Fall 2024

# MATH 712-001: Numerical Methods II

P. Petropoulos

# MATH 712: Numerical Methods II
## *Fall 2024 Course Syllabus*

**NJIT Academic Integrity Code**: All Students should be aware that the Department of Mathematical Sciences takes the University Code on Academic Integrity at NJIT very seriously and enforces it strictly. This means that there must not be any forms of plagiarism, i.e., copying of homework, class projects, or lab assignments, or any form of cheating in quizzes and exams. Under the University Code on Academic Integrity, students are obligated to report any such activities to the Instructor.

## COURSE INFORMATION

**Course Description**: Numerical methods for the solution of initial- and boundary-value problems for partial differential equations, with emphasis on finite difference methods. Consistency, stability, convergence, and implementation are considered.

**Number of Credits**: 3

**Prerequisites**: MATH 614, MATH 331 or departmental approval, and proficiency in a computer programming language (MATLAB, C, C++, Fortran, etc.)

**Course-Section and Instructors:**

| Course-Section | Instructor |
|---|---|
| Math 712-001 | Professor P. G. Petropoulos |

**Office Hours for All Math Instructors**: Fall 2024 Office Hours and Emails

**Required Textbook**: Course material and homework assignments will be drawn from the following two textbooks.

1) “Numerical Partial Differential Equations: Finite Difference Methods,” Thomas, J.W., Springer-Verlag New York, 1995; ISBN 978-1-4419-3105-4

2) “Finite Difference Schemes and Partial Differential Equations,” by J. Strikwerda, SIAM, 2004; ISBN 0-898715679

**University-wide Withdrawal Date**: The last day to withdraw with a **M** is **Monday, November 11, 2024**. It will be strictly enforced.

## POLICIES

**DMS Course Policies**: All DMS students must familiarize themselves with, and adhere to, the Department of Mathematical Sciences Course Policies, in addition to official university-wide policies. DMS takes these policies very seriously and enforces them strictly.

**Grading Policy**: The final grade in this course will be determined as follows:

| | |
|---|---|
| **Homework/Projects** | 50% |
| **Midterm Exam** | 20% |
| **Final Project** | 30% |

Your final letter grade will be based on the following tentative curve.

| | | | |
|---|---|---|---|
| **A** | 90 - 100 | **C** | 70 - 74 |
| **B+** | 85 - 89 | **D** | 60 - 69 |
| **B** | 80 - 84 | **F** | 0 - 59 |
| **C+** | 75 - 79 | | |

**Attendance Policy**: Attendance at all classes will be recorded and is **mandatory**. Please make sure you read and fully understand the Math Department's Attendance Policy. This policy will be strictly enforced.

**Exams**: There will be one midterm exam held in class during the semester and one comprehensive final exam. Exams are held on the following days:

| | |
|---|---|
| Midterm Exam | October 16, 2024 |
| Final Project | Due on the day of the final exam for this course. |

The final exam will test your knowledge of all the course material taught in the entire course. Make sure you read and fully understand the Math Department's Examination Policy. This policy will be strictly enforced.

**Makeup Exam Policy**: There will be **NO MAKE-UP QUIZZES OR EXAMS** during the semester. In the event an exam is not taken under rare circumstances where the student has a legitimate reason for missing the exam, the student should contact the Dean of Students office and present written verifiable proof of the reason for missing the exam, e.g., a doctor's note, police report, court notice, etc. clearly stating the date AND time of the mitigating problem. The student must also notify the Math Department Office/Instructor that the exam will be missed.

**Cellular Phones**: All cellular phones and other electronic devices must be switched off during all class times.

## ADDITIONAL RESOURCES

**Further Assistance**: For further questions, students should contact their instructor. All instructors have regular office hours during the week. These office hours are listed on the Math Department's webpage for Instructor Office Hours and Emails.

**Accommodation of Disabilities**: The Office of Accessibility Resources and Services (OARS) offers long term and temporary accommodations for undergraduate, graduate and visiting students at NJIT.

If you are in need of accommodations due to a disability please contact Scott Janz, Associate Director of

Disability Support Services at 973-596-5417 or via email at scott.p.janz@njit.edu. The office is located in Kupfrian Hall, Room 201. A Letter of Accommodation Eligibility from the Office of Accessibility Resources and Services office authorizing your accommodations will be required.

For further information regarding self identification, the submission of medical documentation and additional support services provided please visit the Office of Accessibility Resources and Services (OARS) website at:

https://www.njit.edu/studentsuccess/accessibility/

**Important Dates** (See: Fall 2024 Academic Calendar, Registrar)

| Date | Day | Event |
|---|---|---|
| September 2, 2024 | Monday | Labor Day |
| September 3, 2024 | Tuesday | First Day of Classes |
| September 9, 2024 | Monday | Last Day to Add/Drop Classes |
| November 11, 2024 | Monday | Last Day to Withdraw |
| November 26, 2024 | Tuesday | Thursday Classes Meet |
| November 27, 2024 | Wednesday | Friday Classes Meet |
| November 28 to December 1, 2024 | Thursday and Sunday | Thanksgiving Recess - Closed |
| December 11, 2024 | Wednesday | Last Day of Classes |
| December 12, 2024 | Thursday | Reading Day 1 |
| December 13, 2024 | Friday | Reading Day 2 |
| December 15 to December 21, 2024 | Sunday to Saturday | Final Exam Period |

# Course Outline

| | Topics |
|---|---|
| 1 | Review of classification of Partial Differential Equations (PDEs), Fourier analysis of PDEs, symbols of operators, dispersion relations. Well-posedness of Initial-Value Problems (IVP) and Initial-Boundary-Value Problems (IBVP) for PDEs. |
| 2 | Numerical differentiation on a grid. Fourier analysis on a grid. The Evaluation, Truncation, and Interpolation operators. |
| 3 | Explicit & implicit Finite Difference (FD) numerical schemes for solving PDEs. |
| 4 | The concepts of Order of Accuracy, Stability, Consistency, and Convergence of FD numerical schemes for PDEs. |
| 5 | Stability of single- and multi-step FD schemes. The effect on stability of boundary |

| | |
|---|---|
| | conditions. |
| 6 | Numerical Dispersion and Numerical Dissipation of FD schemes. |
| 7 | FD schemes for Hyperbolic and Parabolic PDEs and systems in 1 and 2 dimensions. |
| 8 | Fundamentals of Spectral Methods – The Method of Weighted Residuals, Galerkin & Collocation Approximation of a Given Function, Galerkin & Collocation Approximation of the Solution of a Differential Equation. Differentiation Matrices. |
| 9 | Periodic Grids – The DFT and FFT - Smoothness and Spectral Accuracy. Initial Boundary Value Problems and the Chebyshev Method. Application to model problems. |

*Updated by Professor P. G. Petropoulos - 8/2024*
*Department of Mathematical Sciences Course Syllabus, Fall 2024*