|  |  |
| --- | --- |
| American International University-Bangladesh (AIUB) | **AMERICAN INTERNATIONAL UNIVERSITY-BANGLADESH (AIUB)**  Faculty of Science and Information (FST)  Department of Mathematics  Undergraduate Program |

****

**PART-A**

|  |  |
| --- | --- |
| Course Outline |  |
| 1. Course No./ Course Code | **MAT** 2101 |
| 1. Course Title | **Complex Variable, Laplace, and Z Transformations** |
| 1. Course Type (General Education / Core Course / Electives) | **GED** |
| 1. Semester | **Fall 2022-2023** |
| 1. Academic Session | **22-23** |
| 1. Course Teacher/Instructor | **Assistant Professor Khadiza Akter Mitu** |
| 1. Pre-requisite (If any) | MAT 1205: Integral Calculus and Ordinary Differential Equations |
| 1. Credit Value: | 03 |
| 1. Contact Hours: | 3 hours per week (14 weeks) |
| 1. Total Marks: | 100 |
| 1. Rationale of the Course: | Complex variables focus on the study of the root finding, complex differentiation and integration, and power series. Conformal mappings can be successfully used for constructing solutions to the Laplace equation on complicated planar domains that are used several fields such as in fluid mechanics, aerodynamics, thermomechanics, electrostatics, elasticity etc. Applied mathematician, scientist and engineers can convert natural as well as engineering phenomena the form of DEs which can be solve using Laplace transformation. The Laplace transform is unable to find closed form solution of higher order and nonlinear DEs as well as difference equations (algorithms used in scientific computation). The Z-transform can give us the solutions of both linear and nonlinear difference equations. Z-transform can also be used to solve many engineering, scientific, and financial problems such in digital signal processing, in economics, control theory, finance, in algorithms and Data structures, combinatorics, etc. |
| 1. Course Objectives: | 1. To describes basic of complex number, roots of an equation, complex differentiation and integration, power series and conformal mapping with its applications 2. To illustrate basic of Laplace transformations and their application for solving ODE. 3. To explain two-sided z-transformation and their applications digital signal processing, in economic, control theory, finance, in algorithms and Data structures, combinatorics, etc. |

1. **Course Learning Outcomes (CLOs) and Mapping of CLOs with Program Learning Outcomes (PLOs)**

**Course Learning Outcomes (CLO) Matrix:**

By the end of this course, students should be able to:

|  |  |  |  |
| --- | --- | --- | --- |
| CLOs | CLO Descriptions | PLO Assessed | |
| CLO1 | Know Laplace transformation, Z-transformation, and basics of complex variable. | | PLO-a-2 |
| CLO2 | Apply Laplace transformation in solving differential equation and apply Z-transformation in solving difference equation | | PLO-b-2 |
| CLO3 | Evaluate complex integral, expand a function in a series and solve complex equations | | PLO-b-2 |

1. *Cognitive; P: Psychomotor; A: Affective; S: Soft-skills (CT: Critical Thinking, TS: Teamwork)*

*\*CLO assessment method and rubric of CLOs assessment is provided in Appendix section*

*\*\*\* The numbers under the ‘PLO Assessed’ column represent the PLO (appendix) each CLO corresponds to.*



American International University-Bangladesh (AIUB)

**PART-B**

1. **Course plan specifying content, CLOs, co-curricular activities (if any), teaching learning and assessment strategy mapped with CLOs.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Week | Topic | Teaching-Learning  Strategy | Assessment strategy | Corresponding CLOs |
| 1 | Definition, Application of Laplace Transformation, some important formulae and solving mathematical problems using that formula | Lecture delivery, Board work, Solving exercises, Discussion | Lecture notes, question-answer session | **CLO1** |
| 2 | Definition of Unit Step Function, Rectangular Pulse, Laplace Transformation of Unit Step Function, Mathematical problems on Laplace Transformation of Unit Step Function, some important formulae, solving mathematical problem using direct formulae and property of inverse Laplace transformation. Some important formula and mathematical problems | Lecture delivery, Board work, Solving exercises, Discussion | Quiz-1  Lecture notes, question-answer session | **CLO1** |
| 3 | Inverse Laplace transformation using partial fraction- associated with unit step function.  Process of solving differential equations using Laplace transformation, some important formula and mathematical problems | Lecture delivery, Board work, Solving exercises, Discussion | Lecture notes, question-answer session | **CLO1** |
| 4 | Solving Simultaneous Ordinary Differential Equations by Laplace Transform, some mathematical examples. | Lecture delivery, Board work, Solving exercises, Discussion | Quiz 2, | **CLO2** |
| 5 | Complex number, Graphical representation, Fundamental operations, Conjugates, Absolute value/modulus, Power of imaginary unit, Polar form, and argument  Complex equations, complex roots and application of De Moivre’s theorem | Lecture delivery, Board work, Solving exercises, Discussion | Lecture notes, question-answer session | CLO1, CLO3 |
| 6 | Complex differentiable function, Conformal mappings | Lecture delivery, Board work, Solving exercises, Discussion | Quiz 3  Lecture Notes,  Question- answer session | **CLO1** |
| 7 |  | MIDTERM EXAM |  |  |
| 8 | Definition of line integral, path of integration, line integral along simple curve | Lecture delivery, Board work, Solving exercises, Discussion | Lecture  Notes, question-answer session | CLO3 |
| 9 | line integral along the curve consisting multiple paths, singularity, poles, zeros and residue of complex valued function, Cauchy Residue Theorem | Lecture delivery, Board work, Solving exercises, Discussion | Quiz 1  Lecture  Notes, question | CLO3 |
| 10 | Line integral along a simple closed curve using CRT, Contour integral, improper integral, Jordan’s Lemma | Lecture delivery, Board work, Solving exercises, Discussion | Lecture  Notes, question-answer session. | CLO3 |
| 11 | Laurent series,  Definition of Z-transform, its physical meaning and applications, Z-transform of some simple sequences, properties of Z- transform, discrete time unit step function, Kronecker delta function. | Lecture delivery, Board work, Solving exercises, Discussion | Quiz 2  Lecture  Notes, question-answer session. | CLO1, CLO3 |
| 12 | Use of direct formulae for z-transform,  Inverse Z-Transform | Lecture delivery, Board work, Solving exercises, Discussion | Lecture  Notes, question-answer session. | CLO1 |
| 13 | Solution of linear difference equations by z-transform,  Inversion integral method, some physical problems | Lecture delivery, Board work, Solving exercises, Discussion | Quiz 3,  Lecture  Notes, question-answer session | CLO2 |
| 14 |  | **Final exam** |  |  |



American International University-Bangladesh (AIUB)

**Part-C**

1. **Assessments and Evaluation**
2. Assessment strategy:

|  |
| --- |
| 1. Attending at least 80% of the classes is mandatory |
| 1. Attending the midterm and final term exams |

1. Marks distribution:

|  |  |
| --- | --- |
| **Midterm and Final term** | |
| Quiz | 20% |
| Attendance | 10% |
| Assignment | 20% |
| Viva | 30% |
| Lab Performance | 20% |
| **Total** | 100% |
| **Final Grade/ Grand Total** | |
| Midterm: | 50% |
| Final Term: | 50% |

|  |  |  |
| --- | --- | --- |
| **Letter** | **Grade Point** | **Numerical %** |
| A+ | 4.00 | 90-100 |
| A | 3.75 | 85<90 |
| B+ | 3.50 | 80<85 |
| B | 3.25 | 75<80 |
| C+ | 3.00 | 70<75 |
| C | 2.75 | 65<70 |
| D+ | 2.50 | 60<65 |
| D  F | 2.25  0.00 | 50<60  <50(Failed) |

1. Make-up Procedures: As per University policy.

American International University-Bangladesh (AIUB)

****

**PART-D**

1. **Learning materials**
2. Recommended Readings:

* Advanced Engineering Mathematics (10th edition) by Erwin Kreyszig, Herbert Kreyszig, Edward J. Norminton, published by John Wiley & Sons, Inc
* Complex Variables and Applications – R.V. Churchill and J.W.Brown E

1. Supplementary Readings:

* Laplace Transform – Murray R. Spiegel(Schaum’s Outline Series)
* Complex Variables and Applications M.R.Spiegel (Schaum’s Outline Series)
* The Recurrence Relations in Teaching Students of Informatics by Valentin P.BAKOEV
* Z-Transform and Its Application to Development of Scientific Simulation Algorithms by ZVONKO FAZARINC, Comput Appl Eng Educ:21:75-88,2013
* Lecture Notes



American International University-Bangladesh (AIUB)

**Appendix**

**Mapping of PLOs to CS courses:**

|  |  |
| --- | --- |
| **PLO-a: Engineering Knowledge** Apply knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization. | |
| **PLO Indicator ID** | **PLO Indicators Definition** |
| PLO-a-1 | Apply information and concepts in natural science with the familiarity of issues. |
| PLO-a-2 | Apply information and concepts of mathematics with the familiarity of issues. |
| PLO-a-3 | Apply information and concepts in engineering fundamentals to solve complex engineering problems with a range of conflicting requirements. |
| PLO-a-4 | Apply information and concepts in specialized engineering sciences with the in-depth of analysis of a complex engineering problem. |

|  |  |
| --- | --- |
| **PLO-b: Problem Analysis** Identify, formulate, research literature and analyses complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences. | |
| **PLO Indicator ID** | **PLO Indicators Definition** |
| PLO-b-1 | Identify first principles of natural sciences and engineering sciences in practical applications. |
| PLO-b-2 | Formulate solutions, procedures, and methods using first principles of mathematics for engineering sciences. |
| PLO-b-3 | Analyze solutions for complex engineering problem reaching substantiated conclusion. |
| PLO-b-4 | Research literature of engineering science and analyze the validity and accuracy of existing solution for complex engineering problems. |

|  |  |
| --- | --- |
| **PLO-c: Design/ development of solutions**  Design solutions for complex 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. | |
| **PLO Indicator ID** | **PLO Indicators Definition** |
| PLO-c-1 | Design solutions for a complex engineering problem considering public health and safety. |
| PLO-c-2 | Develop system or components that meets specific needs considering health, safety and environment. |

|  |  |
| --- | --- |
| **PLO-d: Investigation** Conduct investigations of complex problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions. | |
| **PLO Indicator ID** | **PLO Indicators Definition** |
| PLO-d-1 | Conduct investigations of complex problems using research-based knowledge |
| PLO-d-2 | Use appropriate research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions. |

American International University-Bangladesh (AIUB)

|  |  |
| --- | --- |
| **PLO-e: Modern Tool Usage**  Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering problems, with an understanding of the limitations. | |
| **PLO Indicator ID** | **PLO Indicators Definition** |
| PLO-e-1 | Select and apply appropriate techniques, tools and resources (e.g., prediction & modeling) to solve complex engineering problems considering their limitations. |
| PLO-e-2 | Create appropriate techniques, tools or resources (e.g., prediction & modeling) to solve complex engineering problems considering their limitations. |

|  |  |
| --- | --- |
| **PLO-f: 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 and solutions to complex engineering problems. | |
| **PLO Indicator ID** | **PLO Indicators Definition** |
| PLO-f-1 | Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues in relation to professional engineering practice and solution. |
| PLO-f-2 | Assess the consequent responsibilities relevant to professional engineering practice and solutions to complex engineering problems. |

|  |  |
| --- | --- |
| **PLO-g: Environment and Sustainability**  Understand and evaluate the sustainability and impact of professional engineering work in the solution of complex engineering problems in societal and environmental contexts. | |
| **PLO Indicator ID** | **PLO Indicators Definition** |
| PLO-g-1 | Understand the sustainability and impact of professional engineering work in the solution of complex engineering problems in societal and environmental contexts. |
| PLO-g-2 | Evaluate the sustainability and impact of professional engineering work in the solution of complex engineering problems in societal and environmental contexts. |

American International University-Bangladesh (AIUB)

|  |  |
| --- | --- |
| **PLO-h: Ethics**  Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice. | |
| **PLO Indicator ID** | **PLO Indicators Definition** |
| PLO-h-1 | Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice. |

|  |  |
| --- | --- |
| **PLO-i: Individual and Teamwork**  Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings. | |
| **PLO Indicator ID** | **PLO Indicators Definition** |
| PLO-i-1 | Function effectively as an individual in diverse teams and in multi-disciplinary settings. |
| PLO-i-2 | Function effectively as a member or leader in diverse teams and in multi-disciplinary settings. |

|  |  |
| --- | --- |
| **PLO-j: 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 | |
| **PLO Indicator ID** | **PLO Indicators Definition** |
| PLO-j-1 | Comprehend and write effective reports and design documentation for effective communication on complex engineering activities. |
| PLO-j-2 | Make effective presentations to exchange clear instructions with engineering community and the society at large. |

|  |  |
| --- | --- |
| **PLO-k: 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. | |
| **PLO Indicator ID** | **PLO Indicators Definition** |
| PLO-k-1 | Apply engineering management principles and economic decision to manage project as a team member / team leader. |
| PLO-k-2 | Apply engineering management principles and economic decision to manage project in multidisciplinary environments. |

|  |  |
| --- | --- |
| **PLO-l: Lifelong learning**  Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change. | |
| **PLO Indicator ID** | **PLO Indicators Definition** |
| PLO-l-1 | Identify the need and prepare accordingly for independent learning in solving complex engineering problems and change of technologies. |
| PLO-l-2 | Demonstrate the ability to engage in independent and life-long learning in the broadest context of technological change. |

American International University-Bangladesh (AIUB)



**Verification:**

|  |  |  |
| --- | --- | --- |
| **Prepared by:**  Khadiza Akter Mitu  ---------------------------------  **Name**  *Course Convener*  Date:......................................... | **Moderated by:**  Dr. Md. Jashim Uddin  ----------------------------  **Name**  *Point Of Contact*  *OBE Implementation Committee for Mathematics*  Date:......................................... | |
| **Checked by:**  ....................................................  Dr. Md. Jashim Uddin  *Head*,  *Department of Mathematics*  Date:.......................................... | **Certified by:**  .........................................................  **Dr. Dip Nandi**  *Director*,  *Faculty of Science & Technology*  Date:............................................... | **Approved by:**  .........................................................  **Mr. Mashiour Rahman**  *Associate Dean*,  *Faculty of Science & Technology*  Date:............................................... |