Bangladesh University of Engineering and Technology (BUET)
Department of Computer Science and Engineering (CSE)

Course Outline

Program: B.Sc.Engg.

Course Title: Numerical Methods

Course Code: CSE218

Semester: 1st Semester

Level: 2nd Year

Credit Hour: 2.00

Name & Designation of Course Teacher: Sukarna Barua

Office/Room: Virtual

Class Hours: 4

Consultation Hours: 1

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Mobile: 01674069126

Rationale: N/A

Pre-requisite (if any)**:** None

Course Synopsis:

This course is the study of numerical methods to solve mathematical problems. The course teaches in-depth knowledge of the mathematical formulations of numerical methods and the computer algorithms for generating numerical solutions. The topics expected to be covered include the following: i) Solution of Non-linear Equations: Fixed Point Iteration, Bi-Section method, False Position method, Newton-Raphson method, Bairstow's Method; ii) Solution of Linear equations: Triangular systems and back substitution, Gauss-Jordan elimination method, Pivoting, LU-factorization, Cholesky's method, Dolittle and Crout factoriza- tion; iii) Interpolation and Approximation: Taylor's Series, Lagrangian interpolation,

Divided differences formula, Newton's forward and backward interpolation, Spline interpolation; iv) Differentiation: Numerical differentiation, Richardson's extrapolation; iv) Integration: Newton's-Cote integration, Trapezoidal rule, Simpson's rule, Romberg's integration; vi) Ordinary Differential Equations: Euler's method, Picard's method, Milne's method, Taylor's series method, Runge-Kutta method; vii) Curve Fitting: Least squares lines, Least square polynomials, Non-linear curve fitting; viii) Numerical Optimization: Golden Ratio search, Newton's search, Powell's method, Gradient search.

Course Objectives:

Upon completion of this course, the students will be able to -

1. analyze numerical method formulations for different mathematical and engineering problems.

2. apply numerical methods to find solutions of mathematical problems.

3. write computer programs to implement numerical methods in Python.

4. analyze and evaluate the accuracy of numerical method solutions.

Course Outcomes (CO) and their mapping with Program outcomes (PO) and Teaching-Learning Assessment methods:

CO No.	CO Statements: Upon successful completion of the course, students should be able to -	Corresponding POs (Appendix-1)	Bloom's taxonomy domain/level (Appendix-2)	Delivery methods and activities	Assessment Tools
CO1	analyze numerical method formulations for different mathematical and engineering problems.	1	1	Lecture	Assignment, Final quiz
CO2	apply numerical methods to find solutions of mathematical problems.	2	1	Lecture, Problem Solving	Assignment, Final quiz
CO3	write computer programs to implement numerical methods in Python.	6	1	Lecture, Problem Solving	Assignment
CO4	analyze and evaluate the accuracy of numerical method solutions.	1	1	Lecture, Problem Solving	Assignment, Final quiz

Weighting COs with Assessment methods:

Assessment Type	% weight	CO1	CO2	CO3	CO4
Assignment	**65%**		25	35	5
Final quiz	**35%**	15	15		5
Total	**100%**	15	40	35	10

Grading Policy: As per the approved grading policy of BUET (Appendix-3)

Course Content Outline and mapping with COs

Weeks	Topics / Content / Assignment	Course Outcomes	Delivery methods and activities	Reading Materials
1	Theory: Introduction; *Lab*: Lecture on Python	CO1	Lecture	Book - Numerical Methods with Applications by Autar K Kaw, Egwu Eric Kalu
2	*Theory*: Solution of Non-linear equations-1 *Lab*: Lecture on Python	CO1, CO2	Lecture, Programming Practice	Book- Numerical Methods with Applications by Autar K Kaw, Egwu Eric Kalu
3	*Theory*: Solution of Non-linear equations-2 *Lab*: Lecture on Python. Home assignment 1 on solution of non-linear equations	CO1 - CO4	Lecture, Problem Solving, Home Assignment	Book- Numerical Methods with Applications by Autar K Kaw, Egwu Eric Kalu
4	*Theory*: Solution of Linear equations-1 *Lab*: Evaluation of Home Assignment 1	CO1, CO2	Lecture, Home Assignment Evaluation	Book- Numerical Methods with Applications by Autar K Kaw, Egwu Eric Kalu
5	*Theory*: Solution of Linear equations-2 *Lab*: Home Assignment 2 on Solution on Linear Equations.	CO1 - CO4	Lecture, Home Assignment	Book- Numerical Methods with Applications by Autar K Kaw, Egwu Eric Kalu

6	Theory: Interpolation and Approximation-1 *Lab*: Evaluation of Home Assignment 2	CO1, CO2	Lecture, Home Assignment Evaluation	Book- Numerical Methods with Applications by Autar K Kaw, Egwu Eric Kalu
7	Theory: Interpolation and Approximation-2 *Lab*: Online assignment 1 on Solving Linear and Non-Linear Equations	CO1 - CO4	Lecture, Lab Assignment	Book- Numerical Methods with Applications by Autar K Kaw, Egwu Eric Kalu
8	Theory: Interpolation and Approximation-3	CO1, CO2	Lecture	Book- Numerical Methods with Applications by Autar K Kaw, Egwu Eric Kalu
9	Theory: Integration-1 *Lab*: Online assignment 2 on Interpolation and approximation	CO1 - O4	Lecture, Lab Assignment	Book- Numerical Methods with Applications by Autar K Kaw, Egwu Eric Kalu
10	Theory: Integration-2 Lab: Home Assignment on Integration	CO1- CO4	Lecture, Home Assignment	Book- Numerical Methods with Applications by Autar K Kaw, Egwu Eric Kalu
11	Theory: Curve Fitting Lab: Evaluation of Home Assignment on Integration	CO1, CO2	Lecture, Home Assignment Evaluation	Book- Numerical Methods with Applications by Autar K Kaw, Egwu Eric Kalu
12	Theory: Ordinary Differential Equations Lab: Online assignment on Curve Fitting	CO1 – CO4	Lecture, Lab Assignment	Book- Numerical Methods with Applications by Autar K Kaw, Egwu Eric Kalu
13	Theory: Numerical Optimization: Golden Ratio search, Newton's search, Powell's method, Gradient search. Lab: Final Quiz	CO1, CO2, CO4	Lecture, Final Quiz	Book- Numerical Methods with Applications by Autar K Kaw, Egwu Eric Kalu

Required Reference(s):   Numerical Methods with Applications by Autar K Kaw and Egwu Eric Kalu

Recommended Reference(s):   Numerical Methods for Engineers 7th Edition by Steven Chapra and Raymond Canale

Special Instructions:

1. Attendance: Attendance in 60% of classes is recommended.

2. Assignment submission rules: Deadlines are strictly followed. No late submission is allowed except extraordinary circumstances.

3. Plagiarism policy: Copying code and assignment will be strictly punished. These will be reported to Academic Council and action will be taken according to the university policy.

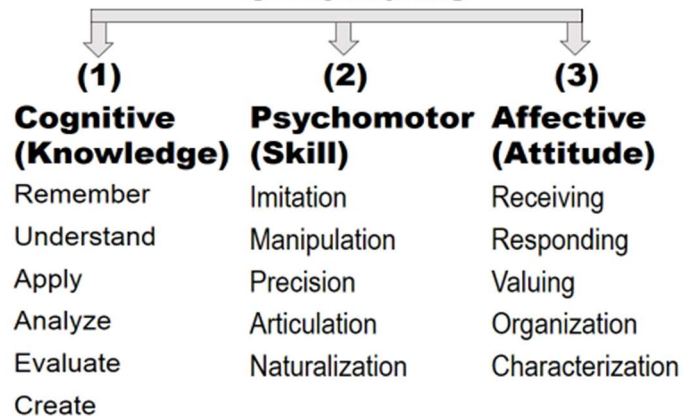| Prepared by	Checked by	Approved by
Sukarna Barua (**Course Teacher & Sessional Class Coordinator**)	**Chairman, SAC committee**	*Head of the Department*

Appendix-1:

Washington Accord Program Outcomes (PO) for engineering programs:

No.	PO	Differentiating Characteristic
1	Engineering Knowledge	Breadth and depth of education and type of knowledge, both theoretical and practical
2	Problem Analysis	Complexity of analysis
3	Design/ development of solutions	Breadth and uniqueness of engineering problems i.e. the extent to which problems are original and to which solutions have previously been identified or codified
4	Investigation	Breadth and depth of investigation and experimentation
5	Modern Tool Usage	Level of understanding of the appropriateness of the tool
6	The Engineer and Society	Level of knowledge and responsibility
7	Environment and Sustainability	Type of solutions.
8	Ethics	Understanding and level of practice
9	Individual and Team work	Role in and diversity of team
10	Communication	Level of communication according to type of activities performed
11	Project Management and Finance	Level of management required for differing types of activity
12	Lifelong learning	Preparation for and depth of Continuing learning.

Appendix-2

Bloom's Taxonomy (Taxonomy of Learning)
3 Domains

(1) Cognitive (Knowledge)	(2) Psychomotor (Skill)	(3) Affective (Attitude)
Remember	Imitation	Receiving
Understand	Manipulation	Responding
Apply	Precision	Valuing
Analyze	Articulation	Organization
Evaluate	Naturalization	Characterization
Create		

BUET Grading Policy:

Numeric Grade	Letter Grade	Grade Point
80% and above	A+	4.00
75% to less than 80%	A	3.75
70% to less than 75%	A-	3.50
65% to less than 70%	B+	3.25
60% to less than 65%	B	3.00
55% to less than 60%	B-	2.75
50% to less than 55%	C+	2.50
45% to less than 50%	C	2.25
40% to less than 45%	D	2.00
Less than 40%	F	0.00