AMERICAN INTERNATIONAL UNIVERSITY-BANGLADESH (AIUB)

Faculty of Science and Technology
(FST) Department of Mathematics
Undergraduate Program

COURSE PLAN

Fall 2021-2022

I. Course Core and Title
MAT-3101: Numerical Methods for Science and Engineering.
II. Credit
3 credit hours (3 hours of theory per week)
III. Nature
Core Course for CS, Engineering
IV. Prerequisite
MAT 2202: M**atrices, Vectors and Fourier Analysis**
MAT 2203: **Linear Algebra, Complex Variables, Laplace Transformations and Fourier Analysis**

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 of computing 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 computing, and to motivate them towards a life-long learning process.

VII - Course Description:

- Introduce commands, built in functions in MATLAB and necessary in real life to solve problems.
- Discussion about equations in one variable, System of linear, non-linear equations and introduce useful numerical methods to solve them.
- Discussion about Spline Interpolation to observing behavior of functions.
- Explanation about Interpolation and curve fitting with useful numerical methods.
- Discussion about Numerical Differentiation and Numerical Integration with applications in real life problems.
- Discussion about ODE (Ordinary Differential Equations) with IVP (Initial value problem) and BVP (Boundary value problem) and its applications in real life problems.

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	Understand fundamental concepts of MATLAB.	1	3		CT	1.1,1.2,2.1,2.2
CO2	Solve problems and write code by applying commands, built in functions in MATLAB.	1	4	5	CT	1.1,1.2,2.1,2.2
CO3	Solve equation in one variable, system of linear and non-linear equations by utilizing useful numerical methods.	1	3	6	CT	1.1,1.2,2.1,2.2
CO4	Analyze data sets and observe behavior of functions by applying Mathematical operations.	1	2,3	6	CT	1.1,1.2,2.1,2.2
CO5	Solve problems numerically to get approximate solutions by using different Integration methods.	1	2,3	6	CT	1.1,1.2,2.1,2.2
CO6	Solve problems numerically to obtain approximate solutions of ODE including IVP & BVP by applying numerical methods.	1	2,3	6	CT	1.1,1.2,2.1,2.2

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:

TOPICS	Specific Objective(s)	Time Frame	Suggested Activities	Teaching Strategy(s)	
Representation of numbers & errors Decimal places, Significant figures. Rounding. Error estimation. Short introduction of MATLAB (numerical and symbolic) **Systems of linear equations:** Gaussian elimination with pivoting. Iterative methods of solution. Solutions using MATLAB commands.	To know the idea of numerical approximation. Able to use MATLAB. Able to find approximate solutions of linear systems.	Week 1 &2	Lecture Discussion	Lecture notes, question-answer session.	CO1, CO2, CO3
Solution of equations in one variable: Number of roots by graphical method. Bisection, false position, secant and Newton-Raphson methods. Fixed point iteration method.	Able to find approximate solution of nonlinear equations.	Week 2 &3	Justifying, Group study, solving exercises	Quiz 1 Lecture, Student reporting and Board work	CO2, CO3
Solutions of nonlinear system: Newton-Raphson method & fixed-point iteration. Solutions using MATLAB command	Able to find approximate solution of system of nonlinear equations.	Week 4 &5	Justifying, Group study, solving exercises	Quiz 2 Lecture, Student reporting and Board work	CO2, CO3
Spline interpolation: Linear, quadratic and cubic splines. Solutions using MATLAB commands	Able to interpolate data points by a polynomial.	Week 6	Justifying, Group study, solving exercises.	Lecture, Student reporting and Board work	CO2, CO4

Revision					
Midterm Exam		**Week 7**			
Interpolation: Finite differences and shift operators. Polynomial approximation. Newton's forward, backward and divided difference formulae. Lagrange form. **Curve fitting:** Interpolation using a fixed curve. Least square method.	Able to interpolate data points by a polynomial. Learn least square method to fit the data points by a curve.	Week 8&9	Justifying, Group study, solving exercises	Lecture, Student reporting and Board work	CO2, CO4
Numerical Differentiation: Forward, backward and central difference formulae for derivatives. Richardson's extrapolation	Able to estimate numerical values of derivative from discrete set of values.	Week 10	Justifying, Group study, solving exercises	Quiz 1 Lecture, Student reporting and Board work	CO2, CO4
Numerical Integration: Introduction. Newton-Cotes quadrature rules. Composite trapezoidal and Simpson's rules. Romberg integration. Double Integration. Gaussian quadrature rule.	Able to evaluate difficult types of integration numerically.	Week 11 & 12	Justifying, Group study, solving exercises	Lecture, Student reporting and Board work	CO2, CO5
Ordinary Differential Eequations (ODEs) and System of ODEs: Taylor series solution. Euler's and modified Euler's method. Runge-Kutta methods (RK-2 and RK-4 methods). Solution of ODE by finite difference method. (initial & boundary value problems)	Able to solve ODEs numerically.	Week 13	Justifying, Group study, solving exercises	Quiz 2 Lecture, Student reporting and Board work	CO2, CO6
Final Exam		**Week 14**			

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

XI- 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 counseling, 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.

XII – Evaluation & Grading System

The following grading system will be strictly followed in this class

Marking system for Theory Classes (Midterm and Final term)	
Quizzes (Best two will be counted out of three quizzes)	40%
Attendance & Performance	10%
Assignment	10%
Midterm/Final term assessment	20%
VIVA	20%
Total	**100%**
Final Grade/Grand Total	
Midterm	40%
Final Term	60%

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)

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

XIII – 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.

XIV – Textbook/ References

Text Book:

1. Applied Numerical Methods with MATLAB for Engineers and Scientists- S.C. Chapra, 4th Edition, 2017, McGraw Hill-Europe.

Reference Books and Study Materials:

1. Numerical Methods in Engineering with MATLAB – Jaan Kiusalaas, 4th Edition, 2018, CAMBRIDGE UNIVERSITY PRESS, UK.
2. Applied Numerical Analysis – C.F.Gerald & P.O.Wheatley, 7th Edition, 2003, Pearson Education Limited, USA
3. Numerical Analysis & Computing – W. Cheney & D. Kincaid, 6th Edition, 2007, Cengage Learning, Inc, USA.
4. Numerical Analysis – J. Douglas Faires , Annette Burden , Richard Burden, 10th Edition, 2015, Cengage Learning, Inc, USA.
5. Lecture slides.

XV - List of Faculties Teaching the Course

1. Prof. Dr. Md Jashim Uddin
2. Prof. Dr. Kh Abdul Maleque
3. Prof. Dr. Madhabi Islam
4. Dr. Fatema Tuz Zohra
5. Dr. Dilruba Yasmin
6. Tanzia Zerin Khan
7. Ayesha Siddiqua
8. Mahfuzur Rahman
9. Khadiza Akhter Mitu
10. Sajjadul Bari
11. Shikha Saha

XVI – Verification:

Prepared by :	Moderated by :
---------- **Md Rezwan Bin Mizan** Date: 22/5/2021	---------- Fatema Tuz Zohra Date: 22/05/2021

Checked by:	Certified by:	Approved by:
..... **Dr. Md. Jashim Uddin** *Head,* *Department of Mathematics* Date:.....	..... **Dr. Dip Nandi** *Director,* *Faculty of Science & Technology* Date:.....	..... **Mr. Mashiour Rahman** *Associate Dean,* *Faculty of Science & Technology* Date:.....

APPENDIX

Program Outcomes (POs)

PO1	Engineering Knowledge
1.1	Apply the knowledge of mathematics, science, engineering fundamentals to the solution of complex engineering problems.
1.2	Apply the knowledge of an engineering specialization to the solution of complex engineering problems
PO2	**Problem Analysis**
2.1	Identify, Research and Formulate complex engineering problems
2.2	Analyze and Reach substantiated conclusions using the principle of mathematics, the natural sciences and the engineering sciences

Mapping of CO Assessment Method and Rubric

The mapping between Course Outcome(s) (COs) and The Selected Assessment method(s) and the mapping between Assessment method(s) and Evaluation Rubric(s) is shown below:

CO	Description	Learning Domain	Assessment Method	Assessment Rubric
CO1	Understand fundamental concepts of MATLAB.	Cognitive	Midterm Exam	Rubric for Midterm Exam
CO2	Solve problems and write code by applying commands, built in functions in MATLAB.	Psychomotor	Midterm Exam	Rubric for Midterm Exam
CO3	Solve equation in one variable, system of linear and non-linear equations by utilizing useful numerical methods.	Psychomotor	Midterm Exam	Rubric for Midterm
CO4	Analyze data sets and observe behavior of functions by applying Mathematical operations.	Psychomotor	Midterm & Final Term Exam	Rubric for Midterm & Final Term Exam
CO5	Solve problems numerically to get approximate solutions by using different Integration methods.	Psychomotor	Final Term Exam	Rubric for Final Term Exam
CO6	Solve problems numerically to obtain approximate solutions of ODE Including IVP & BVP by applying numerical methods.	Psychomotor	Final Term Exam	Rubric for Final Term Exam

Rubric for Midterm Exam Assessment (CO1)

Marking Criteria	Marks Distribution (Maximum 5X3=15)				Acquired Marks
	Inadequate (0-2)	**Satisfactory (3)**	**Good (4)**	**Excellent (5)**	
Definition	• Student does not answer or vaguely define the terms or concept	• Definition provided with partial relevance to the subject matter.	• Correctly define the terms. May miss minor detail.	• Correctly and comprehensive ly define the term with examples.	
Fundamental concepts (laws) of MATLAB.	• No usage of laws or incorrect usage of laws.	• Usage of laws without mentioning the name of laws.	• Usage of laws with mentioning the name of laws but with minor mistakes.	• Proper usage of laws mentioning their names correctly and without any mistake.	
Correctness of answer	• Arrived at incorrect answer.	• Arrived at correct answer but with some logical errors.	• Arrived at correct answer with minor errors.	• Arrived at correct answer with no error.	
				Acquired Marks:	
				CO Pass / Fail:	

Rubric for Midterm Exam Assessment (CO2)

Marking Criteria	Marks Distribution (Maximum 5X3=15)				Acquired Marks
	Inadequate (0-2)	Satisfactory (3)	Good (4)	Excellent (5)	
Definition	• Student does not define or vaguely define the terms or concept	• Definition provided with partial relevance to the subject matter.	• Correctly define the terms. May miss minor detail.	• Correctly and comprehensive ly define the terms.	
Solve problems and write code in MATLAB	• Student does not provide correct MATLAB code to solve problems.	• MATLAB code provided with partial relevance to the subject matter.	• MATLAB code provided with minor mistakes.	• Correct MATLAB code provided with no mistake.	
Correctness of answer	• Arrived at incorrect answer.	• Arrived at correct answer but with some missing steps.	• Arrived at a correct answer with minor errors.	• Arrived at correct answer showing all the relevant steps and with no error.	
				Acquired Marks:	
				CO Pass / Fail:	

Rubric for Final term Exam Assessment (CO3)

Marking Criteria	Marks Distribution (Maximum 5X3=15)				Acquired Marks
	Inadequate (0-2)	**Satisfactory (3)**	**Good (4)**	**Excellent (5)**	
Definition	• Student does not define or vaguely define the terms or concept	• Definition provided with partial relevance to the subject matter.	• Correctly define the terms. May miss minor detail.	• Correctly and comprehensively define the terms.	
Choosing necessary numerical methods of solving equation in one variable, system of linear and non-linear equations	• Student does not choose necessary numerical methods or choose totally incorrect methods.	• Student identifies the necessary methods with major errors.	• Student identifies the correct necessary methods with minor errors.	• Student correctly identifies the necessary methods without any error.	
Correctness of answer	• Arrived at incorrect answer.	• Arrived at correct answer but with some missing steps.	• Arrived at a correct answer with minor errors.	• Arrived at correct answer showing all the relevant steps and with no error.	
				Acquired Marks:	
				CO Pass / Fail:	

Rubric for Final Term Exam Assessment (CO4)

Marking Criteria	Marks Distribution (Maximum 5X3=15)				Acquired Marks
	Inadequate (0-2)	**Satisfactory (3)**	**Good (4)**	**Excellent (5)**	
Definition	• Student does not define or vaguely define the term or concept	• Definition provided with partial relevance to the subject matter.	• Correctly define the term with no example. May miss minor detail.	• Correctly and comprehensively define the term with example.	
Analyze data sets and observe behavior of functions by applying Mathematical operations.	• Student does not provide reasoning or incorrect reasoning.	• Reasoning provided with partial relevance to the subject matter.	• Correct reasoning provided with minor mistakes.	• Correct reasoning provided with no mistake.	
Correctness of answer	• Arrived at incorrect answer.	• Arrived at correct answer but with some missing steps.	• Arrived at a correct answer with minor errors.	• Arrived at correct answer showing all the relevant steps and with no error.	
				Acquired Marks:	
				CO Pass / Fail:	

Rubric for Final Term Exam Assessment (CO5)

Marking Criteria	Marks Distribution (Maximum 5X3=15)				Acquired Marks
	Inadequate (0-2)	**Satisfactory (3)**	**Good (4)**	**Excellent (5)**	
Definition	• Student does not define or vaguely define the term or concept	• Definition provided with partial relevance to the subject matter.	• Correctly define the term with no example. May miss minor detail.	• Correctly and comprehensive ly define the term with example.	
Uses different Integration methods to solve problems numerically	• Student does not provide appropriate methods or incorrect methods.	• Appropriate methods are provided with partial relevance to the subject matter.	• Correct methods are provided with minor mistakes.	• Correct methods are provided with no mistake.	
Correctness of answer	• Arrived at incorrect answer.	• Arrived at correct answer but with some missing steps.	• Arrived at a correct answer with minor errors.	• Arrived at correct answer showing all the relevant steps and with no error.	
				Acquired Marks:	
				CO Pass / Fail:	

Rubric for Final Term Exam Assessment (CO6)

Marking Criteria	Marks Distribution (Maximum 5X3=15)				Acquired Marks
	Inadequate (0-2)	**Satisfactory (3)**	**Good (4)**	**Excellent (5)**	
Definition	• Student does not define or vaguely define the term or concept	• Definition provided with partial relevance to the subject matter.	• Correctly define the term with no example. May miss minor detail.	• Correctly and comprehensive ly define the term with example.	
Solve problems numerically to obtain approximate solutions of ODE Including IVP & BVP	• Student does not apply numerical methods to solve problems step by steps or does incorrect way.	• Approximate solution provided with partial relevance to the subject matter.	• Approximate solution provided with minor mistakes.	• Approximate solution provided with no mistake.	
Correctness of answer	• Arrived at incorrect answer.	• Arrived at correct answer but with some missing steps.	• Arrived at a correct answer with minor errors.	• Arrived at correct answer showing all the relevant steps and with no error.	
				Acquired Marks:	
				CO Pass / Fail:	