

## MATH 613: Advanced Applied Mathematics I: Modeling

### *Fall 2020 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 2020 Office Hours and Emails](#)

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

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

**University-wide Withdrawal Date:** The last day to withdraw with a **W** is **Monday, November 9, 2020**. 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 29, 2020
Final Exam Period	December 15 - 21, 2020

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](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](mailto:dos@njit.edu)

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## 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](tel:973-596-5417) or via email at [lyles@njit.edu](mailto: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 2020 Academic Calendar](#), Registrar)

Date	Day	Event
September 1, 2020	T	First Day of Classes
September 5, 2020	S	Saturday Classes Begin
September 7, 2020	M	Labor Day
September 8, 2020	T	Monday Classes Meet
September 8, 2020	T	Last Day to Add/Drop Classes
November 9, 2020	M	Last Day to Withdraw
November 25, 2020	W	Thursday Classes Meet
November 26-29, 2020	R - Su	Thanksgiving Recess
December 10, 2020	R	Last Day of Classes
December 11 & 14 2020	F & M	Reading Days
December 15 - 21, 2020	T - M	Final Exam Period

## Course Outline

Date	Topic
Sept. 3	Introduction to modeling. Units, dimensions, and dimensional analysis.
Sept. 7	Nondimensionalization: examples from various models
Sept. 10	Nondimensionalization: the Buckingham's $\Pi$ theorem
Sept. 14	ODE models in 1D: stability analysis and the phase line
Sept. 17	ODE models in 2D: linear stability analysis and the phase plane; diagonalization
Sept. 21	ODE models in 2D: vector calculus review, conservative fields, Lyapunov functions
Sept. 24	ODE models in 2D: chemical reactions and the principle of mass action
Sept. 28	ODE models in 2D: SRI model for infectious disease propagation in a population
Oct. 1	ODE models: perturbation methods, asymptotic series
Oct. 5	ODE models: perturbation methods, asymptotic series (continued)
Oct. 8	PDE models in $\mathbb{R}^d$ : random walks and the diffusion equation.
Oct. 12	PDE models in $\mathbb{R}^d$ : equilibrium solutions of diffusion equation

Oct. 15	PDE models in $\mathbb{R}^n$ : traffic modeling, method of characteristics for hyperbolic PDEs
Oct. 19	PDE models in $\mathbb{R}^n$ : method of characteristics continued; shocks
Oct. 22	Einstein notation: vector and tensor operations
Oct. 26	Einstein notation: partial differentiation, product rules, higher-order derivatives
<b>Oct. 29</b>	<b>Midterm Exam</b>
Nov. 2	PDE models in $\mathbb{R}^3$ : Divergence Theorem and the continuity equation
Nov. 5	PDE models in $\mathbb{R}^3$ : Maxwell's equations, EM wave in vacuum, electrostatics
Nov. 9	PDE models in $\mathbb{R}^3$ : Electrostatics (continued)
Nov. 12	PDE models in $\mathbb{R}^3$ : reaction-diffusion equations, conservation laws, cell calcium dynamics
Nov. 16	PDE models in $\mathbb{R}^3$ : incompressible flows, inviscid and viscous fluid flows, 2D flows
Nov. 19	PDE models in $\mathbb{R}^3$ : Navier-Stokes Equation
Nov. 23	PDE models in $\mathbb{R}^3$ : Navier-Stokes Equation: derivation
Nov. 30	Stochastic processes: continuous-time Markov processes
Dec. 3	Stochastic processes: Chemical Master Equations (CMEs) and moment equations
Dec. 7	Stochastic processes: solving CMEs using the generating function
Dec. 10	Stochastic processes: finding the generating function using the method of characteristics

*Updated by Professor V. Matveev - 8/14/2020  
Department of Mathematical Sciences Course Syllabus, Fall 2020*

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