



**University of International Business and Economics
International Summer School**

MAT 220 Linear Algebra and Differential Equations

Term: October 26th – November 20th, 2020

Instructor: Shuxi Wang

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Class Hours: Monday through Friday, 120 minutes each day (2,400 minutes in total)

Office Hours: TBD

Discussion Session: 2 hours each week

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 (3rd Edition), Pearson Prentice Hall, 2007.

Attendance:

Students are expected to be present at all class meetings and examinations.

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, and having such a device in view during the exam is an academic honesty violation.

Grading Scale:

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.

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.

Attendance Policy:

Summer school is very intense and to be successful, students need to attend every class. Occasionally, due to illness or other unavoidable circumstance, a student may need to miss a class. UIBE policy requires a medical certificate to be excused. Any unexcused absence may affect the student's grade. Moreover, UIBE policy is that a student who has more than 1/3 (6 times) of the class in unexcused absences will fail the course.

Course Schedule:

Week 1

Assignment

Topics Covered:

1.1- How Differential Equations Arise

Supplementary Problems: 1, 7, 8, 13, 14

1.2- Basic Ideas and Terminology

Supplementary Problems: 1, 3, 5, 8, 14, 24, 30, 39

1.3- The Geometry of First-Order Differential Equations

Supplementary Problems: 1, 3, 5, 9, 15, 17, 21, 27, 33

1.4- Separable Differential Equations

Supplementary Problems: 1, 3, 9, 13, 15, 19, 22, 23

1.6- First-Order Linear Differential Equations

Supplementary Problems: 1-13(odd), 17, 19, 23, 26, 28, 29

1.7- Modeling Problems using First-Order Linear Differential Equations

Supplementary Problems: 1, 3, 5, 9, 13, 17

2.1- Matrices: Definitions and Notation

Supplementary Problems: 1, 3, 9, 11, 15, 17, 19, 21, 27

2.2- Matrix Algebra

Supplementary Problems: 1, 3, 7, 13, 15, 19, 27

2.3- Terminology for Systems of Linear Equations

Supplementary Problems: 3, 7, 9, 13, 17

Week 2

Assignment

2.4- Elementary Row Operations and Row-Echelon Matrices

Supplementary Problems: 9, 11, 13, 19, 21, 25

2.5- Gaussian Elimination

Supplementary Problems: 1-13 odd, 17, 21, 23

2.6- The inverse of a Square Matrix

Supplementary Problems: 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: 9-21 odd

3.2- Properties of Determinants

Supplementary Problems: 3, 5, 7, 9, 13, 15, 17, 21, 23, 37, 39

3.3- Cofactor Expansions

Supplementary Problems: 15, 17, 19, 25, 27, 31, 39

3.4- Summary of Determinants

Supplementary Problems: 3, 7, 9, 11, 15, 17, 19

Midterm Exam

Week 3

Assignment

4.1- Vectors in \mathbb{R}^n

Supplementary Problems: 1, 3, 5, 7,

4.2- Definition of a Vector Space

Supplementary Problems: 1, 3, 5, 7, 11, 13, 15

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, 23, 25, 31

4.6- Bases and Dimension

Supplementary Problems: 3, 5, 11, 13, 15, 21, 27

4.7- Change of Basis

Supplementary Problems: 1, 3, 5, 7, 9, 11, 13, 17, 19, 21, 23, 25

4.8- Row Space and Column Space

Supplementary Problems: 1, 3, 5, 7, 9, 11

4.9- The Rank-Nullity Theorem

Supplementary Problems: 1, 3, 5, 7, 9, 11

Week 4

Assignment

4.10- The Invertible Matrix Theorem II

Supplementary Problems: 1, 3, 5, 9

6.1- General Theory for Linear Differential Equations

Supplementary Problems: 1-27 odd, 33, 37,

6.2- Constant-Coefficient Homogeneous Linear Differential Equations

Supplementary Problems: 1-35 odd

6.3- The Method of Undetermined Coefficients: Annihilators

5.6- The Eigenvalue/Eigenvector Problem

Supplementary Problems: 1-27 odd, 31, 33

5.7- General Results for Eigenvalues and Eigenvectors

Supplementary Problems: 1-27 odd

7.1- First-Order Systems

Supplementary Problems: 1-17 odd

7.2- Vector Formulation

Supplementary Problems: 1-13 odd

7.3- General Results for First-Order Linear Differential Systems

Supplementary Problems: 1, 3, 5

7.4- Vector Differential Systems: Nondetective 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.

During the COVID-19, the course could be moved to online delivery format. We will make the final decision before October 12,2020