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

PART-A

Course Outline		
I.	**Course No./ Course Code**	**MAT 2202**
II.	**Course Title**	**Matrices, Vectors and Fourier Analysis**
III.	**Course Type (General Education / Core Course / Electives)**	**GED**
IV.	**Semester**	**Spring**
V.	**Academic Session**	**2022-2023**
VI.	**Course Teacher/Instructor**	**Asst. Prof. Dr. Dilruba Yasmin and Asst. Prof. Roushanara Begum**
VII.	**Pre-requisite (If any)**	**MAT 1205 Integral Calculus & Ordinary Differential Equations, MAT 2101 Complex Variables, Laplace, and Z-Transformation**
VIII.	**Credit Value:**	**3.0**
IX.	**Contact Hours:**	**3 hours of the theory per week**
X.	**Total Marks:**	100
XI.	**Rationale of the Course:**	This course focuses on linear algebra, vector differentiation, integration in rectangular, cylindrical and spherical coordinate system and Fourier series and Fourier transform. Linear algebra has many applications in engineering, physics, geometry, computer science, economics, and other areas. Understanding of vector calculus helps to solve many problems exist in aerodynamics, aeronautics, fluid flow, heat flow, electrostatics, quantum physics, laser technology, robotics etc. Vector integral calculus is very important to engineer and physicist to solve many problems related to solid mechanics, fluid flow, heat

	flow and others. Continuous Fourier analysis is used to solve differential equations (PDEs) related to boundary value problem and initial value problem in mechanics, heat flow, electrostatics, and other fields. Discrete Fourier transform (DFT) has practical applications in digital signal processing, image processing etc.
XII. **Course Objectives:**	• To understand matrix algebra, matrix inversion, row-echelon form. • To know solution techniques of the system of linear equations and their applications (in network system, linear programming and cryptographically problem etc.). • To know about eigenvalues, eigenvectors, and their application such as the solution of 1st order ordinary DEs. • To know about Fourier series and Fourier transformation and Fourier integral. • To understand about rectangular, cylindrical & spherical coordinate systems and conversion to each other. • To know about vector calculus such as gradient, divergence, and curl in three coordinates systems also in general curvilinear coordinates system. • To know about the line, surface and volume integrals and their applications (Gauss divergence and Stokes theorems in three coordinates systems).

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

CLOs	CLO Descriptions	PLO Assessed
CLO1	Know the fundamental concepts of linear algebra, co-ordinate systems, vector calculus and Fourier analysis.	**PLO-a-2**
CLO2	Solve the system of linear equations, ordinary differential equations by applying gained fundamental concepts related to linear algebra.	**PLO-b-2**
CLO3	Solve the real life problem such as networking problem, circuit problem and cryptography, optimization problem by applying gained fundamental concepts related to linear algebra.	**PLO-b-2**

PART-B

XIV. **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	Matrix algebra, inverse of a matrix. Elementary row transformation, row echelon form, reduced row echelon form.	Lecture Brain Storming Problem Solving	Class Performance	CLO1, CLO2
2	Solution of system of linear equations by using Gaussian elimination method, matrix inverse method and determinant (Cramer's rule).	Lecture Brain Storming Problem Solving	Class Performance	CLO2
3	Applications of matrices (Networking Problems, Circuit problems, Robotics & Cryptography) in real life.	Lecture Brain Storming Problem Solving	Class Performance Quiz-1	CLO3
4	**Linear programming problems** (Maximization/ Minimization or Optimization).	Lecture Brain Storming Problem Solving	Class Performance	CLO3
5	**Fourier Analysis:** Periodic functions and periodicity of a given function, even and odd function, Fourier series in real form, odd and even extensions.	Lecture Brain Storming Problem Solving	Class Performance.	CLO1, CLO2
6	Fourier series in complex form, Half range Fourier sine and cosine series.	Lecture Brain Storming Problem Solving	Class Performance Quiz-2	CLO1, CLO2

7	Finite Fourier sine/cosine transform of a function, Fourier transform and Fourier Integral of a function, Discrete Fourier Transform.	Lecture Brain Storming Problem Solving	Class Performance Quiz-3	CLO1, CLO2
8		Mid Term Exam		
9	Eigenvalues & eigenvectors; applications of eigenvalues & eigenvectors to solve the system of ordinary differential equations (ODEs).	Lecture Brain Storming Problem Solving	Class Performance.	CLO1, CLO2
10	Cayley-Hamilton theorem and it's applications, vector space. Coordinate systems (cartesian coordinate, cylindrical coordinate, and spherical coordinate).	Lecture Brain Storming Problem Solving	Class Performance Quiz-1	CLO2
11	Gradient, directional derivative and Laplacian of scalar function.	Lecture Brain Storming Problem Solving	Class Performance.	CLO1, CLO2
12	Divergence and curl of a vector function, line integral, surface integral and volume integral in three co-ordinate systems.	Lecture Brain Storming Problem Solving	Class Performance. Quiz-2	CLO2, CLO3
13	Gauss's Divergence theorem in cartesian and cylindrical coordinates.	Lecture Brain Storming Problem Solving	Class Performance.	CLO1, CLO3
14	Gauss's Divergence theorem in spherical coordinates.	Lecture Brain Storming Problem Solving	Class Performance.	CLO1, CLO3
15	Stokes theorem in cartesian and cylindrical coordinate system.	Lecture Brain Storming Problem Solving	Class Performance.	CLO1, CLO3

16	Stokes Theorem in spherical coordinate system.	Lecture Brain Storming Problem Solving	Class Performance. Quiz-3	CLO1, CLO3
17		Final Exam		

Part-C

XV. Assessments and Evaluation

1) Assessment strategy:

Class Attendance	Mid-term examination
Class Performance/Assignments	Final-term examination
Quizzes	

2) Marks distribution:

Midterm and Final term	
Quiz	40%
Attendance	10%
Class performance/Assignment	10%
Mid/Final term Examination	40%
Total	100%
Final Grade/ Grand Total	
Mid term:	40%
Final Term:	60%

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	2.25	50<60
F	0.00	<50(Failed)

3) Make-up Procedures:

Students are allowed to apply for a makeup exam (quiz, terms) as per university policy.

PART-D

XVI. Learning materials

1) Recommended Readings:

• Elementary Linear Algebra: Applications Version – H. Anton and C. Rorres, 11th edition, Wiley, 2013.
• Fundamentals of Applied Electromagnetics - Fawwaz T. Ulaby and Umberto Ravaioli, 7th edition, Pearson, 1999.

2) Supplementary Readings:

• Linear Algebra and It's Application – David C. Lay and Steven R Lay, 5th edition, Pearson, 1997.
• Advanced Engineering Mathematics - E. Kreyszig, 10th edition, John Wiley and Sons, 2010.

• Lecture notes

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.

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.

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.