AMERICAN INTERNATIONAL UNIVERSITY-BANGLADESH (AIUB)

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

COURSE PLAN

Spring 2020-2021 SEMESTER

I. Course Core and Title

MAT 2202: Matrices, Vectors, Fourier Analysis

II. Credit

3 credit hours (3 hours of theory per week)

III. Nature

Core Course for CS, Engineering

IV. Prerequisite

MAT 2201: **Complex Variables, Laplace and Z-Transformations**
MAT 1205: **Integral Calculus & Ordinary Differential Equation**

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:

- Discussion about Matrix Algebra, inverse of a matrix, row echelon form, reduced row echelon form
- Discussion about system of linear equations, application of system of linear equations
- Discussion about periodic function, Fourier series of a periodic function and half range Fourier series
- Discussion on Fourier integral, Fourier sine and cosine integrals
- Explain Fourier transformation, inverse Fourier transformations, and discrete Fourier transform.
- Discussion about applications of Fourier transformations to solve boundary value problems
- Discussion about eigenvalues, eigenvectors and Cayley-Hamilton theorem
- Discussion on Linear combination and linear dependency of vectors
- Discussion about coordinate transform of vectors and points
- Discussion about differentiation of a vector function, gradient and directional derivative of a scalar function
- Discussion about Divergence theorem and Stokes theorem in Cartesian, cylindrical and spherical co-ordinate systems

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	Calculate matrix addition, subtraction, multiplication, find the inverse of a matrix, find rank of a matrix and convert a matrix to row echelon form (REF) and reduced row echelon form (RREF)	1	2		CT	1.1, 1.2, 2.1, 2.2
CO2	Solve system of linear equations, know about the application of system of linear equations and solve problems about Fourier analysis	1	3		CT	1.1, 1.2, 2.1, 2.2
CO3	Find eigenvalues, eigenvectors and inverse of a matrix using Cayley Hamilton theorem, determine whether a vector is dependent or independent and transform point and vector from one coordinate system to another.	1	3		CT	1.1, 1.2, 2.1, 2.2
CO4	Calculate gradient, divergence, curl, Laplacian and verify Divergence and Stokes theorem	1	4		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)	
Matrix algebra, inverse of a matrix. Elementary row transformation, row echelon form, reduced row echelon form. Solution of system of linear equations by using Gaussian elimination method, matrix inverse method and using determinant (Cramer's rule)	How to calculate matrix addition and subtraction, multiplication and rank. How to find the determinant and inverse of a matrix. How to find Row Echelon Form (REF) & Reduced Row Echelon Form (RREF). How to solve a system of linear equation. Analysis of some real life applications of system of linear equations.	Week 1 & 2	Justifying, Group study, solving exercises	Lecture, Student reporting and Board work	CO1 CO2
Application of system of linear equations (i.e., network problem, traffic problem, current calculation using mesh analysis, solving linear	To know how to expand a periodic function in terms of an infinite sum of sines and (or) cosines, i.e. full range Fourier series in real form. To discuss about even extension and odd	Week 3 & 4	Justifying, Group study, solving exercises	Quiz 1 Lecture, Student reporting and Board work	CO2

programming problems (maximization or minimization)). **Fourier Analysis:** Periodic function and periodicity of a given function, even and odd function, Fourier series in real form, Half range Fourier sine and cosine series.	extension. To find series expression of any periodic function				
Finite and infinite form of Fourier integral, Finite Fourier sine and cosine transforms.	To discuss Fourier sine and cosine integral. Discuss how Fourier transform is a generalization of Fourier series. How to find Fourier transform of a function	Week 5	Justifying, Group study, solving exercises	Quiz 2 Lecture, Student reporting and Board work	CO2
Solution of partial differential equations (boundary value problem) by Fourier transforms. Discrete Fourier Transform	To apply Fourier transform to solve partial differential equation To solve problem using discrete Fourier transform	Week 6	Justifying, Group study, solving exercises.	Lecture, Student reporting and Board work	CO2
Midterm Exam	**Week 7**				
Eigenvalues & Eigenvectors Applications of Eigenvalues & Eigenvectors	Discussion about eigenvalues & eigenvectors and How to find eigenvalues & eigenvectors of a matrix. Solving system of differential equations using Eigenvalues & Eigenvectors	Week 8	Justifying, Group study, solving exercises	Lecture, Student reporting and Board work	CO3
Cayley-Hamilton theorem, Vector Space	Verification of Cayley-Hamilton theorem and finding inverse of a square matrix using Cayley-Hamilton theorem Discussion about vector space, subspace, linear dependency and linear combination	Week 9	Justifying, Group study, solving exercises	Quiz 1 Lecture, Student reporting and Board work	CO3
Coordinate Systems	To discuss about Cartesian coordinate, cylindrical coordinate and spherical coordinate and how to transfer a vector and a point from one coordinate to another.	Week 10	Justifying, Group study, solving exercises	Lecture, Student reporting and Board work	CO3
Gradient, directional derivative and Laplacian	Discussion about Gradient, directional derivative and Laplacian and calculating	Week 11	Justifying, Group study, solving	Lecture,	CO4

Divergence and Curl	Gradient, directional derivative and Laplacian for scalar valued function in Cartesian coordinate, cylindrical coordinate and spherical coordinate. Discussion about divergence and curl in all the three coordinate systems.		exercises	Student reporting and Board work	
Divergence theorem in Cartesian, cylindrical and spherical coordinate	Discussion about divergence theorem and application of divergence theorem in Cartesian, cylindrical and spherical coordinate	Week 12	Justifying, Group study, solving exercises	Lecture, Student reporting and Board work	CO4
Stokes Theorem in Cartesian, Cylindrical and Spherical Coordinate	Discussion about Stokes theorem in Cartesian, cylindrical and spherical coordinate	Week 13	Justifying, Group study, solving exercises	Quiz 2 Lecture, Student reporting and Board work	CO4
Final Exam	**Week 14**				

* 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 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.

XI – Evaluation & Grading System

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

The tentative marks distributions for course evaluation are as follows:	
Attendance + Performance	10%
Assignment	10%
Quizzes(at least two)	40%
Mid Term/Final Assessment	20%
Viva	20%
Total (Final Grade/ Grand Total)	100%
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)

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:
Elementary Linear Algebra: Applications Version – H. Anton and C. Rorres, 11th edition, Wiley, 2013.
Reference Book/ Materials:
1) Linear Algebra and It's Application – David C. Lay and Steven R Lay, 5th edition, Pearson, 1997.
2) Advanced Engineering Mathematics - E. Kreyszig, 10th edition, John Wiley and Sons, 2010.
3) Fundamentals of Applied Electromagnetics - Fawwaz T. Ulaby and Umberto Ravaioli, 7th edition, Pearson, 1999.

XIV – Verification:

Prepared by :	Moderated by :
---------- **Amit Kumar Saha** Date:.....	---------- **Dilruba Yasmin** Date:.....

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	Solved problems on matrix algebra, inverse, row echelon form, reduced row echelon form and rank	Psychomotor	Midterm Exam	Rubric for Midterm Exam
CO2	Solve system of linear equation and problems related to Fourier analysis	Psychomotor	Midterm Exam	Rubric for Midterm Exam
CO3	Finding Eigenvalues, eigenvectors, determining whether a vector is linear dependent or independent and coordinate transformation	Psychomotor	Final Term Exam	Rubric for Final Term Exam
CO4	Finding values of gradient, divergence, curl and verification of Divergence and Stokes's theorem	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.	
Procedure to perform matrix algebra, inverse, row echelon form, reduced row echelon form and rank	• Students do not apply correct procedure	• Students apply partially correct procedure.	• Students apply correct procedure with minor mistakes	• Students apply the exact procedure	
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.	
procedure to solve system of linear equations and Fourier analysis	• Students do not apply correct procedure to solve problems	• Students solve the problem which is partially correct	• Students solve the problem with minor mistakes.	• Student solves the problem correctly.	
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 comprehensive ly define the terms.	
Usage of method for Eigenvalues, Eigen vectors, Linear dependency, linear combination and coordinate transformation	• Student does not apply the correct procedure or apply totally incorrect procedure	• Student apply partially correct procedure	• Students apply correct procedure with minor errors.	• Student correctly apply exact procedure	
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 comprehensive ly define the term with example.	
Correctness of formula for Gradient, divergence, curl and verification of Divergence & Stokes theorem in Cartesian, cylindrical and spherical system.	• Student does not apply correct method to verify	• Students apply method partial relevance to the subject matter.	• Students apply correct method with minor mistakes.	• Students apply correct method 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:	