Fall 2019

# MATH 613-001: Advanced Applied Mathematics I - Modeling

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NJIT New Jersey's Science & Technology University

THE COLLEGE OF SCIENCE AND LIBERAL ARTS

THE DEPARTMENT OF MATHEMATICAL SCIENCES

# MATH 613: Advanced Applied Mathematics I: Modeling
## *Fall 2019 Graduate 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**: Concepts and strategies of mathematical modeling are developed by investigation of case studies in a selection of areas. Consistency of a model, nondimensionalization and scaling, regular and singular effects are discussed. Possible topics include continuum mechanics (heat and mass transfer, fluid dynamics, elasticity), vibrating strings, population dynamics, traffic flow, and the Sommerfeld problem.

**Number of Credits**: 3

**Prerequisites**: MATH 331 and MATH 337, or departmental approval.

**Course-Section and Instructors**

| Course-Section | Instructor |
|---|---|
| Math 613-001 | Professor V. Matveev |

**Office Hours for All Math Instructors**: Fall 2019 Office Hours and Emails

**Recommended Textbook** (there is no *required* textbook for this course):

| | |
|---|---|
| **Title** | *Applied Mathematics* |
| **Author** | J. David Logan |
| **Edition** | 4th |
| **Publisher** | Wiley |
| **ISBN #** | 978-1118475805<br>978-1118514924<br>978-1118514931 |

**University-wide Withdrawal Date**:The last day to withdraw with a **W** is **Monday, November 11, 2019**. 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:

| | |
|---|---|
| **Assignments** | 25% |
| **Midterm Exam** | 35% |
| **Final Exam** | 40% |

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

| | | | |
|---|---|---|---|
| **A** | 84 - 100 | **C+** | 60-69 |
| **B+** | 77-83 | **C** | 50-59 |
| **B** | 70-76 | **F** | 0 - 49 |

**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.

**Homework Policy**: Homework is assigned each week, and is expected to be handed in on time. Late submissions will be penalized.

**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 31, 2019 |
| Final Exam Period | December 14 - 20, 2019 |

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**: To properly report your absence from a midterm or final exam, please review and follow the required steps under the DMS Examination Policy found here:

- http://math.njit.edu/students/policies_exam.php

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

**Policy on Academic Integrity:** Academic Integrity is the cornerstone of higher education and is central to the ideals of this course and the university. Cheating is strictly prohibited and devalues the degree that you are working on. As a member of the NJIT community, it is your responsibility to protect your educational investment by knowing and following the academic code of integrity policy that is found at: http://www5.njit.edu/policies/sites/policies/files/academic-integrity-code.pdf.

Please note that it is my professional obligation and responsibility to report any academic misconduct to the Dean of Students Office. **Any student found in violation of the code by cheating, plagiarizing or using any online software inappropriately will result in disciplinary action.** This may include a failing grade of F, and/or suspension or dismissal from the university. If you have any questions about the code of Academic Integrity, please contact the Dean of Students Office at dos@njit.edu

## ADDITIONAL RESOURCES

**Accommodation of Disabilities**: Disability Support Services (DSS) 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 Chantonette Lyles, Associate Director of Disability Support Services at 973-596-5417 or via email at lyles@njit.edu. The office is located in Fenster Hall, Room 260. A Letter of Accommodation Eligibility from the Disability Support 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 Disability Support Services (DSS) website at:

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

**Important Dates** (See: Fall 2019 Academic Calendar, Registrar)

| Date | Day | Event |
|---|---|---|
| September 3, 2019 | T | First Day of Classes |
| September 13, 2019 | F | Last Day to Add/Drop Classes |
| November 11, 2019 | M | Last Day to Withdraw |
| November 26, 2019 | T | Thursday Classes Meet |
| November 27, 2019 | W | Friday Classes Meet |
| November 28-29, 2019 | R-F | Thanksgiving Recess |
| December 11, 2019 | W | Last Day of Classes |
| December 12, 13 2019 | R & F | Reading Days |
| December 14-20, 2019 | F - R | Final Exam Period |

# Course Outline

| Date | Topic |
|---|---|
| Sept. 5 | Introduction to modeling. Units, dimensions, and dimensional analysis. |
| Sept. 9 | Nondimensionalization: examples from various models |
| Sept. 12 | Nondimensionalization: the Buckingham's Π theorem |
| Sept. 16 | ODE models in 1D: stability analysis and the phase line |
| Sept. 19 | ODE models in 2D: linear stability analysis and the phase plane; diagonalization |
| Sept. 23 | ODE models in 2D: vector calculus review, conservative fields, Lyapunov functions |
| Sept. 26 | ODE models in 2D: chemical reactions and the principle of mass action |
| Sept. 30 | ODE models in 2D: SRI model for infectious disease propagation in a population |
| Oct. 3 | ODE models: perturbation methods, asymptotic series |
| Oct. 7 | ODE models: perturbation methods, asymptotic series (continued) |
| Oct. 10 | PDE models in R´R+: random walks and the diffusion equation. |
| Oct. 14 | PDE models in R´R+: equilibrium solutions of diffusion equation |
| Oct. 17 | PDE models in R´R+: traffic modeling, method of characteristics for hyperbolic PDEs |
| Oct. 21 | PDE models in R´R+: method of characteristics continued; shocks |

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|---|---|
| Oct. 24 | Einstein notation: vector and tensor operations |
| Oct. 28 | Einstein notation: partial differentiation, product rules, higher-order derivatives |
| Oct. 31 | Midterm Exam |
| Nov. 4 | PDE models in R3: Divergence Theorem and the continuity equation |
| Nov. 7 | PDE models in R3: Maxwell's equations, EM wave in vacuum, electrostatics |
| Nov. 11 | PDE models in R3: Electrostatics (continued) |
| Nov. 14 | PDE models in R3: reaction-diffusion equations, conservation laws, cell calcium dynamics |
| Nov. 18 | PDE models in R3: incompressible flows, inviscid and viscous fluid flows, 2D flows |
| Nov. 21 | PDE models in R3: Navier-Stokes Equation |
| Nov. 25 | PDE models in R3: Navier-Stokes Equation: derivation |
| Nov. 26 | Stochastic processes: continuous-time Markov processes |
| Dec. 2 | Stochastic processes: Chemical Master Equations (CMEs) and moment equations |
| Dec. 5 | Stochastic processes: solving CMEs using the generating function |
| Dec. 9 | Stochastic processes: finding the generating function using the method of characteristics |

*Updated by Professor V. Matveev - 7/22/2019*
*Department of Mathematical Sciences Course Syllabus, Fall 2019*