University of International Business and Economics
International Summer School

MAT 220 Linear Algebra and Differential Equations

Term: May 24 -June 24, 2021
Instructor: Sema Salur
Home Institution: University of Rochester
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Class Hours: Monday through Thursday, 120 minutes each day (2,400 minutes in total)
Office Hours: TBD
Discussion sessions: TBD

Total Contact Hours: 64 contact hours (45 minutes each, 48 hours in total)
Credit: 4 units

Course Description:

We present core topics in elementary differential equations and related concepts and methods of elementary linear algebra, with emphasis on real world applications: First- and Second-Order Differential Equations; Exact and separable Equations; Mathematical and Numerical Methods; Linear Systems and Matrices; Vector Spaces; Higher-Order Linear Differential Equations.

Course Goals:

Students who satisfactorily complete this course will:
1. Understand what a differential equation is, especially linear differential equations.
2. Understand how differential equations are used to model real life phenomena.
3. Relate the theory to graphical and numerical methods of solutions.
4. Understand the basics of linear algebra.
5. Relate linear algebra to techniques for solving linear differential equations.

Required Textbook:

Stephen Goode and Scott Annin, Differential Equations and Linear Algebra (4th Edition), Pearson Prentice Hall, 2017.

Attendance policy:

Summer school is very intense and to be successful, students need to attend <u>every class</u>. Occasionally, due to illness or other unavoidable circumstance, a student may need to miss a class. A medical certificate is required to be excused. Any absence may impact on the student's grade. Arriving late or leaving early will count as a partial absence. If a student is missing less than a point for a better grade, the better grade will be given, provided the student had no unexcused absences during the course.

Grading Policy:

There will be one midterm and a final exam in this class. All exams will be closed-book. No notes, calculators, or other electronic devices will be allowed.
The course grades will be calculated based on the following percentages:
- • Homework: 30%
- • Midterm: 30%
- • Final Exam: 40%

The final exam will be cumulative. There will be no make-up exams.

Grading Scale:

Assignments and examinations will be graded according to the following grade scale:

A	90-100	C+	72-74
A-	85-89	C	68-71
B+	82-84	C-	64-67
B	78-81	D	60-63
B-	75-77	F	below 60

Class Rules:

All academic work should be done with the high level of honesty and integrity. Academic misconduct of any kind may result in a grade penalty or the assignment of a failing grade.

Course Schedule:

Week 1
Assignment
Topics Covered:
1.1- Differential Equations Everywhere
Supplementary Problems: 1, 3, 5, 7, 11, 13
1.2- Basic Ideas and Terminology
Supplementary Problems 1, 3, 5, 7, 11, 15, 33, 37
1.3- The Geometry of First-Order Differential Equations
Supplementary Problems: 3, 5, 7, 9, 11, 13, 19, 31
1.4- Separable Differential Equations
Supplementary Problems: 1, 3, 5, 7, 9, 19
1.6-First-Order Linear Differential Equations
Supplementary Problems: 1-13(odd), 17, 19, 23
1.7-Modeling Problems using First-Order Linear Differential Equations
Supplementary Problems: 1, 3, 5
 2.1- Matrices: Definitions and Notation
Supplementary Problems: 1-21(odd)
2.2- Matrix Algebra
Supplementary Problems: 1, 3, 7, 11, 13, 15, 19, 27

Week 2
Assignment
Topics Covered:
2.3- Terminology for Systems of Linear Equations
Supplementary Problems: 1, 3, 5, 7, 9, 13, 17, 21
2.4- Elementary Row Operations and Row-Echelon Matrices
Supplementary Problems: 1, 3, 5, 7, 9, 11, 13, 19, 21
 2.5- Gaussian Elimination
Supplementary Problems: 1-13 odd, 19, 21
2.6- The inverse of a Square Matrix
Supplementary Problems:1, 3, 5, 7, 9, 11, 15, 23
2.7- Elementary Matrices and the LU Factorization
Supplementary Problems: 3, 5, 7, 11
2.8- The Invertible Matrix Theorem I
Supplementary Problems: No Assignment
3.1- The Definition of the Determinant
Supplementary Problems: 17, 19, 21, 43
3.2- Properties of Determinants
 Supplementary Problems: 3, 5, 7, 9, 15, 17, 21, 23, 33, 37, 39

Week 3
Assignment
Midterm Exam
Topics Covered:
3.3- Cofactor Expansions
Supplementary Problems: 1, 3, 7, 15, 17, 19, 25, 31, 39, 55
3.4- Summary of Determinants
Supplementary Problems: 3, 7, 9, 11, 15, 17, 19
4.1- Vectors in R^n
Supplementary Problems: 1, 3, 5, 7
4.2- Definition of a Vector Space
Supplementary Problems: 1, 3, 5, 7, 11, 13
4.3- Subspaces
Supplementary Problems: 3, 5, 7, 9, 13, 15, 19, 21
4.4- Spanning Sets
Supplementary Problems: 1, 3, 5, 9, 15, 17, 23
4.5- Linear Dependence and Linear Independence
Supplementary Problems: 1, 3, 5, 7, 11, 13, 21, 25, 33

Week 4
Assignment
Topics Covered:
4.6- Bases and Dimension
Supplementary Problems: 3, 5, 11, 13, 15, 21, 25

4.7- Change of Basis
Supplementary Problems: 1, 3, 5, 7, 9, 11, 13, 17, 19
4.8- Row Space and Column Space
Supplementary Problems: 3, 5, 7
 4.9- The Rank-Nullity Theorem
Supplementary Problems: 1, 3, 5, 7, 9
4.10- The Invertible Matrix Theorem II
Supplementary Problems: 1, 3, 5, 9
8.1- General Theory for Linear Differential Equations
Supplementary Problems: 1-17 odd, 23, 27,
8.2- Constant-Coefficient Homogeneous Linear Differential Equations
Supplementary Problems: 1-35 odd
8.3- The Method of Undetermined Coefficients: Annihilators
Supplementary Problems: 1-35 odd

Week 5
Assignment
Topics Covered:
7.1- The Eigenvalue/Eigenvector Problem
Supplementary Problems: 1, 3, 7, 13, 15
7.2- General Results for Eigenvalues and Eigenvectors
Supplementary Problems: 1-27 odd
9.1- First-Order Systems
Supplementary Problems: 1-17 odd
9.2- Vector Formulation
Supplementary Problems: 1-9 odd
9.3- General Results for First-Order Linear Differential Systems
Supplementary Problems: 1, 3, 5
9.4- Vector Differential Systems: Nondefective Coefficient Matrix
Supplementary Problems: 1-19 odd
Final Exam

General Comments:

1. In order to train your minds in mathematical thinking, much of lecture will consist of the "Socratic Method" of questioning. Even if silently, do try to puzzle out the answers. An analogy: the lecture should be a "mental exercise" class. Knowledge cannot be given: it must be stolen. Engage your mind.
2. Many problems will not be solvable at first (or second) viewing. Be patient: clarify any unknown concepts, try to reduce the problem, brainstorm to unearth possibly relevant concepts, and follow your intuition. It may help to, after a period of hard work, put the problem away. Do not worry if you cannot do every problem: what is important is that you try.
3. If you find yourself getting lost in the material, come to office hours immediately! It is much is easier to lead a student's mind individually rather than in a group.

4. Note that we may not dot every i or cross every t in class: you are responsible for reading the text. In particular, it is to your advantage to read the material before coming to class; in this way the student becomes an active participant rather than a passive recipient.

5. Basic etiquette should be maintained. For example: to give your classmates time to think, please do not blurt out answers unless called upon (or overcome with excitement); please do not walk out of class without prior explanation, etc.

6. Using a cell phone in class is not permitted; students using phones will be penalized 5 percentage points on the next exam.

7. Tests will check your understanding of the lectures as well as cover homework-type problems; it will benefit you to check after each lecture to see if you've understood the line of the arguments. Precise knowledge of the theory is vital!

Online Possibility:

Due to the on-going pandemic, there is a possibility that in-person courses are changed to online ones. UIBE ISS will notify the students once the decision has been made.

If the in-person courses are to be changed to online courses, we will make a few adjustments:

1. **Lecture:** Each lecture will be uploaded on UIBE's online learning platform on a daily basis. Students are required to watch them according to the course schedule.

2. **Discussion:** There will be an open session on ZOOM every Wednesday. The attendance of the discussion is important as it is part of your final score.

3. **Office hours:** I will release the office hours once the course starts. You are very welcome to send me emails to book my time. We will have video or audio calls through ZOOM. Please be noted to book them at least 3 days in advance.

4. **Exam:** All students will attend the exams at the same time but at their own places. To ensure a fair exam, you are required to turn on your web cameras during the exam. Once you encounter any unexpected technical issues that most likely stop you from submitting your exam on time, contact the TA and/or the Instructor immediately.