



School of Science | Numerical Methods | Fall 2022

Department of Mathematics | Course Syllabus

Course name and code: Numerical Methods (0301472). **Credit hours:** 3 hrs

Class time and room: Sun, Tue, Thru: 9:30-10:30 am. Math Bldg. 103

Prerequisite: Linear Algebra (0301241)

Instructor Name	Professor Baha Alzalg
Office No.	Math Bldg. 204
Office hours	Sun, Tue, Thru: 10:30-11:30 am
Email	b.alzalg@ju.edu.jo
Course webpage	sites.ju.edu.jo/sites/alzalg/pages/472.aspx

Course Description:

This course analyzed the basic techniques for the efficient numerical solution of problems in science and engineering. Topics spanned root finding, interpolation, approximation of functions, integration, differential equations, direct and iterative methods in linear algebra.

Course General Objectives:

Upon completion of this course, the student should be able to:

1. Use several methods of solving algebraic and transcendental equations of one variable.
2. Approximate functions by polynomials.
3. Approximate differentiation & integration.
4. Solve IVP numerically.
5. Solve linear systems of equation.
6. Use Iterative Techniques to solve linear systems.

Course Specific Objectives:

Learning outcomes:

Successful completion of this course should lead to the following learning outcomes for each student:

A) Knowledge and understanding:

A1) List theories and concepts used in Numerical Analysis.

A2) Identify the steps required to carry out a piece of research on a topic within Numerical Analysis.

A3) Recognize the contribution and impacts of Numerical Analysis in real life.

B) Intellectual skills:

- B1) Apply appropriate theories, principles and concepts relevant to the numerical analysis.
- B2) Formulate a reasoned argument from a variety of sources relevant to Numerical Analysis.
- B3) Analyze and interpret information from a variety of sources relevant to Numerical Analysis.
- B4) Select a reasoned argument to the solution of familiar and unfamiliar problems relevant to Numerical Analysis.

C) Professional skills:

- C1) Plan practical activities using techniques and procedures appropriate to Numerical Analysis.
- C2) Design a piece of independent research using Numerical Analysis.

D) General skills:

- D1) Think independently, set tasks and solve problems on ethical scientific basis relevant to Numerical Analysis.
- D2) Communicate with others positively as part of a group, involving leadership, group dynamics and interpersonal skills such as listening, negotiation and persuasion relevant to Numerical Analysis.
- D3) Use information and communication technology to discuss problems relevant to Numerical Analysis

Teaching methods:

In order to succeed in this course, each student needs to be an active participant in learning – both in class and out of class.

- The instructor will spend most of the class time on presenting the new material as well as on discussing homework problems.
- Group work in this class is encouraged.
- To actively participate in class, you need to prepare by reading the textbook and to do all assigned problems before class. (Problems will be assigned each class period, then to be discussed the following period).
- You should be prepared to discuss your homework at each class meeting.
- You are encouraged to work together with other students and to ask questions and seek help from your professor, both in and out of class.
- Students are also encouraged to use graphing calculators extensively and to use computer software supplements.

Tests & evaluations:

Grades of this course will be calculated from two exams and a final exam. Grade distribution as follows:

Exam	Percentage	Time
Med Term Exam	30 %	Sunday 27/11/2022
Second Term	20 %	Sunday 18/12/2022
Final Exam	50 %	To be announced later

Course contents:**Topic** **Reading and preparation assignment**

- 1 **Mathematical Preliminaries**
 - 1.1 Review of Calculus (Taylor's Theorem).
 - 1.2 Round-Off Errors.
- 2 **Solutions of Equations in One Variable**
 - 2.1 The Bisection Method.
 - 2.2 Fixed Point Iteration.
 - 2.3 The Newton-Raphson Method.
 - 2.4 Error Analysis for Iterative Methods.
 - 2.5 Accelerating convergence.
 - 2.6 Zeros of Polynomials and Muller's Methods.
- 3 **Interpolation and Polynomial Approximation**
 - 3.1 Interpolation and the Lagrange Polynomials.
 - 3.2 Divided Differences.
- 4 **Numerical Differentiation and Integration**
 - 4.1 Numerical Differentiation.
 - 4.2 Richardson Extrapolation.
 - 4.3 Elements of Numerical Integration.
 - 4.4 Composite Numerical Integration.
 - 4.5 Romberg Integration.
 - 4.6 Adaptive Quadrature methods.
- 5 **Initial Values Problems for ODE**
 - 5.1 Elementary Theory of IVP.
 - 5.2 Euler's Method.
 - 5.3 Higher Order Taylor's Method.
 - 5.4 Runge-Kutta Methods.

6 **Direct Methods for Solving Linear Systems**

- 6.1 Linear Systems of Equations.
- 6.2 Pivoting Strategies.
- 6.3 Linear Algebra and Matrix Inversion.
- 6.4 The Determinant of a Matrix.
- 6.5 Matrix Factorization.
- 6.6 Special Types of Matrices.

7 **Iterative Techniques in Matrix Algebra**

- 7.1 Norms of Vectors and Matrices.
- 7.2 Iterative Techniques for Solving Linear Systems.
- 7.3 Error Estimates and Iterative Refinement.

Text book:

Numerical Analysis by Burden and Fairs, the latest edition, Brooks/Cole Pub. Co.

References:

1. Numerical Mathematics and Computing by W. Cheney and D. Kincaid, 3rd edition, Brooks/Cole Pub. Co. 1994.
2. Elementary Numerical Analysis by K. Atkinson, 2nd edition, John Wiley & Sons, Inc., 1993.

Important regulations:

1. Attendance is absolutely essential to succeed in this course. You are expected to attend every class; please notify your instructor if you know you are going to be absent. All exams must be taken at the scheduled time. Exceptions will be made only in extreme circumstances, by prior arrangement with the instructor.
2. If a student is absent for more than 10% of lectures without an excuse of sickness or due to other insurmountable difficulty, then he/she shall be barred from the final examination also he/she will get a failing grade in this course.
3. Medical certificates shall be given to the University Physician to be authorized by him. They should be presented to the Dean of the Faculty within two weeks of the student's ceasing to attend classes.
4. Test papers shall be returned to students after correction. His/her mark is considered final after a lapse of one week following their return.
5. Solutions for the exams questions and marks will be announced at the course webpage.
6. Cheating is prohibited. The University of Jordan regulations on cheating will be applied to any student who cheats in exams or on homework.

Important dates:

The first semester 2022/2023 begins	09-10-2022		Sunday
Incomplete course exams week	09-10-2022	13-10-2022	Sunday - Thursday
Mid-term Exam	27-11-2022		Sunday
Registration for the second semester 2022/2023 begins	11-12-2022		Sunday
Second Exam	18-12-2022		Sunday
Christmas Day	25-12-2022		Sunday
New Year	01-01-2023		Sunday
End of Withdrawal Period from one or more courses for the first semester 2022/2023	12-01-2023		Thursday
End of Withdrawal Period from the first semester 2022/2023	12-01-2023		Thursday
Last day of teaching classes in the first semester 2022/2023	17-01-2023		Tuesday
Final Examinations	19-01-2023	30-01-2023	Thursday - Monday
Vacation (for the students)	31-01-2023	16-02-2023	Tuesday - Thursday
Deadline for submission of the final exams' results to the Admission and Registration Unit	01-02-2023		Wednesday
Deadline for the Faculties' Councils to submit recommendations to grant degrees and certificates to the Deans' Council	02-02-2023		Thursday