Course Specification
(Bachelor)

Course Title:	**Linear Algebra and Differential Equations**
Course Code:	**MAT 1228**
Program:	**Bachelor of Science in Engineering**
Department:	**Mathematics and Statistics**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**
Version:	**2024 – V1**
Last Revision Date:	**08/10/2024**

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A. General information about the course:

1. Course Identification

1. Credit hours:					
3 (3 Lectures, 0 Lab, 2 Tutorial)					
2. Course type					
A.	☐University	☐ College	☒ Program	☐Track	☐Others
B.	☒ Required		☐Elective		
3. Level/year at which this course is offered: Level 4 / Year 2					
4. Course general Description:					
The first part of this course covers matrix theory and linear algebra, emphasizing topics useful in other disciplines. Due to its broad range of applications, linear algebra is one of the most widely taught subjects in different programs. The laws of nature are expressed as differential equations. Scientists must know how to model the world in terms of differential equations, and how to solve these equations and interpret the solutions. The second part of course focuses on solving linear differential equations and their applications in science and economics.					
5. Pre-requirements for this course (if any):					
MAT 1115					
6. Co-requisites for this course (if any):					
None.					
7. Course Main Objective(s):					
To provide students with a good understanding about matrices concept and methods of linear algebra To let students be familiar with basics of solving differential equations. To connect linear algebra and differential equations to other fields.					

2. Teaching mode (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	75	100%
2	E-learning	0	0%
3	Hybrid • Traditional classroom • E-learning	0	0%
4	Distance learning	0	0%

3. Contact Hours (based on the academic semester)

No	Activity	Contact Hours
1.	**Lectures**	45
2.	**Laboratory/Studio**	0
3.	**Field**	0
4.	**Tutorial**	30
5.	**Others (specify)**	0
Total		75

B. Course Learning Outcomes (CLOs), Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Code of CLOs aligned with program	Teaching Strategies	Assessment Methods
1.0	**Knowledge and understanding**			
1.1	Explain the processes of Gauss elimination, matrix operations, determinants, and the concept of matrix inverses.	K2	Lecture and guided problem-solving sessions	Quizzes and written assignments
1.2	Identify key concepts of vector spaces, including linear dependence, basis, and dimension.	K1	Lecture discussions and visual demonstrations	Exams and problem sets
1.3	Describe the fundamentals of eigenvalues and eigenvectors, including diagonalization and their applications.	K2	Project-based learning and collaborative work	Projects and presentations
1.4	Summarize the concept of ordinary differential equations, the meaning of the meaning of their solutions, and the methods to find them.	K1	4 lecture hours\week 2 tutorial hours\week Self-study	Regular Exams Assignments Short Quizzes
2.0	**Skills**			
2.1	Find inverse of a square matrix by using its determinant and extension	S1, S2	Self-study	Participations

Code	Course Learning Outcomes	Code of CLOs aligned with program	Teaching Strategies	Assessment Methods
	matrix to solve some world-real problems.		Real-life problems	Short Quizzes
2.2	Solve real-world problems involving differential equations and initial value problems in field of economics.	S1, S2	Self-study Real-life problems	Participations Short Quizzes
2.3	Formulate, clearly and precisely, differential equations to solve various applied problems.,	S4	Self-study Real-life problems	Participations Short Quizzes
2.4	Compute eigenvalues and eigenvectors of square matrix to produce the diagonalization of the matrix.	S3	Short Quizzes	Participations
3.0	**Values, autonomy, and responsibility**			
3.1	Work individually and in group	V1, V3	Class activities	Individual and group coursework
3.2	Show attitude of support the use of computers in Matrix manipulation.	V1, V2	Class discussion	participation

C. Course Content

No	List of Topics	Contact Hours
1.	**Matrices and Gauss Elimination:** Solving linear systems, matrix notation, augmented matrix of a linear system, echelon form a matrix, Gaussian and Gauss-Jordan Elimination. Algebra of matrices, Inverse of a square matrix, Determinants and their properties, cofactor expansions, Cramer's Rule.	**20**
2.	**Vector Spaces: Vectors in R2 and R3.** Dot product, norm, angle and distance, orthogonal vectors, Vector spaces and subspaces, Linear dependence and independence, Spanning sets, Basis and dimension.	**10**
3.	**Eigenvalues and eigenvectors:** Eigenvalues and eigenvectors of a square matrix, characteristic polynomial of a square matrix, and basis of eigenvector subspace, Diagonalization of a Matrix.	**10**
4.	**First Order Differential Equations:** Introduction and First Definitions, Initial Value Problems, Differential Equations as Mathematical Models, Separable Equations, First Order Linear Equations, Exact Differential Equations, Homogeneous Differential Equations, Bernoulli Equations.	**15**

5	**Second Order Linear Differential Equations with Constant Coefficients:** General Solution of the Homogeneous Equation, Reduction of the Order Method, Particular Solution of the Nonhomogeneous Equation, The Undetermined Coefficients and Variation of Constants Methods, Variation of Parameters Method, Euler-Cauchy Equation, Some Applications: Damped Free and Forced Vibrations, Mechanical Vibrations....	**20**
Total		**75**

D. Students Assessment Activities

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	HomeWorks, Quizzes, Mini-projects	During the term	10%
2.	First Midterm	Week 5-6	25%
3.	Second Midterm	Week 10-11	25%
4.	Final Exam	Week 15-16	40%

*Assessment Activities (i.e., Written test, oral test, oral presentation, group project, essay, etc.).

E. Learning Resources and Facilities

1. References and Learning Resources

Essential References	• **Gareth Williams, Linear Algebra with Applications, (Jones & Bartlett Learning, LLC), 8th Edition, 2014 (for the first part, Chapters 1-4)** • ***Elementary Differential Equations and Boundary Value Problems,*** W. Boyce and R. DiPrima, 9th Edition, New York: John Wiley & Sons, 2010. **(for the second part, Chapters 5-6)**
Supportive References	**1.** *Elementary Linear Algebra;* **11th Edition; H. Anton, C. Rorres, Wiley, 2014.** 2. *Linear Algebra with Application,* **5th Edition; W. K. Nicholson, McGraw- Hill, 2006.** 3. **Denis G. Zill, A First Course in Differential Equations with Modeling Applications, 10th Edition, Brooks/Cole, Cengage Learning, 2013** 4. ***A first course in differential equations with applications,*** Dennis G. Zill, 5th Edition, PWS Kent Publishing Company, 2000.
Electronic Materials	
Other Learning Materials	

2. Required Facilities and equipment

Items	Resources
facilities (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	• **Classrooms:** Equipped with whiteboards, projectors, and Smart Boards for interactive lessons and group discussions. • **Laboratories:** Feature computers with internet access, enabling hands-on activities and exploration of algebraic and trigonometric concepts. • **Exhibition Rooms:** Spaces for showcasing projects and presentations to encourage collaborative learning.
Technology equipment (projector, smart board, software)	• **Data Show Projectors:** For clear presentations in classrooms and labs. • **Smart Boards:** To enhance interactivity during lessons. • **Mathematical Software:** Essential for graphing and analysis.
Other equipment (depending on the nature of the specialty)	• **Computers:** For mini-project and homework and practical applications in laboratories. • **Advanced Calculators:** For computations and problem-solving and supporting matrix computation. • **Whiteboards and Markers:** To facilitate brainstorming and collaboration.

F. Assessment of Course Quality

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	Student and teaching staff	Surveys and Questionnaires
Effectiveness of Students assessment	Course Coordinator	Peer Reviews
Quality of learning resources	Students and teaching staff	Classroom Observations
The extent to which CLOs have been achieved	Student Representatives	Student Performance Evaluations (exams, projects) CLOs Excel sheet.
Other	**None**	

Assessors (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify)

Assessment Methods (Direct, Indirect)

G. Specification Approval

COUNCIL /COMMITTEE	**MATHEMATICS AND STATISTICS DEPARTMENT COUNCIL**
REFERENCE NO.	**8/1446**
DATE	**05/04/1446 (08/10/2024)**