King Saud University
College of Science
Numerical Methods
Course Syllabus
Second Semester 1444 - 1445

1. Course General Information:

Course Title: Numerical Methods	**Course Code:** MATH 351
Course Level: 5	**Course Prerequisite:** (MATH107 or MATH202 or MATH244) and (CSC101 or CSC206 or CSC207). **Co-requisites for this course (if any):** None
Lecture Time: 10-11 AM.	**Credit Hours:** 3

2. Faculty Member Responsible for the Course:

Name	Rank	Office Number and Location	Office Hours	Email Address
Dr. Bandar Almohsen	Professor	2A284 Building 4 Main Campus	8 AM-1PM Monday and Wednesday	balmohsen@ksu.edu.sa

3. Course Description:

Numerical Methods for Solving Nonlinear Equations: Bisection method, fixed point method, Newton's method, secant method, multiple roots, modified Newton's method, rate of convergence (error analysis), Newton's method for solving nonlinear systems. Solving Systems of Linear Equations: Gaussian elimination, Gaussian elimination with partial pivoting, LU-decomposition, Jacobi method, Gauss-Seidel method. Interpolation and Polynomial Approximations Lagrange interpolation formula, Newton's interpolation formula, interpolation using linear splines. Numerical Differentiation and Integration: Trapezoidal, and Simpson's rules. Numerical solutions of Ordinary Differential equations; Taylor methods and Runge-Kutta method of order two.

4. Course Academic Calendar

Week	Topics to be Covered
1-3	Numerical Methods for Solving Nonlinear Equations: Bisection method, fixed point method, Newton's method, secant method, multiple roots, modified Newton's method, rate of convergence (error analysis), Newton's method for solving nonlinear systems.
4-7	Solving Systems of Linear Equations: Direct methods: Gaussian elimination, Gaussian elimination with partial pivoting, LU-decomposition. Iterative methods: Jacobi method, Gauss-Seidel method. Error analysis for solving Linear system

8-10	Interpolation and Polynomial Approximations Lagrange interpolation formula, divided differences, Newton's interpolation formula, error in polynomial interpolation, interpolation using linear splines.
11-13	Numerical Differentiation and Integration First derivative: two-point formulas (forward and backward) and three-point formulas (forward, central and backward). Second derivative: the central method. Trapezoidal, Simpson's rules, and the error bounds.
14-15	Numerical solutions of Ordinary Differential equations; Taylor methods, Runge-Kutta method of order two and the local truncation error for Euler's and Taylor's formulas.
16	Final exam

5. Course Objectives:

The main purpose for this course is to introduce the following concepts:

- The main purpose for this course is to introduce:
- Numerical methods for solving mathematical problems
- Analyze the error for these methods
- Write computer algorithms to implement these methods for solving certain mathematical problems using computer.

6. Course References:

6.1 Textbooks:

An Introduction to Numerical Analysis using MATLAB**, by** Rizwan Butt**,** Infinity Science Press, Hingham, Massachusetts, New Delhi**, 2008**

6.2 Essential References Materials (Journals, Reports, etc.)

1-Numerical Analysis, Richard L. Burden and J. Douglass Faires, fifth edition, Brooks/Cole

2- An Introduction to Numerical Linear Algebra using MATLAB, Rizwan Butt, Heldermann Verlag, Germany, 2008.

6.3 Recommended Textbooks and Reference Material (Journals, Reports, etc)

1-Numerical Analysis, Richard L. Burden and J. Douglass Faires, fifth edition, Brooks/Cole

2- An Introduction to Numerical Linear Algebra using MATLAB, Rizwan Butt, Heldermann Verlag, Germany, 2008.

6.4 Websites:

1- KSU Learning Management System

2- Internet websites relevant to the course

6.5 Other learning material such as computer-based programs/CD, professional standards or regulations and software.

- None

7. Teaching Methods:

- At the beginning of studying each topic some examples will be laid out and discussed with the students encouraging them to discover the relevant concepts.
- At the beginning of each lecture, a discussion is conducted with the students about what has been done in the previous lecture in order to establish a link with the current lecture.
- Discussions in the class

- Homework assignments
- Independent study

8. Learning Outcomes:

8.1 Knowledge and Understanding:

After studying this course, the student will acquire the following knowledge and be able to:

- Define error, absolute error and relative error.
- Define a fixed point of a given function.
- State Newton's, Secant and Modified Newton's formulas.
- Define a multiple root of a nonlinear equation, and the order of convergence of an iterative scheme.
- Define the residual vector corresponding to an approximate solution of a given linear system.
- Define the condition number of a given nonsingular matrix.
- Define divided differences of a function and state Lagrange and Newton's interpolation formulas.
- State Taylor's and Runge - Kutta methods for solving an initial value problem.

8.2 Cognitive Skills (Thinking and Analysis):

After studying this course, the student will able to:

1) Solve a nonlinear equation numerically by different numerical methods and analyze the resulting error.
2) Compute the rate of convergence for iterative schemes.
3) Solve a system of linear equations by direct and indirect methods and analyze the resulting error.
4) Approximate a function or data using polynomial interpolation formulas and analyze the error in these formulas.
5) Apply difference formulas to approximate derivatives and analyzing the error in these formulas.
6) Approximate a definite integral using trapezoidal and Simpson’s rules and analyzing the error in these methods.
7) Solve an initial value problem of ordinary differential equations using different methods.
8) Write mathematical algorithms for different numerical methods.

8.3 Interpersonal Skills and Responsibility:

After studying this course, the student is expected to:

- To participate in the discussion
- Study, learn and work independently.
- Work effectively in teams.
- Meet deadlines and manage time properly.
- Exhibit ethical behaviour and respect different points of view.

8.4 Communication, Information Technology and Numerical Skills

After studying this course, the student is expected to be able to:

- Present mathematics to others, both in oral and written form clearly and in a well-organized manner.
- Use IT facilities as an aid to mathematical processes and for acquiring available information
- Write algorithms and solve mathematical problems numerically.
- Use library to locate mathematical information.

9. Methods of Assessment:

Course Assessment	Mark
Class activates (in class quizzes, and homework)	10
Midterm exams I	25
Midterm exams II	25
Final Examination	40
Total	**100**

10. Course Policies:

- All exams are closed book.
- The final exam will be comprehensive.

11. Attendance Policy:

Absence from lectures and/or tutorials shall not exceed 25%. Students who exceed the 25% limit without an accepted medical or emergency excuse shall not be allowed to take the final examination and shall receive a grade of "DN" for the course.