# Ahsanullah University of Science and Technology
# Bangladesh

## COURSE OUTLINE

**1. Title**: **Numerical Methods**

**2. Code**: **CSE2201**

**3. Credit hours**: **3**

**4. Level**: **Level 2, Term 2**

**5. Faculty**: **Engineering**

**6. Department**: **Computer Science and Engineering (CSE)**

**7. Programme**: **Bachelor of Science in Computer Science and Engineering (B.Sc. in CSE)**

**8. Synopsis from the Approved Curriculum**:

Methods for solving non-linear equations: Iterative methods, Evaluation of polynomials, Bisection method, False position method, Newton-Raphson method, Secant method, Fixed point method; Interpolation; Curve fitting methods; Numerical differentiation and integration; Solution of systems of linear equations: Solution by elimination, Iteration methods, Matrix inversion method, Basic Gauss Elimination method, Gauss Elimination with Pivoting, Gauss-Jordan method; Numerical solution of ordinary differential equations: Taylor's series method, Euler's method, Predictor-Corrector methods.

**9. Type of course (core/elective)**: **Core**

**10. Prerequisite(s) (if any)**:

**11. Name of the instructor(s) with contact details and office hours**:

**Ms. Raqeebir Rab**
**Room: 7A01/L**
**Phone: Extension 516**
**E-mail: raqeebir.cse@aust.edu**
**Office hour: SUN 1:00 – 1:00 PM, TUE 2:00 – 3:00 PM**

**12. Semester Offered**: **Spring, 2020**

## 13. Mapping of Course Outcomes with Bloom's Taxonomy and Programme Outcomes

**After successful completion of the course, the students will be expected to:**

| Sl. No. | Cos | POs | Bloom's Taxonomy | | |
|---|---|---|---|---|---|
| | | | C | A | P |
| **1** | **Comprehend the fundamental concepts of error analysis and numerical methods.** | **1** | **2** | | |
| **2** | **Apply right numerical techniques such as interpolation, differentiation, integration, the solution of linear and nonlinear equations, and the solution of differential equations to solve computational and mathematical problems.** | **2** | **3** | | |
| **3** | **Analyze and interpret results obtain from different numerical solutions.** | **4** | **4** | | |

## 14. Mapping of COs with Knowledge Profiles, Complex Engineering Problem Solving and Complex Engineering Activities

| Course Outcome | Knowledge Profile | Complex Problem Solving | Complex Engineering Activities |
|---|---|---|---|
| **CO1** | **K3** | | |
| **CO2** | **K4** | | |
| **CO3** | **K8** | | |

## 15. Percentages of Assessment Methods

| Method | Percentage |
|---|---|
| **Class Performance** | **10** |
| **Quizzes** | **20** |
| **Final Examination** | **70** |

**16. Week wise distribution of contents and assessment methods**

| Week | Topics | Assessment Method(s) |
|---|---|---|
| 1 | System of Non-linear Equation:<br>Root findings: Open End Methods: Bisection Methods and Methods of False Position.<br>Open end Methods: Newton Raphson Method, Secant Methods and Fixed Point Iteration.<br>Evaluation of polynomials--Horner's rule.<br>Convergence Analysis of Bisection and Newton Raphson Methods.<br>Finding root using Horners Methods.<br>Basic Concepts of Deflation and Synthetic division, finding multiple roots using Bisection method and Newton's methods. | **Quiz 1** |
| 2 | | |
| 3 | Basic Concept of numerical methods. Applications of Numerical Methods<br>Number System: Exact & Approximate numbers, Significant Digits, Accuracy & Precision.<br>Error Analysis: Sources of errors–Inherent errors, Round-off errors, Truncation errors; Absolute & Relative errors, Error propagation. | |
| 4 | Definition of linear equations, Gauss Elimination method, Gauss-Jordan method, Review of Matrix, Cramer's rule. | |
| 5 | Matrix inversion method, Gauss-Jordan matrix inversion method, Do little's LU Decomposition method. Iterative methods - Jacobi's method, Gauss-Seidel method. | |
| 6 | Definition of curve fitting regression, importance of curve fitting, Least Square method: Fitting a straight line, Non-linear curve fitting: Fitting an exponential function, Fitting polynomial function. | |
| 7 | Definition of interpolation, Finite Differences – Forward difference, Backward difference, Central differences; Shift operator, Averaging operator; Divided difference; Error propagation in a difference table. Newton's Binomial Expansion formula. | **Quiz 2** |
| 8 | Newton's Forward and Backward interpolation formulas. Central difference interpolation formulas – Gauss Forward and Gauss Backward formula. | |

| | | |
|---|---|---|
| 9 | Central difference interpolation formulas – Stirling's formula, Bessel's formula. Interpolation with unequal intervals – Lagrange's interpolation formula, inverse interpolation formula, Newton's General Divided Difference formula. | **Quiz 3** |
| 10 | Definition of numerical differentiation, Derivatives using Newton's Forward and Backward difference and Central difference interpolation formulas. Finding first and second derivatives of a tabulated function. | |
| 11 | Definition of numerical integration, General Quadrature formula, Trapezoidal rule, Simpson's 1/3 rule, Simpson's 3/8 rule, Weddle's rule. Romberg Integration. | |
| 12 | Review of Ordinary Differential equations, Taylor's series method, Euler's method, Picard's method, Heun's method, R-K method. | **Quiz 4** |
| 13 | | |
| 14 | **Review classes.** | |

**17. References**

17.1. Required (if any)

1. ***Numerical Methods*** **(4th Edition).**
   **Authored by: E. Balagurusamy**
   **Publisher: Tata McGraw-Hill, Inc, 1999.**
2. ***Numerical Analysis*** **(2nd Edition).**
   **Authored by: G. Shanker Rao.**
   **Publisher: New Age International (P) Limited, 1997.**

17.2. Recommended (if any)

1. ***Numerical Methods*** **for Engineers (4th Edition).**
   **Authored by: Steven C. Chapra, Raymond P. Canale**
   **Publisher: Tata McGraw-Hill, Inc, 2003.**

| Prepared by: | Checked by: | Approved by: |
|---|---|---|
| Signature:<br>_____<br>Name: **Raqeebir Rab**<br>Department: **CSE**<br>Date: | Signature:<br>_____<br>Name:**Dr. Mohammad Shafiul Alam**<br>**OBE Program Coordinator, CSE**<br>Date: | Signature:<br>_____<br>Name: :**Dr. Mohammad Shafiul Alam**<br>HOD, **CSE**<br>Date: |

## Annex-1: PEO of CSE

**PEO1 - Professionalism**
Graduates will demonstrate sound professionalism in computer science and engineering or related fields.

**PEO2 – Continuous Personal Development**
Graduates will engage in life-long learning in multi-disciplinary fields for industrial and academic careers.

**PEO3 – Sustainable Development**
Graduates will promote sustainable development at local and international levels.

## Annex-2: Mapping of PEO-PO

| | PEO1 | PEO2 | PEO3 |
|---|---|---|---|
| PO1 - Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems. | √ | | |
| PO2 - Problem analysis: Identify, formulate, research and analyze complex engineering problems and reach substantiated conclusions using the principles of mathematics, the natural sciences and the engineering sciences. | √ | | |
| PO3 - Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety as well as cultural, societal and environmental concerns. | √ | | |
| PO4 – Investigation: Conduct investigations of complex problems, considering design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions. | √ | | |
| PO5 - Modern tool usage: Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations. | √ | | |

| | | | |
|---|---|---|---|
| PO6 - 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. | √ | | √ |
| PO7 - 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. | √ | | √ |
| PO8 – Ethics: Apply ethical principles and commit to professional ethics, responsibilities and the norms of engineering practice. | √ | | |
| PO9 - Individual work and teamwork: Function effectively as an individual and as a member or leader of diverse teams as well as in multidisciplinary settings. | √ | √ | |
| PO10 – Communication: Communicate effectively about complex engineering activities with the engineering community and with society at large. Be able to comprehend and write effective reports, design documentation, make effective presentations and give and receive clear instructions. | √ | | |
| PO11 - Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work as a member or a leader of a team to manage projects in multidisciplinary environments. | √ | | |
| PO12 - Life-long learning: Recognize the need for and have the preparation and ability to engage in independent, life-long learning in the broadest context of technological change. | | √ | |

## Annex-3: Blooms Taxonomy *

| Level | Cognitive Domain – Revised Version | Affective Domain | Psychomotor Domain |
|---|---|---|---|
| 1 | Remember (1) | Receiving Phenomena (1) | Perception (1) |
| 2 | Comprehend (2) | Responding to Phenomena (2) | Set (2) |
| 3 | Apply (3) | Valuing (3) | Guided Response (3) |
| 4 | Analyse (4) | Organizing Values (4) | Mechanism (4) |
| 5 | Evaluate (5) | Internalising Values (5) | Complex Overt Response (5) |
| 6 | Create (6) | | Adaption (6) |
| | | | Origination (7) |

* Based on "REVISED BLOOM'S TAXONOMY INDICATOR v3.31" , available athttp://adept.mmu.edu.my/wp-content/uploads/2018/09/Blooms-Taxonomy-Indicator-v3.31.xls

# Annex-4: Knowledge Profile

| | BAETE MANUAL 2019, 2nd ed. (TABLE 4.1) - KNOWLEDGE PROFILE | |
|---|---|---|
| K1 | **Natural sciences** | A systematic, theory-based understanding of the natural sciences applicable to the discipline. |
| K2 | **Mathematics** | Conceptually-based mathematics, numerical analysis, statistics and formal aspects of computer and information science to support analysis and modelling applicable to the discipline. |
| K3 | **Engineering fundamentals** | A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline. |
| K4 | **Specialist Knowledge** | Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline. |
| K5 | **Engineering Design** | Knowledge that supports engineering design in a practice area. |
| K6 | **Engineering Practice** | Knowledge of engineering practice (technology) in the practice areas in the engineering discipline. |
| K7 | **Comprehension** | Comprehension of the role of engineering in society and identified issues in engineering practice in the discipline: ethics and the professional responsibility of an engineer to public safety; the impacts of engineering activity: economic, social, cultural, environmental and sustainability. |
| K8 | **Research literature** | Engagement with selected knowledge in the research literature of the discipline. |