Date	**Fall 2018-2019**	Credits	**3**
Course Title	**Mathematics III**	Course Number	**MATH 215**
Pre-requisite (s)	**MATH113**	Co-requisite (s)	**None**
Hours	**60**	Out of Class Work Hours	**120**

Place and Time of Class Meeting

Name and Contact Information of Instructor

Book required

(The School recognizes the use of the textbook in the classroom as part of the educational methodology and strategy applied in diverse materials. The textbook is part of the curriculum and is used to reach the student in an effective manner in the classroom. Every student is expected to acquire and use the textbook.)

Linear Algebra and Its Applications, 5th Edition
David C. Lay, Stephan R. Lay, Judi J. McDonald
Pearson Education Limited

Classroom expectations for students

Attendance Policy

Students are liable to attend every course, practical and laboratory work of the program they are enrolled and to take the exams and participate in academic work required for achieving the course. Student attendance to all courses is compulsory. Students who do not attend a minimum 70% of the theoretical courses and 80% of the practical courses will be considered as absent for the related courses. Students who do not meet the mandatory minimum requirement of attendance will fail the course. Students who fail a course for not fulfilling minimum attendance requirement are obliged to meet the attendance requirement when they re-take the course.

Student Tardiness Policy

Students are permitted to arrive to the class in the first 15 minutes after the scheduled start of the course; extension of tardiness time is in instructor's discretion.

Course Description (must correspond exactly to Catalog description)

This course will investigate systems of linear equations and their solutions, the operations of the matrix and vector algebra, evaluations of the determinants and inverse matrix, properties of determinants, Cramer's Rule, vector spaces, subspaces, linear independence, basis, row space, column space, null space, rank, linear transformations, eigenvalues and eigenvectors, diagonalization, inner product spaces, orthogonality, Gram-Schmidt process, least squares, orthogonal diagonalization and singular value decomposition.

Learning Objectives

At the end of this course the student will be able to:

- Solve systems of linear equations
- Determine the inverse of a matrix
- Calculate the determinant of a matrix.
- Determine the linear independence of a vector set and solve the problems about linear transformations and inner product spaces.
- Determine the eigenvalues and eigenvectors and diagonalize a matrix.
- Orthogonalize a vector set by using Gram-Schmidt Method and apply Singular Value Decomposition.

Topical Outline and Schedule

DATE	WEEK 1

SPECIFIC OBJECTIVES	• Describe the course. • Explain the areas the linear algebra is needed. • Write an example about linear equations. • Identify the relationship between a linear equation and its solution. • Show some examples about the systems which have same solution set. • Define row echelon, reduced row echelon and leading term. • Compare row echelon and reduced row echelon form. • Reduce some systems into row echelon form/ reduced row echelon form. • Define the general solution of a linear system. • Explain the differences between consistent and inconsistent system • Explain the trivial solution.
TOPIC (S)	• Syllabus. • Systems of linear equations. • Elementary row operations. • Gauss-Jordan Elimination.
LEARNING ACTIVITIES	Discussion of Syllabus. Discuss solution types of the linear equations. Solve two systems which have same solution set. Discussion of the solution types of a system of the linear equations. Evaluate the relation between unknown number and the free variables by discussing. Completion of exercises and problems.
OUT OF CLASS WORK ASSIGNMENT	Review the Syllabus. Read sections 1.1, 1.2, 1.3, 1.4, 1.5, 1.6 Read sections 2.1, 2.2, 2.3 and be prepared to discuss in class.
DATE	**WEEK 2**
SPECIFIC OBJECTIVES	• Define the matrix, entries in a matrix, main diagonal, dimension of a matrix, square matrix, equality of matrices. • Show how to name a matrix and its entries. • Determine the dimension of a matrix. • Compare two matrices to decide equality. • Define matrix operations: addition, subtraction, multiplication by a scalar, and multiplication. • Calculate the sum and difference of two matrices. • Find a scalar multiple of a matrix • Determining whether a product is defined • Define linear combination of r matrices. • Writing a system of m equations with n unknowns as a single matrix equation.

	• Define transpose and trace of a matrix. • Explain the properties of matrix arithmetic by giving an example. • Define zero matrix. • Define inverse matrix. • Explain properties of the inverse matrices. • Define elementary matrices. • Solve a system by matrix inversion.
TOPIC (S)	• Matrices and matrix operations. • Definition of the inverse matrix. • Algebraic properties of a matrix. • Elementary matrices. • Calculating the inverse of a matrix.
LEARNING ACTIVITIES	Finding unknown terms by comparing two equal matrices. Discussion of the existence of the product of the two matrices. Finding a suitable way to denote the systems of the linear equations. Group discussion: how to illustrate a system of equations by using matrices. Support the students to make inferences about existence of the properties of the matrix arithmetic and prove them step by step. Encourage the students to show a new way to finding the solution sets of the systems. Discuss the conditions to solve a system with matrix inversion. Completion of exercises and problems.
OUT OF CLASS WORK ASSIGNMENT	Read sections 2.1, 2.2, and 2.3 Read sections 2.6, and be prepared to discuss in the class.
DATE	**WEEK 3**
SPECIFIC OBJECTIVES	• Explain the relation between consistency and invertibility. • Define diagonal, triangular, and symmetric matrices. • Solve some examples about network analysis, design of traffic patterns, and chemical reactions.
TOPIC (S)	• Inverse Matrices • Diagonal, triangular, and symmetric matrices. • Applications of linear systems.
LEARNING ACTIVITIES	Discussion of the connection between consistency and invertibility. Formulate the power of a diagonal matrix by discussion. Discuss some brief applications of linear systems. Modelling problem by discussion. Completion of exercises and problems.
OUT OF CLASS WORK ASSIGNMENT	**Homework**: Read Chapter 2 **MyLab** (This course is based on Linear Algebra and Its Applications, 5th Edition; David C. Lay, Stephan R. Lay, Judi J. McDonald Pearson Education Ltd.) Doing **Homework I**

DATE	WEEK 4
SPECIFIC OBJECTIVES	• Define minor and cofactor of an entry • Define determinant. • Explain properties of the determinant.
TOPIC (S)	• Determinants by cofactor expansion. • Evaluating determinant by row reduction.
LEARNING ACTIVITIES	Discuss how to choose a row or a column to solve by using easiest way. Discuss how to use properties of the determinants to obtain determinant of a matrix. Completion of exercises and problems.
OUT OF CLASS WORK ASSIGNMENT	**Homework**: Read Chapter 3 **MyLab** (This course is based on Linear Algebra and Its Applications, 5th Edition; David C. Lay, Stephan R. Lay, Judi J. McDonald Pearson Education Ltd.) Doing **Homework I, II**
DATE	**WEEK 5**
SPECIFIC OBJECTIVES	• Use row/column reduction to calculate the determinant of a matrix. • Define adjoint matrix. • Using adjoint matrix to find the inverse. • Using Cramer's Rule to solve a system.
TOPIC (S)	• Evaluating determinant by row reduction. • Properties of the determinant • Adjoint Matrix. • Cramer's Rule
LEARNING ACTIVITIES	Completion of exercises and problems.
OUT OF CLASS WORK ASSIGNMENT	**Homework**: Read Chapter 3 **MyLab** (This course is based on Linear Algebra and Its Applications, 5th Edition; David C. Lay, Stephan R. Lay, Judi J. McDonald Pearson Education Ltd.) Doing **Homework II**
DATE	**WEEK 6**
SPECIFIC OBJECTIVES	• Overview of the vectors in two dimensional space and related definitions • Define Norm, dot product, and distance. • Explain the importance of the unit vector and normalization. • Define dot product. • Explain the properties of the dot product. • Define orthogonal and orthonormal set. • Illustrate the orthogonal projection of a vector on a plane. • Define the vectors and vector spaces in general. • Give some examples • Explain subspace, its properties and related thoerems

	• Define linear combinations of the vectors and span. • Define the linearly independent set. • Explain how to determine the linearly independency of a set. • Define Wronskian determinant and the relationship between Wronkian determinant and the linearly dependeny.
TOPIC (S)	Overview of the sections 4.1, 4.2, and 4.3 Real vector spaces Subspaces Linear Independence
LEARNING ACTIVITIES	Discuss the number of the unit vectors. Illustrate the relation between norm and distance. Obtain the formula of the orthogonal projection of a vector on a plane step by step by discussion. Show that every vector can be denoted by the linear combinations of some special vectors. Discuss the minimum number of the vectors in S span the same space. Completion of exercises and problems.
OUT OF CLASS WORK ASSIGNMENT	**Homework**: Read Chapter 3, 4 **MyLab** (This course is based on Linear Algebra and Its Applications, 5th Edition; David C. Lay, Stephan R. Lay, Judi J. McDonald Pearson Education Ltd.) Doing **Homework II, III**
DATE	**WEEK 7**
SPECIFIC OBJECTIVES	• Define basis, standard basis • Show that a space can be spanned by several bases. • Define coordinate vector of a vector relative to a basis set. • Explain all bases for a finite dimensional vector space have the same number of vector. • Define dimension of a vector space. • Calculate the dimension of the solution set of a linear equation system. • Explain coordinate mapping. • Explain how to change of basis • Explain row space, column space and null space and related theorems.
TOPIC (S)	Coordinates and Basis Dimension Change of Basis Row Space, Column Space, and Null Space
LEARNING ACTIVITIES	Represent a vector by using different bases. Do the same operation by using different bases. Discuss whether changing the basis can be more effective. Completion of exercises and problems.
OUT OF CLASS WORK ASSIGNMEN	**Homework**: Read Chapter 4 and be prepared to discuss in class. **MyLab** (This course is based on Linear Algebra and Its Applications, 5th Edition; David C. Lay, Stephan R. Lay, Judi J. McDonald Pearson Education Ltd.) Doing **Homework III**

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DATE	**WEEK 8**
SPECIFIC OBJECTIVES	**First Midterm Exam** • Define rank and nullity. • Explain linear operator and related theorems. • Define kernel and range. • Explain the topics by examples. Explain one-to-one, onto, isomorphism and related theorems.
TOPIC (S)	Rank, Nullity, and the Fundamental Matrix Spaces General Linear Transformations Isomorphism
LEARNING ACTIVITIES	Discuss the relationship between operators and functions. Discuss the similarities between column space and range, null space and kernel. Solve examples about related topics. Completion of exercises and problems.
OUT OF CLASS WORK ASSIGNMENT	**MyLab** (This course is based on Linear Algebra and Its Applications, 5th Edition; David C. Lay, Stephan R. Lay, Judi J. McDonald Pearson Education Ltd.) Doing **Homework III, IV**
DATE	**WEEK 9**
SPECIFIC OBJECTIVES	
TOPIC (S)	
LEARNING ACTIVITIES	
OUT OF CLASS WORK ASSIGNMENT	
DATE	**WEEK 10**
SPECIFIC OBJECTIVES	• Explain the matrix representation of a linear transformation. • Explain similar matrices and their properties. • Calculate determinant of a linear operator. • Obtain the eigenvalues and bases for the eigenspaces of a linear operator.
TOPIC (S)	Matrices for General Linear Transformations Similarity
LEARNING ACTIVITIES	Completion of exercises and problems.
OUT OF CLASS WORK	**Homework:** Read Chapter 5 **MyLab** (This course is based on Linear Algebra and Its Applications, 5th Edition; David C. Lay, Stephan R. Lay, Judi J. McDonald Pearson Education Ltd.) Doing **Homework IV**

ASSIGNMENT	
DATE	**WEEK 11**
SPECIFIC OBJECTIVES	• Define eigenvalue of a matrix and corresponding eigenvectors. • Explain how to find eigensystem of a matrix. • Explain similarity transformation and related theorems. • Overview of the complex numbers • Obtaining complex eigensystem.
TOPIC (S)	Eigenvalues and Eigenvectors Diagonalization Complex Vector Spaces
LEARNING ACTIVITIES	Discuss how to find a way to obtain the eigenvalues of a triangular matrix easily. Discussion of the relations between the eigensystems of the A and powers of A. Completion of exercises and problems.
OUT OF CLASS WORK ASSIGNMENT	**Homework:** Read sections 7.1, and 7.2, and be prepared to discuss in class. **MyLab** (This course is based on Linear Algebra and Its Applications, 5th Edition; David C. Lay, Stephan R. Lay, Judi J. McDonald Pearson Education Ltd.) Doing **Homework IV**
DATE	**WEEK 12**
SPECIFIC OBJECTIVES	**MIDTERM EXAM II** • Define the inner product, length and orthogonality • Explain orthogonal matrices and related theorems. • Explain the orthogonally diagonalization. • Define Hermitian matrix, unitary matrix. • Explain the unitarily diagonalization.
TOPIC (S)	Inner Product Orthogonal Matrices Orthogonal Diagonalization Hermitian, Unitary, and Normal Matrices
LEARNING ACTIVITIES	Diagonalize a symmetric matrix to point P is a orthogonal matrix. Discuss the benefits of the orthogonal diagonalization. Discuss how to generalize the method if the system has comlex eigensystem. Completion of exercises and problems.
OUT OF CLASS WORK ASSIGNMENT	**Homework:** Read sections 6.1, 6.2, 6.3, 6.4 and 6.7 and be prepared to discuss in class. **MyLab** (This course is based on Linear Algebra and Its Applications, 5th Edition; David C. Lay, Stephan R. Lay, Judi J. McDonald Pearson Education Ltd.) Doing **Homework V**
DATE	**WEEK 13**
SPECIFIC OBJECTIVES	• Show that how to two vectors are orthogonal. • Define orthogonal complement.

	• Explain Gram-Schmidt Process • Define inner product spaces and explain related thoerems
TOPIC (S)	Orthogonality Gram-Schmidt Process Inner product spaces
LEARNING ACTIVITIES	Illustrate that a vector equals to sum of the orthogonal projection on a subspace of the vector space and its complement. Discussion of obtaining a approximation by using least squares. Completion of exercises and problems.
OUT OF CLASS WORK ASSIGNMENT	**Homework:** Read section 7.4 and be prepared to discuss in class **MyLab** (This course is based on Linear Algebra and Its Applications, 5th Edition; David C. Lay, Stephan R. Lay, Judi J. McDonald Pearson Education Ltd.) Doing **Homework V**
DATE	**WEEK 14**
SPECIFIC OBJECTIVES	• Define singular values of a matrix. • Explain how to obtain the singular value decomposition of a matrix.
TOPIC (S)	Singular Value Decomposition General review.
LEARNING ACTIVITIES	Discuss whether A^TA and AA^T have the same nonzero eigenvalues. Completion of exercises and problems.
OUT OF CLASS WORK ASSIGNMENT	**Homework:** Read Chapter 7. **MyLab** (This course is based on Linear Algebra and Its Applications, 5th Edition; David C. Lay, Stephan R. Lay, Judi J. McDonald Pearson Education Ltd.) Doing **Homework V**
DATE	**WEEK 15**
SPECIFIC OBJECTIVES	• **Final Exam.**
TOPIC (S)	
LEARNING ACTIVITIES	
OUT OF CLASS WORK ASSIGNMENT	**MyMathLab** (This course is based on Linear Algebra and Its Applications, 5th Edition; David C. Lay, Stephan R. Lay, Judi J. McDonald Pearson Education Ltd.) Doing **Homework V .**

Instructional Methods

In developing methodological strategies, it is best to discuss them between teachers and students in an environment of freedom and mutual agreement in order to ensure that the students make them their own and take responsibility for their execution and for attaining the goals of this course.

The following strategies may be used in this class:

1. A review of the literature.
2. Analysis of assigned readings.
3. Individual and group discussions.
4. Preparation of a didactic plan.
5. Preparation of lecture notes.

Instructional Materials and References

Linear Algebra with Applications
Authors: W. Keith Nicholson
Publisher: McGraw-Hill; 6th edition
ISBN-13: 978-0070985100 | ISBN-10: 0070985100

Linear Algebra and Its Application
Authors: David Lay
Publisher: Pearson; 4th edition
ISBN-13: 978-0078111006 | ISBN-10: 0078111005

Assessment Criteria and Methods of Evaluating Students

Grade	Coefficient
AA	4.00
BA	3.50
BB	3.00
CB	2.50
CC	2.00
DC	1.50

DD	1.00
FF	0.00
VF	0.00

Distribution of Grade Elements

	In-Term Studies	Quantity	Percentage
	Midterm I	1	20
	Midterm II	1	20
	Homework	5	20
	Total	7	60
	End-Term Studies	**Quantity**	**Percentage**
	Final	1	40
	Total	1	40
	Contribution Of In-Term Studies To Overall Grade		60
	End-Term Studies		40
	Total		100

Date Syllabus Was Last Reviewed: September 13, 2018