Instructor’s Name:

Office Location:

Office Hours:

Office Phone:

E-mail:

Course Description
This is a first course in vectors, matrices, vector spaces, and linear transformations. The ideas in this course serve as an introduction to more abstract mathematics courses at the junior-senior level, and also covers many useful applications outside mathematics. Topics include: vectors, operations on matrices, inverse of a matrix, solution of systems of linear equations, rank of matrix, vector spaces and subspaces, linear dependence and independence, basis and dimension, linear transformation, sums, composites, inverses of linear transformations, range and kernel of a linear transformation, determinants, eigenvalues and eigenvectors, orthogonality and inner product spaces, and real quadratic forms.

Illinois Articulation Initiative (IAI) number: N/A

Credit and Contact Hours:
Lecture  3
Lab      0
Credit Hours  3

Prerequisites: Grade of "C" or better in MATH 172 or equivalent. Concurrent: MATH 172, MATH 220.

Books, Supplies, and Supplementary Materials

A.  Textbooks

              ISBN: 9781118473504, Wiley


B.  Other Required Materials

   None
**Methods of Instruction:**
Lecture

**Student Learning Outcomes: General Education Student Learning Outcomes:**
Students will demonstrate the ability to accurately apply correct mathematical methods and techniques in various applications such as applied sciences, theoretical mathematics, physics, natural sciences and other applied sciences.

**Objectives**

1. Define "set" and the related terminology
2. Define "function" and the related terminology
3. Explain what is meant by and be able to form the composition of functions
4. Explain what is meant by a system of equations, a solution of the system, a consistent system, an inconsistent system and a homogeneous system of equations
5. Define "matrix.
6. Explain what is meant by an "m x n" matrix, a "square matrix of order n," the "(i,j) entry" of a matrix and the "main diagonal" of a square matrix
7. Define and determine the equality of two matrices, the sum of two matrices, the difference of two matrices, the product of two matrices, and the product of the scalar and a matrix
8. Use summation notation in the definition of matrix multiplication and proof of certain matrix properties
9. Define "transpose of a matrix" and find the transpose of a given matrix
10. Make a formal or informal proof of various theorems concerning the above objects and operations
11. State all of the algebraic properties of matrix operations as discussed in class
12. Prove selected algebraic properties of matrix operations as well as various theorems which are off shoots of these properties
13. State what is meant by the zero-matrix, by a diagonal matrix, a scalar matrix, and the identity matrix of order $n$
14. Define "upper triangular form" and "lower triangular form" for a matrix
15. Define "singular" matrix, "nonsingular" matrix, and "inverse" of a matrix and find the inverse of a given matrix when it arrives
16. Prove various theorems concerning the objects mentioned in Objectives 13 - 15
17. Explain the connection between singular and nonsingular matrices to the solution of a system of equations
18. Define "$n$ by $n$" elementary matrices of type I, II, or III
19. Prove selected theorems concerning the operation of elementary matrices on a given matrix
20. Use elementary matrices to develop a technique for finding the inverse of a given matrix
21. Explain what is meant by row-reduced echelon form for a matrix and transform a given matrix into row-reduced echelon form
22. Define the three elementary row operations on a matrix
23. Explain what is meant by one matrix being row equivalent to a second matrix
24. Prove various theorems concerning row equivalence and row-reduced echelon form
25. Use matrix techniques discussed in class to solve systems of linear equations
26. Define "real vector space" and explain the significance of each of the components of the definition
27. Give examples of a vector space
28. Define "subspace of a vector space" and give examples.
29. Determine whether or not a given object is a vector space or subspace
30. Use appropriate notation, work problems, and prove selected theorems involving vector spaces and subspaces
31. Define "linear combination" of a set of vectors
32. State what is meant by a set of vectors "spanning" a vector space
33. Explain what is meant by a linearly dependent or linearly independent set of vectors
34. Define a "basis" for a vector space
35. Explain what is meant by a nonzero vector space
36. Define the dimension of a nonzero vector space
37. Give examples, use appropriate notation, work problems, and prove selected theorems concerning linear dependence and independence, bases, and dimensions of vector spaces
38. Define “row space” and “column space” of an m by n matrix
39. Explain what is meant by the row (column) rank of a matrix
40. Discuss the structure of a linear system of equations
41. Define the “determinant” of an n-by-n matrix and evaluate the determinant of a given matrix
42. Discuss and prove the various properties of determinants and use these properties to aid in solving problems involving determinants
43. Define the "minor" of an element a_{ij} of a matrix A
44. Define the "cofactor" of an element a_{ij} of a matrix A
45. Explain and perform the process of finding a determinant by cofactor expansion
46. Define the “adjoint” of a matrix A and find the adjoint of a given matrix
47. Use appropriate notation and prove selected theorems that demonstrate the connection among the inverse of a matrix, the determinant of a matrix, and the adjoint of a matrix
48. Apply determinants in other selected situations as discussed in class
49. Define the dot product of two vectors and discuss and/or prove its properties
50. State the Cauchy-Schwarz inequality and the triangle inequality by cofactor expansion
51. Define the “distance” between two vectors and what are “orthogonal” vectors
52. Explain what is meant by an orthogonal set of vectors and an orthonormal set of vectors
53. Define and calculate the scalar projection and vector projection of one vector on another
54. Use appropriate notation, work problems, and prove selected theorems concerning inner products, the Cauchy-Schwarz and triangle inequalities, distance and orthogonality
55. Discuss and use the Gram-Schmidt Process for vectors
56. Define "linear transformation" of a vector space V into a vector space W
57. State what is meant by the "null space" and "range" of a linear transformation
58. Explain what is meant by the matrix representation of a linear transformation
59. Find the matrix representation of a given linear transformation
60. Define the "sum," "scalar multiple" and "composition" of linear transformations and thereby define a vector space of linear transformations
61. State what is meant by a vector space of matrices
62. Explain the concept of a coordinate vector with respect to an ordered basis
63. Find how coordinate vectors transform under a change of basis
64. Define "similar matrices"
65. Give examples, use appropriate notation, work problems, and prove selected theorems concerning rank of a matrix, linear transformations, null spaces, ranges, vector spaces of linear transformations, and vector spaces of matrices
66. Define "diagonalizable linear transformation" and give example space of matrices
67. Define "eigenvalue" and "eigenvector" of a linear transformation, give examples, and find the eigenvalues of eigenvectors of a given matrix
68. State what is meant by the characteristic polynomial of a matrix
69. Work problems based on the definitions mentioned in objectives 64-68 and theorems based on those definitions
70. Explain what is meant by a symmetric matrix and skew symmetric matrix, and determine whether or not a given matrix is symmetric or skew symmetric
71. Discuss and/or prove the theorems connecting diagonalization and symmetric matrices
72. Define "Real Quadratic Form" and "equivalence" of real quadratic forms
73. Explain what is meant by congruent matrices
74. Use appropriate notation, work problems and prove selected theorems involving quadratic forms

**TOPICAL OUTLINE**

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic or Class Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sets, Functions, Matrices</td>
</tr>
<tr>
<td>2</td>
<td>More matrices, solving systems of equations</td>
</tr>
<tr>
<td>3</td>
<td>Vector spaces</td>
</tr>
<tr>
<td>4</td>
<td>More on vector spaces, linear independence</td>
</tr>
<tr>
<td>5</td>
<td>Spanning sets, bases, and finite dimensional vector spaces</td>
</tr>
<tr>
<td>6</td>
<td>Rank of a matrix, structure of solutions of a system of equations</td>
</tr>
<tr>
<td>7</td>
<td>Determinants</td>
</tr>
<tr>
<td>8</td>
<td>More on determinants, dot products</td>
</tr>
<tr>
<td>9</td>
<td>Orthogonality, The Gram-Schmidt process</td>
</tr>
</tbody>
</table>
10 Linear Transformations and matrix representations
11 Operations on linear transformations, null space and range
12 Change of basis, more on matrix representation
13 Similar matrices, eigenvalues and eigenvectors
14 Diagonalization and symmetric matrices
15 Applications

Graded Assignments and Policies

Graded Assignments
In class Quizzes           0 – 20%
Participation     0 -  5 %
Projects             0 – 20%
Homework        0 – 30%
Tests                  50 - 85%
Final                  15 – 30%

Grading Policy
The individual instructor will determine which items he or she considers essential for the student to memorize without error and test accordingly.

Each instructor will set minimum standards for performance on tests.

Major Tests and Quizzes
The individual instructor will determine which items he or she considers essential for the student to memorize without error and test accordingly. Each instructor will set minimum standards for performance on tests. A comprehensive final examination will be given.

Classroom Policies and Procedures

General Information

Attendance Policy

Make-up Policy

Extra-credit Policy

Final Exam Information
A comprehensive final examination will be given.

Academic Honor Code
The objective of the academic honor code is to sustain a learning-centered environment in which all students are expected to demonstrate integrity, honor, and responsibility, and recognize the importance of being accountable for one’s academic behavior.

**College Statement about grades of “F” and Withdrawal from Class**
Students may withdraw from a course by processing an add/drop form during regular office hours through the Registration and Records Office at Main Campus or Romeoville Campus, or by phone at 815-744-2200. Please note the withdrawal dates listed on your bill or student schedule. Every course has its own withdrawal date. Failure to withdraw properly may result in a failing grade of “F” in the course.

At any time prior to the deadline dates established, an instructor may withdraw a student from class because of poor attendance, poor academic performance or inappropriate academic behavior, such as, but not limited to, cheating or plagiarism.

**Intellectual Property**
Students own and hold the copyright to the original work they produce in class. It is a widely accepted practice to use student work as part of the college’s internal self-evaluation, assessment procedures, or other efforts to improve teaching and learning and in promoting programs and recruiting new students. If you do not wish your work to be used in this manner, please inform the instructor.

**Student Code of Conduct**
Each student is responsible for reading and adhering to the Student Code of Conduct as stated in the college catalog.

**Sexual Harassment** Joliet Junior College seeks to foster a community environment in which all members respect and trust each other. In a community in which persons respect and trust each other, there is no place for sexual harassment. JJC has a strong policy prohibiting the sexual harassment of one member of the college community by another. See the Catalog or Student Handbook.

**Student Support** [http://jjc.edu/services-for-students/pages/default.aspx](http://jjc.edu/services-for-students/pages/default.aspx)

a. Disability Services: [http://www.jjc.edu/disability-services/Pages/default.aspx](http://www.jjc.edu/disability-services/Pages/default.aspx). Student Accommodations and Resources (StAR): If you need disability-related accommodations, specialized tutoring, or assistive technology in this class, if you have emergency medical information you wish to share with me, or if you need special arrangements in case the building must be evacuated, please inform me immediately. Please see me privately after class. New students should request accommodations and support by scheduling an appointment with the Student Accommodations and Resources (StAR) Office, Campus Center 1125, (815) 280-2230.

b. Tutoring: [http://jjc.edu/tlc/Pages/default.aspx](http://jjc.edu/tlc/Pages/default.aspx)

c. Counseling and Advising: [http://www.jjc.edu/counselingadvising/Pages/default.aspx](http://www.jjc.edu/counselingadvising/Pages/default.aspx)

d. Academic Resources: [http://www.jjc.edu/academic-resources/Pages/default.aspx](http://www.jjc.edu/academic-resources/Pages/default.aspx)

e. Support Programs and Services:
f. Technology Support: [http://jjc.edu/services-for-students/Pages/technology-support.aspx](http://jjc.edu/services-for-students/Pages/technology-support.aspx)

g. My Degree Progress: My Degree Progress is a computerized system to track a student's progress toward graduation. The report indicates every course and places these courses into their appropriate category as a General Education, Major Course, or Elective, according to the degree requirements. This tool is useful for preparing before an advising appointment, for planning, for registering, and for checking that the student is on track for graduation. [https://eresources.jjc.edu](https://eresources.jjc.edu)

* Instructor reserves the right to modify, add to or change the syllabus. Any changes to the syllabus or schedule will be announced in class.

Prepared by: Prof. Robert Tuskey
Mathematics Department

Reviewed by: Prof. Jean McArthur
Department Chair

Revised 04/11
Reviewed 08/09
Revised 11/02
Revised 11/98
Revised 10/93
Revised 08/96
Revised 02/92
Revised 11/91
Revised 11/89