**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 Teacher:** Sukarna Barua

**Office/Room:** Virtual

**Class Hours:** 4

**Consultation Hours:** 1

**E-mail:** sukarnabarua@cse.buet.ac.bd

**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. design algorithms for different numerical method solutions.

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

5. 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 | Final quiz |
| CO2 | apply numerical methods to find solutions of mathematical problems. | 2 | 1 | Lecture, Problem Solving | Final quiz,  Assignment |
| CO3 | design algorithms for different numerical method solutions. | 3 | 1 | Lecture, Problem Solving | Assignment,  Final quiz |
| CO4 | Write computer programs to implement numerical methods in Python. | 6 | 1 | Lecture, Problem Solving | Assignment |
| CO5 | 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** | **CO5** |
| Final quiz | **30%** | 10 | 10 | 5 |  | 5 |
| Assignment | **70%** |  | 10 | 15 | 40 | 5 |
| **Total** | **100%** | 10 | 20 | 20 | 40 | 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  *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  *Lab*: Lecture on Python. Home assignment 1 on solution of non-linear equations | CO1 - CO5 | Lecture, Problem Solving, Home Assignment | Book- Numerical Methods with Applications by Autar K Kaw, Egwu Eric Kalu |
| 4 | *Theory*: Solution of Linear equations  *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  *Lab*: Home Assignment 2 on Solution on Linear Equations. | CO1 - CO3,  CO4 | Lecture, Home Assignment | Book- Numerical Methods with Applications by Autar K Kaw, Egwu Eric Kalu |
| 6 | *Theory*: Solution of Linear equations  *Lab*: Evaluation of Home Assignment 2 | CO1, | Lecture, Home Assignment Evaluation | Book- Numerical Methods with Applications by Autar K Kaw, Egwu Eric Kalu |
| 7 | Theory: Interpolation and Approximation  *Lab*: Online assignment 1 on Solving Linear and Non-Linear Equations | CO1, CO2,  CO4 | Lecture, Lab Assignment | Book- Numerical Methods with Applications by Autar K Kaw, Egwu Eric Kalu |
| 8 | Theory: Interpolation and Approximation | CO1, CO2 | Lecture | Book- Numerical Methods with Applications by Autar K Kaw, Egwu Eric Kalu |
| 9 | Theory: Interpolation and Approximation  *Lab*: Online assignment 2 on Interpolation and approximation | CO1, CO2,  CO4 | Lecture, Lab Assignment | Book- Numerical Methods with Applications by Autar K Kaw, Egwu Eric Kalu |
| 10 | Theory: Integration  Lab: Home Assignment on Integration | CO1, CO2 | Lecture, Problem Solving | Book- Numerical Methods with Applications by Autar K Kaw, Egwu Eric Kalu |
| 11 | Theory: Integration  Lab: Evaluation of Home Assignment on Integration | CO1 – CO4, CO5 | Lecture, Home Assignment | Book- Numerical Methods with Applications by Autar K Kaw, Egwu Eric Kalu |
| 12 | Theory: Ordinary Differential Equations | CO1, CO2 | Lecture, Home Assignment Evaluation | Book- Numerical Methods with Applications by Autar K Kaw, Egwu Eric Kalu |
| 13 | Theory: Curve Fitting  Lab: Online assignment on Curve Fitting | CO1, CO2 | Lecture | Book- Numerical Methods with Applications by Autar K Kaw, Egwu Eric Kalu |
| 14 | Theory: Numerical Optimization: Golden Ratio search, Newton’s search, Powell’s method, Gradient search.  Lab: Final Quiz | CO1-CO3, CO5 | 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.

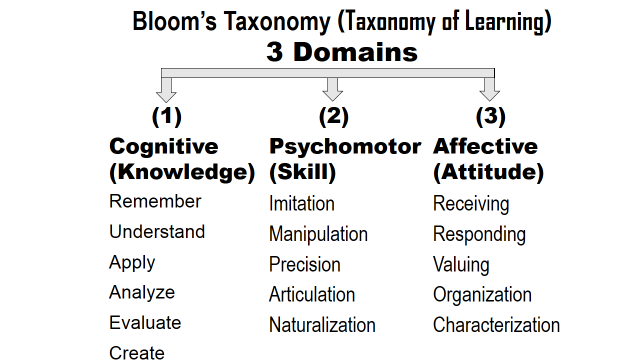
|  |  |  |
| --- | --- | --- |
| **Prepared by** | **Checked by** | **Approved by** |
| Sukarna Barua (**Course Teacher**)  Preetom Saha Arko (**Sessional Class Coordinator**) | **Chairman, SAC committee** | *Head of the Department* |

**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**



**Appendix-3**

**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 |