Course Specification
(Bachelor)

Course Title:	**Numerical Analysis (2)**
Course Code:	**MAT 1442**
Program:	**Bachelor of Science in Applied Mathematics**
Department:	**Mathematics and Statistics**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**
Version:	**2024 – V1**
Last Revision Date:	**08/10/2024**

Table of Contents

A. General information about the course:

1. Course Identification

1. Credit hours:					
3 (2 Lectures, 1 Lab, 1 Tutorial)					
2. Course type					
A.	☐University	☐ College	☒ Program	☐Track	☐Others
B.	☒ Required		☐Elective		
3. Level/year at which this course is offered: Level 7 / Year 4					
4. Course general Description:					
This course builds on Numerical Analysis I, focusing on advanced numerical methods for approximating functions, evaluating integrals, and solving ordinary and partial differential equations. The course covers solving systems of linear equations, approximating eigenvalues, and addressing boundary value problems for ODEs, alongside theoretical analysis and algorithm development. Students will also gain hands-on experience using MATLAB for implementing numerical techniques and analyzing results.					
5. Pre-requirements for this course (if any)**:**					
MAT 1341 Numerical Analysis (1) and **MAT 1334 Introduction to Partial Differential Equations**					
6. Co-requisites for this course (if any)**:**					
None.					
7. Course Main Objective(s):					
The main objective is to equip students with advanced numerical techniques and theoretical understanding necessary for solving complex mathematical problems in diverse applications. This course aims to enhance students' problem-solving skills, enabling them to effectively tackle challenges in fields such as engineering, physics, and data science, thereby preparing them for both academic research and industry roles.					

2. Teaching mode (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	**60**	**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**	30
2.	**Laboratory/Studio**	15
3.	**Field**	0
4.	**Tutorial**	15
5.	**Others (specify)**	0
Total		60

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	Outline Least Squares, multistep, predictor-corrector methods, and some Iterative algorithms for eigenvalue problems:	K2	3 lecture hours\week 1 tutorial hour\week	Regular Exams
1.2	List some numerical method to solve PDE	K1, K2	1 lab hours\week Self-study	Assignments Short Quizzes
2.0	**Skills**			
2.1	To develop advanced techniques of numerical solutions.	S1, S2	Real-life problems	Short Quizzes
2.2	To present numerical methods of differential equations clearly and precisely both orally and in writing.	S4	Self-study	Participations
2.3	To use Internet in searching for different numerical methods of ODEs and PDEs	S5	Real-life problems	Short Quizzes
2.4	To demonstrate some proofs of numerical ODEs and PDEs by using finite difference techniques.	S3	Self-study	Participations
3.0	**Values, autonomy, and responsibility**			
3.1	work individually and in group.	V1, V3	Personal questions	Participation

Code	Course Learning Outcomes	Code of CLOs aligned with program	Teaching Strategies	Assessment Methods
3.2	Show the scientific attitude by mentioning and testing a hypothesis before accepting it.	V1, V2	Team work	Homework and Mini-projects

C. Course Content

No	List of Topics	Contact Hours
1.	**Advanced Numerical Linear Algebra:** Least Squares Method, Matrix Eigenvalue Problems: Power Method, QR Factorization. Use MATLAB for implementing these techniques and analyzing results.	**15**
2.	**Finite difference techniques:** Difference equation replacement, Implicit and explicit finite difference method. Use MATLAB for implementing this method and analyzing results	**10**
3.	**Boundary Value Problems for ODEs:** Multistep Methods, Finite Difference Methods for Systems of Differential Equations. Use MATLAB for implementing these techniques and analyzing results	**15**
4.	**Finite Difference Method for PDEs:** Finite Difference Method for Boundary Value Problems, Numerical Solution of Elliptic PDEs, Numerical Solution of Parabolic PDEs, Numerical Solution of Hyperbolic PDEs. Use MATLAB for implementing these techniques and analyzing results	**20**
Total		**60**

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	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	*Elementary Numerical Analysis, 3rd Edition,* **Kendall Atkinson; Weimin Han; 2004. (Main Reference).**
Supportive References	• *Numerical Solution of Partial Differential Equations: An Introduction,* 2nd Edition, **K. W. Morton & D. F. Mayers, Cambridge University Press, 2005**. • *An Introduction to Numerical methods and Analysis,* **James F. Epperson, Wiley; 2002.** • *Numerical Analysis,* **R. Burden and J. Faires, 8th Edition, Brooks/Cole, 2001.**
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 the study of limits, continuity, and differentiation. • **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)**