49	C	2.25
65 - 69	B+	3.25	40 – 44	D	2.00
60 - 64	B	3.00	00 - 39	F	0.00

Course Contents
Finding roots of Nonlinear Equations: Bisection method, False position method, Newton-Raphson method, Secant Method. **Approximation and Errors:** Measuring Error, Concept of Significant Digits, Sources of Errors. **Series:** Taylor Series, Maclaurin Series. **Interpolation:** Direct method, Newton's Divided Difference interpolation, Lagrangian interpolation, Spline Interpolation. **Regression:** Linear Regression, Nonlinear models for Regression. **Integration:** Trapezoidal Rule of Integration, Simpson's 1/3 rule of Integration, Simpson's 3/8 rule of Integration. **Differential Equations:** Euler's method for Ordinary Differential Equations, Runge-Kutta 2nd order method for Ordinary Differential Equations, Higher order Differential Equations, Runge-Kutta 4th order method for Ordinary Differential Equations, Numerical Differentiation. **Linear Algebra:** LU Decomposition, Eigenvalues, and Eigenvectors.

Course Objectives
The subject aims to equip the students such that they will be able to face an engineering problem and do the following: 1) Understand the use of numerical methods in engineering applications, 2) Formulate problems in a way that can be solved by numerical methods, 3) Measure the accuracy of a numerical analysis system, and 4) Provide background for the study and development of more advanced topics and applications.

Mapping with CO, PO and Bloom's Taxonomy			
CO No.	**Course Outcomes (CO) Statement**	**Levels of Bloom's Taxonomy**	**Matching with Program Outcome (PO)**
CO1	**Formulate** real-life engineering problems into mathematical models/processes that can be solved using numerical methods.	C2	PO2
CO2	**Apply** numerical analysis techniques to solve problems from various engineering disciplines.	C3	PO1, PO2
CO3	**Analyze** the theoretical concepts, complexities, and performances of different numerical algorithms for different problem scenarios and use cases.	C4	PO1, PO2
CO4	**Understand** the underlying fundamental principles to derive and deduce the mathematical concepts behind various numerical methods.	C2	PO1

Weekly plan for course content and mapping with CO		
Weeks	**Topics**	**COs**
1	**Nonlinear Equations:** Intermediate Value Theorem, Bisection method, Advantages and Drawbacks of Bisection method.	CO1, CO2, CO3, CO4
2	**Approximation and Errors:** Measuring Errors, Sources of Errors, Significant Digits.	CO3
3	**Nonlinear Equations (Continued):** Newton-Raphson method, Secant Method, False Position method.	CO1, CO2, CO3, CO4
4	**Taylor Series:** Taylor Series, Maclaurin Series, Error in Taylor Series.	CO2, CO3, CO4
5	**Interpolation:** Difference between Interpolation and Extrapolation, Use of polynomials in Interpolation, Direct Method of Interpolation, Newton's Divided Difference Polynomial Method, Lagrangian Interpolation, Spline method of Interpolation	CO1, CO2, CO3, CO4
6		
7		
8	Midterm examinations	CO1, CO2, CO3, CO4
9		

10	**Regression:** Linear Regression, Nonlinear models for Regression – Exponential model, Growth model, and Polynomial Model, Transforming nonlinear data to use linear regression formula	CO1, CO2, CO3, CO4
11		
12	**Integration:** Concept of Integration, Trapezoidal rule of Integration, Simpson's 1/3 rule, Simpson's 3/8 rule	CO1, CO2, CO3, CO4
13		
14	**Differentiation:** Euler's method for Ordinary Differential Equation, Solution of Definite Integral using Euler's method, Runge-Kutta 2nd order method, Runge-Kutta 4th order method, Higher order equations, Numerical Differentiation	CO1, CO2. CO3, CO4
15		
16	**Linear Algebra:** LU Decomposition, Eigenvalues, and Eigenvectors.	CO1, CO2
17	Final Examinations	CO1, CO2, CO3, CO4
18		
19		

Program Outcomes	
PO 1	**Engineering Knowledge:** Apply knowledge of **mathematics, natural science**, **engineering** fundamentals and system fundamentals, software development, networking & communication, and information assurance & security to the solution of complex engineering problems in computer science and engineering.
PO 2	**Problem Analysis:** Ability to **identify**, **formulate** and **analyze complex** Computer Science and Engineering problems in the areas of hardware, software, theoretical Computer Science and applications to reach significant conclusions by applying Mathematics, Natural sciences, Computer Science and Engineering principles.
PO 3	**Design/ Development of Solutions:** **Design solutions** for complex computer science and engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
PO 4	**Investigation:** Ability to use **research based knowledge** and **research methods** to perform literature survey, design experiments for complex problems in designing, developing and maintaining a computing system, collect data from the experimental outcome, analyze and interpret valid/interesting patterns and conclusions from the data points.
PO 5	**Modern Tool Usage:** Ability to create, select and apply **state-of-the-art tools** and techniques in designing, developing and testing a computing system or its component.
PO 6	**The Engineer and Society:** Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to **professional engineering practice** in system development and solutions to **complex engineering problems** related to system fundamentals, software development, networking & communication, and information assurance & security.
PO 7	**Environment and Sustainability:** Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.
PO 8	**Ethics:** Apply **ethical principles** and commit to **professional ethics** and **responsibilities** and norms of computer science and engineering practice.
PO 9	**Individual Work and Teamwork:** Ability to function as an individual and as a team player or leader in multidisciplinary teams and strive towards **achieving a common goal.**
PO 10	**Communication:**

	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project Management and Finance:** Demonstrate knowledge and understanding of engineering management principles and economic decision making and apply these to one's own work, as a member and leader in a team, to **manage projects** and in multidisciplinary environments.
PO 12	**Life-long learning:** Recognize the need for, and have the preparation and ability to **engage in independent** and **lifelong learning** in the broadest context of technological change.

Mapping of COs and POs [Correlation level 1 for low, 2 for moderate and 3 for high]												
Course Outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1		3										
CO2	3	2										
CO3	2	3										
CO4	3											