| Course Title: | Linear Algebra |
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| Course Number: | MTH 331 -- Section 101 -- CRN 2857 -- Credit: 4 Hours |
| Textbook: | Linear Algebra with Applications, 5E by Otto Bretscher |
| Sections Covered: | 1.1-1.3, 2.1-2.4, 3.1-3.4, 4.1-4.3, 5.1-5.3, 6.1-6.3,7.1-7.3 |
| Course <br> Description: | Vector Spaces, matrices and determinants, systems of linear equations, linear <br> transformations, eigenvalues, eigenvectors, and applications. |
| Calculator: | TI-83 or higher, graphing calculators may not be allowed for some problems in <br> exams. |
| Prerequisites: | PR or CR: MTH 300 with "C" or higher |
| Meeting Time: | MTWR: 11:00 - 11:50 AM |
| Classroom: | Smith Hall 518 |
| Instructor: | Dr. Basant Karna |
| Office: | Smith Hall 715 |
| Office Hours: | MTWR 12:00-2:00 PM, others by appointment |
| Phone/Email: | Phone: (304) 696-4332, Email: karna @marshall.edu |
| Webpage: | http://www.science.marshall.edu/karna/ |
| Course | Students successfully completing this course will learn about vector spaces, <br> matrices and their operations, determinants and applying them to solve system <br> of linear equations, linear transformations, eigenvalues and eigenvectors and <br> their applications. |
| Objectives: | - Linear Equations <br> • Linear Transformations <br> - Subspaces of $R$ n and Their Dimensions <br> • Linear spaces <br> • Orthogonality <br> - Determinants <br> • Eignevalues and Eigenvectors |
| Course Contents: |  |
| Attendance Policy: | Attendance is required and you must come with your text. Having more <br> than 25\% absences may result in a course grade of F! Absences which can <br> be excused include COVID-19 related absences, illness, emergencies, or <br> participation in another university activity. Excused absences must be <br> approved by the office of the dean of students. |


| Grading Policy: | Exams: There will be 3 exams given in class during the semester. Homework Problems: Five homework assignments will be collected. You are responsible for reading the text, working the exercises, coming to office hours for help when you're stuck, and being aware of the dates for the major exams. <br> Final Exam: There will be a two-hour final exam on December 7 (Tuesday) |
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| Points Distribution: | Attendance/Teaching Eval 50 Pts <br> 5 Homework Assignments 50 Pts <br> 3 Exams 300 Pts <br> Final Exam 100 Pts |
|  | Total Points: 500 Pts |
| Grades | The semester grade will be based on the percentage of the 500 total possible points, using the following scale. $\text { A: } 90-100 \% \text {, B: } 80-89 \%, \mathrm{C}: 70-79 \% \text {, D: } 60-69 \%, \mathrm{~F}: 0-59 \%$ <br> Note: The class score will be posted on http://www.marshall.edu/muonline/ |
| Make-ups: | Quizzes: For unavoidable missed quizzes with valid documentation, I will give you make-up quiz within a week of the original quiz date. <br> Exams: Making up a missed exam is possible only if you receive prior permission from me and only for serious and unavoidable circumstances. <br> Final: If you don't take final exam, you will receive " $F$ " for the class. |
| Exam Dates: | Exam 1 - Sep 23, Exam 2 - Oct 21, Exam 3 - Nov 18 (Thursdays) Final Exam: December 7 @ 10:15 AM (Tuesday) |
| Important Dates: | - August 30, Monday - "W" Withdrawal period begins <br> - September 6, Monday - Labor Day - No Class <br> - October 22, Friday - Last day to drop <br> - November 22, Monday - November 27, Saturday - Thanksgiving Break <br> - December 3, Friday - Last class day |
| Disruptive Actions: | If your actions become disruptive or distracting for me or another student, you will be asked to cease your behavior. If you choose to continue, you will be asked to leave. Disruptive behavior may include, but are not limited to the following: cell phone use in class, talking during class, and the use of iPods or MP3 players during class. These will count as unexcused absences. |
| Coming Late: | Students should come on time and stay in the class for entire class. If you are late by more than 5 minutes, you will be considered to be absent. |


| University Policies | By enrolling in this course, you agree to the University Policies. Please read the full text of each policy (listed below) by going to MU Academic Affairs: <br> University Policies. (URL: http://www.marshall.edu/academic-affairs/policies/ ) <br> - Academic Dishonesty Policy <br> - Academic Dismissal Policy <br> - Academic Forgiveness Policy <br> - Academic Probation and Suspension Policy <br> - Affirmative Action Policy <br> - Dead Week Policy <br> - D/F Repeat Rule <br> - Excused Absence Policy for Undergraduates <br> - Inclement Weather Policy <br> - Sexual Harassment Policy <br> - Students with Disabilities (Policies and Procedures) <br> - University Computing Services Acceptable Use Policy |
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| COVID-19 Related Information | Marshall's official COVID-19 protocols are online at https://www.marshall.edu/coronavirus Policies and protocols may change over time as we respond to changing conditions. The website will always contain the most recent information. <br> Key policies at the start of the Fall 2021 semester include the following: <br> - Masks are required for everyone in all public indoor spaces on university property, regardless of one's vaccination status. These spaces include classrooms, labs, office suites, hallways, lobbies, stairwells, etc. Instructors may choose to teach either while wearing a mask or face shield or while standing behind the plexiglass barrier in the classroom. <br> - In order to remain in in-person classes, students must sign the Marshall Return to Campus Student Agreement that outlines public health expectations and University COVID-19 policies: https://bit.ly/2VP3Naa (URL: https://bit.ly/2VPENaa). <br> - In order to remain in in-person classes for the Fall 2021 semester, students must submit their current vaccination status in the online Student Vaccination Registry here: https://mubert.marshall.edu/vaccinerecord.php (URL: https://mubert.marshall.edu/vaccinerecord.php/). The registry offers several possible responses, including an option to not disclose vaccination status. <br> - Students will disinfect their personal workspaces and virtual learning hubs with disinfectant wipes provided nearby. <br> - Students who are unable to follow University requirements due to a disability should seek reasonable accommodations from the Office of Disability Services (ODS) during the first week of class. |

## Teaching Outline

| Week | Sections Covered and topics |
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| 1 | Section 1.1 (Introduction to Linear Systems) <br> Section 1.2 (Matrices, Vectors, and Gauss-Jordan Elimination) |
| 2 | Section 1.3 (Solutions of Linear Systems; Matrix Algebra) <br> Section 2.1 (Introduction to Linear Transformations and Their Inverses) |
| 3 | Section 2.2 (Linear Transformations in Geometry) Section 2.3 (Matrix Products) |
| 4 | Section 2.4 (The Inverse of a Linear Transformation) <br> Section 3.1 (Image and Kernel of a Linear Transformation) |
| 5 | Section 3.2 (Subspaces of $\mathbf{R}^{\mathrm{n}}$; Bases and Linear Independence) <br> Review for Exam 1 <br> Exam 1: Sections: 1.1, 1.2, 1.3, 2.1, 2.2, 2.3, 2.4, 3.1,3.2 |
| 6 | Section 3.3 (The Dimension of a Subspace of $\mathbf{R}^{\mathrm{n}}$ ) Section 3.4 (Coordinates) |
| 7 | Section 4.1 (Introduction to Linear Spaces) <br> Section 4.2 (Linear Transformations and Isomorphisms) |
| 8 | Section 4.3 (The Matrix of a Linear Transformation) <br> Section 5.1 (Orthogonal Projections and Orthonormal Bases) |
| 9 | Section 5.2 (Gram-Schmidt Process and $Q R$-Factorization) Review for Exam 2 <br> Exam 2: Sections: 3.2, 3.3, 3.4, 4.1, 4.2, 4.3, 5.1, 5.2 |
| 10 | Section 5.3 (Orthogonal Transformations and Orthogonal Matrices) Section 5.4 (Least Squares and Data Fitting) |
| 11 | Section 6.1 (Introduction to Determinants) Section 6.2 (Properties of the Determinant) |
| 12 | Section 6.3 (Geometrical Interpretations of the Determinant; Cramer's Rule) Section 7.1 (Dynamical Systems and Eigenvectors) |
| 13 | Section 7.2 (Finding the Eigenvalues of a Matrix) Review for Exam 3 <br> Exam 3: Sections: 5.2, 5.3, 5.4, 5.5, 6.1, 6.2, 6.3, 7.1 |
| 14 | November 22, Monday - November 27, Saturday - Thanksgiving Break (No Class) |
| 15 | Section 7.3 (Finding the Eigenvectors of a Matrix) Section 7.4 (More on Dynamical Systems) |
| 16 | Final Exam: December 7 @ 10:15 AM (Tuesday) |

## Homework Problems

HW 1
Section 1.1: 2, 3, 4, 7, 9, 10, 11, 15, 17, 24, 25, 26, 29, 30, 31, 46,48
Section 1.2: 3, 5, 8, 9, 10, 13, 15, 17, 18, 31, 34, 35, 36, 37, 39, 42, 44, 45, 53, 55, 68, 72, 74,76
Section 1.3: 1-5, 9, 10, 11, 12, 14, 17, 18, 19, 20, 22, 30, 32, 35, 36, 46, 55, 56, 57
Section 2.1: 1, 2, 3, 5, $9-11,13,16, \mathbf{1 7}, 19,20,21,22,25,26,27-29$ HW 2
Section 2.2: 1, 2, 4, 5, 6, 7, 9, 10, 11, 13, 15, 18, 19, 20, 21, 27, 28
Section 2.3: 1, 4, 7, 14, 17, 21, 33, 37, 43, 49, 55, 57
Section 2.4: 1, 4, 5, 7, 13, 14, 16, 17, 19, 20, 21, 22, 24, 29, 32, 33, 55, 76
Section 3.1: 1, 2, 4, 5, 6, 11, 12, 15, 16, 17, 18, 19, 23, 24, 25, 41, 44 HW 3
Section 3.2: 1, 2, 3, 7, 10, 11, 14, 15, 18, 19, 20, 22, 23, 24, 28, 29, 32, 33, 53
Section 3.3: 1, 2, 3, 6, 7, 11, 15, 16, 19, 21, 24, 27, 28, 29, 30, 32, 47, 62, 63, 64, 86
Section 3.4: 1, 2, 5, 8, 9, 12, 13, 17, 19, 20, 22, 25, 28, 29, 31, 59, 60
Section 4.1: 1, 2, 3, 4, 6, 7, 8, 10, 13, 14, 16, 18, 20, 21, 25, 30, 31, 33, 36 HW 4
Section 4.2: 1, 2,5, 7, 9, 13, 18, 19, 23, 28,30, 33, 42, 43, 51, 56, 60, 75
Section 4.3: 5, 6, 7, 9, 11, 13, 14, 19, 23, 24, 28, 41, 44, 46
Section 5.1: 2, 3, 5, 6, 8, 9, 10, 12, 15, 16, 17, 22, 26, 27, 28, 45
Section 5.2: 1, 2, 7, 9, 10, 14, 15, 21, 23, 27, 28, 32, 33, 35, 36, 37
HW 5
Section 5.3: 1, 2, 3, 4, 5, 6, 10, 11, 15, 18, 19, 22, 24, 25, 26, 33, 34, 35, 36, 37, 40, 41
Section 5.4: 5, 9, 20, 21, 22, 25, 30, 31, 32
Section 6.1: 1, 4, 5, 8, 10, 11, 12, 17, 18, 20, 28, 29, 31, 32, 35, 38, 42, 44, 46
Section 6.2: 1, 3, 6, 7, 10, 11, 12, 13, 15, 16, 17, 18, 20, 26, 29
HW 6 (Optional)
Section 6.3: 1, 2, 3, 7, 8, 12, 13, 14, 22, 23, 24, 30, 31, 32, 35
Section 7.1: 1, 2, 3, 4, 6, 8, 10, 12, 13, 15, 16, 18, 20, 24, 25, 26, 29, 30
Section 7.2: 1, 2, 3, 4, 6, 9, 10, 12, 13, 15, 19, 20, 21, 32, 34, 45
Section 7.3: 1, 2, 4, 5, 6, 8, 10, 12, 14, 15, 17, 19, 21, 35, 36, 41, 45, 48, 49

Turn in at least boldface problems.
Due dates are Mondays after the Sections are covered.

