



AMERICAN INTERNATIONAL UNIVERSITY-BANGLADESH (AIUB)

Faculty of Science and Technology (FST)

Department of Mathematics

Undergraduate Program

COURSE PLAN

SEMESTER : Fall 2021-22

I. Course Core and Title

MAT 2101: Complex Variables, Laplace and Z-transformations

II. Credit

3 credit hours (3 hours of theory per week)

III. Nature

Science Core Course for CS, EEE

IV. Prerequisite

Mat 1102: Differential Calculus and Coordinate Geometry
Mat 1205: Integral Calculus and ODE

V. Vision:

Our vision is to be the preeminent Department of Mathematics through creating recognized professionals who will provide innovative solutions by leveraging contemporary research methods and development techniques that is in line with the national and global context.

VI. Mission:

The mission of the Department of Mathematics of AIUB is to educate students in a student-centric dynamic learning environment; to provide advanced facilities for conducting innovative research and development to meet the challenges of the modern era of technology, and to motivate them towards a life-long learning process.

VII - Course Description:

- Explain Laplace transform, inverse Laplace transform and application of Laplace transform
- Explain complex variables, its properties and complex algebra
- Construct an analytic function
- Explore complex integration using line integrals, Cauchy-residue theorem and Cauchy's integral formula
- Apply Laurent's theorem to express the functions as series
- Describe singularity, poles, zeros and residue of complex valued function
- Explain Z-transform, inverse Z-transform and engineering and scientific applications of Z-transform

VIII – Course outcomes (CO) Matrix:

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

COs*	CO Description	Level of Domain**				PO Assessed***
		C	P	A	S	
CO1	Students will be able to know the theory and application of Laplace Transform in solving differential equations, in control theory and in other engineering problems.					
CO2	Students will also be able to know the theory of functions of complex variables and their properties and application in engineering					
CO3	Students will be able to evaluate complex integral easily by using a theorem and also they will learn to expand a function in a series.					
CO4	Students will learn z-transform, the methods of solving the difference equation using z-transform, and then they will learn to apply it in problems					

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

* CO assessment method and rubric of COs assessment is provided in Appendix section

** The numbers under the 'Level of Domain' columns represent the level of Bloom's Taxonomy each CO corresponds to.

*** The numbers under the 'PO Assessed' column represent the PO (appendix) each CO corresponds to.

IX – Topics to be covered in the class:

Mid Term			
Lecture No.	Topics	Objective	Outcome
Lecture 1	Definition, Application, Some important formulae and solving mathematical problems using that formula.	Laplace transformation is widely used by electronic engineers to solve quickly differential equations occurring in the analysis of electronic circuits and solving digital signal processing problem.	The main use of Laplace transform is to solve initial value problems for linear ordinary and partial differential equations. After completing this lecture, students can reduce ordinary differential equations to algebraic equations. The transformed equations are easier to solve, and then the solution in the Laplace domain is transformed back to the time domain.
Lecture 2	First shifting property, multiplication by t^n property and mathematical problems using those properties.	To be expert of solving Laplace transformation problem using properties.	After completing this lecture they will learn how to deal with Laplace transformation using property.
Lecture 3	Definition of Unit Step Function, Rectangular Pulse, Laplace Transformation of Unit Step Function, Mathematical problems on Laplace Transformation of Unit Step Function.	To conduct some engineering applications where we frequently encounter functions whose values change abruptly at specified values of time t .	After finishing this lesson, they will be introduced to unit step function that occurs in circuit analysis problem and how they behave with using Laplace transformation.
Lecture 4	Some important formulae, solving mathematical problem using direct formulae and property of inverse Laplace transformation.	To be transformed back to time domain, inverse Laplace transformation is used. So this lecture focuses on discussing regarding that issue.	At the end of the lecture students will come up with full confidence to apply inverse Laplace transformation in suitable place with using formula and property.
Lecture 5	Inverse Laplace transformation using partial fraction- (a) type unrepeatd factor, (b) type repeated factors, and (c) type factors with irrational or complex root, and inverse Laplace transformation associated with unit step function.	In some cases, it is easy to apply partial fraction technique to solve inverse Laplace transformation problem. So we cover this topic to make students known on this event. Also to introduce inverse Laplace transformation results with unit step	After completing this lecture, students will learn to solve inverse Laplace transformation using partial fraction and produce result associated with unit step function.

		function that is more convenient to express mathematically.	
Lecture 6	Process of solving differential equations using Laplace transformation, some important formula and mathematical problems.	To solve ordinary differential equations using Laplace transformation while we can avoid introducing arbitrary constants.	At the finishing, they will learn how to solve differential equation with implementing Laplace and inverse Laplace transformation both.
Lecture 7	Solving Simultaneous Ordinary Differential Equations by Laplace Transform, some mathematical examples	To solve simultaneous Ordinary differential equations by Laplace transformation.	After completing this lecture students can solve simultaneous differential equation using Laplace transformation.
Lecture 8	Some examples of engineering problems where actually Laplace transformation is used.	To understand the importance of Laplace transformation.	At the end of the lecture, students will realize where they need Laplace transformation.
Lecture 9	Complex number, Graphical representation, Fundamental operations, Conjugates, Absolute value/modulus, Power of imaginary unit, Polar form and argument	Surveying the algebraic and geometric structure of the complex number system through the discussed topics	Students will be able to deal with imaginary numbers and complex variables.
Lecture 10	Complex equations, complex roots and application of De Moivre's theorem	Obtaining complex roots of polynomial equations using De Moivre's theorem	Students will be able to solve complex equation with complex roots
Lecture 11	Complex differentiable function	Identify and construct complex-differentiable functions	To be able to determine the given function is differentiable and if so to find its derivative
Lecture 12	Conformal mappings	To use conformal mappings	Students will be able to construct conformal mappings between many kinds of domain

Final Term

Lecture No.	Topics	Objective	Outcome
Lecture 13	Definition of line integral, path of integration	Finding the path of integration from parametric to complex form	Students can evaluate equation of straight line, circle, ellipse, parabola in complex form from parametric form

Lecture 14	Path of integration, line integral along simple curve	Finding the path of integration from complex to parametric form and evaluating some line integrals along a simple curve	Students can evaluate equation of straight line, circle, ellipse, parabola in parametric form from complex form. Also, they will be able to evaluate complex integrations along some simple open or closed curve
Lecture 15	line integral along the curve consisting multiple path	Evaluating line integrals for the paths which consists of multiple paths (line segments).	Students will be able to evaluate complex integrations along some open or closed curve consisting of multiple paths
Lecture 16	Singularity, poles, zeros and residue of complex valued function, Cauchy Residue Theorem	Finding residues at the singular points	Students will be able to identify the singular points with its order. They will also be able to evaluate corresponding residues at the singular points
Lecture 17	Line integral along a simple closed curve	Evaluating complex integration by using Cauchy Residue Theorem	Students will be able to evaluate line integrals for a function analytic inside and on a simple closed curve except at a finite number of singular points more easily.
Lecture 18	Contour integral, improper integral, Jordan's Lemma	To evaluate real valued improper integrals using contour integral method (Application of Cauchy Residue Theorem)	Students will be able to evaluate real valued improper integrals by applying Cauchy residue theorem
Lecture 19	Laurent series	Finding Laurent series expansion of a complex valued function where Taylor series is not applicable	Students will be able to apply binomial series expansion to evaluate Laurent Series expansion
Lecture 20	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.	Using the properties and definition of Z-transform and inverse Z-transform. Also some formulae will be developed.	Students will be familiar with so many real life applications of z-transform and be able to find formulae for any sequence

Lecture 21	Use of direct formulae for z-transform	To evaluate z-transform of some sequences and inverse z-transform of some complex valued function by using direct formulae developed in previous lecture	Students will become expert in applying the formulae of z-transform for any sequence or complex valued functions
Lecture 22	Inverse Z-Transform	Finding inverse z-transform by the method of partial fraction	Students will be able to apply partial fraction in complex valued rational function
Lecture 23	Solution of linear difference equations by z-transform	To solve a difference equation using the properties of z-transformation and partial fraction to determine the required sequences.	Students will be able to find a sequence from a difference equation with some initial conditions
Lecture 24	Inversion integral method, some physical problems	Forming and solving difference equations/recurrence relations from some physical problems by using inversion integral method and partial fraction method	Students will be able to relate z-transform in their real life

* The faculty reserves the right to change, amend, add or delete any of the contents.

X- Course Requirements

At least 80% class attendance is mandatory to pass the course. All students are expected to attend all scheduled classes as well as counselling, and to read all assigned chapters/materials before coming to class. If there is any assignment given to the students, they have to submit it before the deadline decided by the course teacher.

XI – Evaluation & Grading System

The tentative marks distribution for course evaluation are as follows:

1. Attendance & Performance10%
2. Assignment.....10%
3. Quiz (at least two).....40%
4. Midterm/ Final assessment.....20%
5. Viva.....20%

Total.....100%

Final Grading: 40% of Mid assessment + 60% of Final assessment

The evaluation system will be strictly followed as par the AIUB grading policy

Letter	Grade Point	Numerical %
A+	4.00	90-100
A	3.75	85-89
B+	3.50	80-84
B	3.25	75-79
C+	3.00	70-74
C	2.75	65-69
D+	2.50	60-64
D	2.25	50-59
F	0.00	<50(Failed)

XII – Teaching Methods

Most of the topics will be covered from the textbook. For the rest of the topics, reference books will be followed. Class lectures will be uploaded on the web on a regular basis. White board will be used for most of the time. Multimedia projector will be used for the convenience of the students. Students must study up to the last lecture before coming to the class and it is suggested that they should go through the relevant topics before coming to the class. Just being present in the class is not enough- students must participate in classroom discussion and classwork actively.

XIII– Textbook/ References

Text Book:

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

Reference Books and Study Materials:

1. Laplace Transform – Murray R. Spiegel (Schaum's Outline Series).
2. Complex Variables and Applications – M.R.Spiegel (Schaum's Outline Series).
3. The Recurrence Relations in Teaching Students of Informatics by Valentin P.BAKOEV
4. Lecture notes

XIV - List of Faculties Teaching the Course

1. Dr. Madhabi Islam
2. Dr. Khondaker Abdul Maleque
3. Dr. Fatema-Tuz-Zohra
4. Tanzia Zerin Khan
5. Ayesha Siddiqua
6. Roushanara Begum (Co - Ordinator)
7. Sajjadul Bari

XVI – Verification:

Prepared by : Roushanara Begum Date: 23/01/2021	Moderated by : Dr. Fatema Tuz Zohra Date: 23/01/2021	
Checked by: Dr. Md Jashim Uddin <i>Head, Department of Computer Science</i> Date:.....	Certified by: Dr. Dip Nandi <i>Director, Faculty of Science & Technology</i> Date:.....	Approved by: Mr. Mashiour Rahman <i>Associate Dean, Faculty of Science & Technology</i> Date:.....