



OUTCOMES-BASED EDUCATION (OBE) COURSE SYLLABUS

Math 131s: Linear Algebra and Matrix Theory

1st Semester, A.Y. 2020-2021

I. UNIVERSITY INFORMATION

1. Vision of the University

A globally competitive university for science, technology, and environmental conservation

2. Mission of the University

Development of a highly competitive human resource, cutting-edge scientific knowledge, and innovative technologies for sustainable communities and environment.

3. VSU Quality Policy Statement

The Visayas State University (VSU), a globally competitive university of science and technology and environmental conservation, is created by law to develop highly competitive human resource, cutting-edge scientific knowledge and innovative technologies for sustainable communities and environment.

Towards this end, we, at the Visayas State University, commit to:

- Produce highly competent, quality and world-class manpower in science and technology, especially for agriculture, environmental management and industry who are proficient in communication skills, critical thinking and analytical abilities;
- Generate and disseminate relevant knowledge and technologies that lead to improved productivity, profitability and sustainability in agriculture, environment and industry; and
- Satisfy the needs and applicable requirements of the industry, the community and government sectors who are in need of quality graduates and technology ready for commercialization through the establishment, operation, maintenance and continual improvement of a Quality Management System (QMS) which is aligned with the requirements of ISO 9001:2015.

It shall be the policy of the university that the quality policies and procedures are communicated to and understood by all faculty, staff, students and other stakeholders and that the system be continually improved for its relevance and effectiveness.


EDGARDO E. TULIN
President
v0 07-16-2019

4. Quality Goals of the College of Arts and Sciences

- To produce quality manpower and graduates in biology, biotechnology, chemistry, English, liberal arts and behavioral sciences, mathematics, physics, and statistics to serve the development needs of the region.
- To uplift the economic well-being of the region through relevant R and D and extension programs.
- Enhance regional development of the Visayas for global competitiveness.

5. Quality Objectives of the Department of Mathematics

The Department of Mathematics to:

- Offer courses in mathematics aimed at developing students' intellectual curiosity, problem-solving skills, critical thinking, and analytical abilities;
- Offer baccalaureate and graduate degrees in mathematics to produce quality graduates, who satisfy the needs of the industry, the community, and the government sector;
- Provide opportunities for students and faculty to conduct and/or participate in research projects in mathematics and allied fields that lead to the generation of relevant knowledge and technology; and
- Conduct extension projects designed to train professionals in the education of mathematics at all levels.

II. PROGRAM INFORMATION

1. Name of the Program	Bachelor of Statistics (BSS)
2. CHED CMO Reference	CMO No. 42, s. 2017
3. BOR Approval	BOR Resolution No. 61, s. 2018

4. Program Educational Objectives and Relationship to Institution Mission

Program Educational Objectives	Mission*		
	a	b	c
1. Produce graduates who can postulate real-life problems into statistical problems.	√	√	√
2. Produce graduates who can collect data, aggregate data, analyze data using computing technologies, interpret results, and communicate results to different stakeholders towards the solution of real-life problems based on statistically sound methods/techniques.	√	√	√
3. Equip students with quantitative skills and methods that they can employ and build on in flexible ways.	√	√	√
4. Prepare students for graduate work in statistics and/or allied fields.	√	√	√

**a - development of a highly competitive human resource, b - cutting-edge scientific knowledge, c - innovative technologies for sustainable communities and environment*

III. COURSE INFORMATION

1. Course Code	Math 131s
2. Course Title	Linear Algebra and Matrix Theory
3. Pre-requisite	Math 122s – Calculus 3
4. Co-requisite	None

5. Credit	3.0 units
6. Semester Offered	First Semester
7. Number of hours	3 hours lecture
8. Course Description	This course introduces to students the basic concepts of linear algebra. It covers matrices, systems of linear equations, vector spaces, linear independence, linear transformation, determinants, eigenvalues and eigenvectors, diagonalization, and inner product spaces.

9. Program Outcomes and Relationship to Program Educational Objectives					
Program Outcomes (POs)		Program Educational Objectives			
		1	2	3	4
a	Articulate and discuss the latest developments in the practice of Statistics (PQF Level 6 descriptor);	√	√	√	√
b	Effectively communicate orally and in writing using both the English and Filipino languages;	√	√	√	√
c	Work effectively in multi-disciplinary and multi-cultural teams (PQF Level 6 descriptor);	√	√	√	√
d	Demonstrate professional, social, and ethical responsibility, especially in practicing intellectual property rights and sustainable development;	√	√	√	√
e	Preserve and promote " <i>Filipino historical and cultural heritage</i> " (based on RA 7722);				
f	Demonstrate broad and coherent knowledge and understanding in the core areas of the physical and natural sciences and mathematics;	√	√	√	√
g	Apply critical and problem-solving skills using the scientific method;	√	√	√	√
h	Interpret relevant scientific data and make judgments that include reflection on relevant scientific and ethical issues;	√	√	√	√
i	Carry out basic mathematical and statistical computations and use appropriate technologies in (i.1) the analysis of data; and (i.2) in pattern recognition, generalization, abstraction, critical analysis, and problem-solving;	√	√	√	√
j	Communicate information, ideas, problems, and solutions, both orally and in writing, to other scientists, decision-makers, and the public;	√	√	√	√
k	Relate science and mathematics to the other disciplines	√	√	√	√
l	Design and perform safe and responsible techniques and procedures in laboratory or field practices;	√	√	√	√
m	Critically evaluate inputs from others;	√	√	√	√
n	Appreciate the limitations and implications of science in everyday life;	√	√	√	√
o	Commit to the integrity of data;	√	√	√	√
p	Demonstrate broad and coherent knowledge and understanding in the core areas of statistics, computing, and mathematics;	√	√	√	√
q	Translate real-life problems into statistical problems;	√	√	√	√
r	Generate information involving the conceptualization of a strategy for generating timely and accurate/reliable data, organizing a process for putting together or compiling the needed data, and transforming available data into relevant and useful forms; and	√	√	√	√
s	Identify appropriate statistical tests and methods and use these properly for the given problems, select optimal solutions to problems, and make decisions in the face of uncertainty.	√	√	√	√

10. Course Outcomes (COs) and Relationship to Program Outcomes (POs)																			
After completing this course, the student must be able to perform the following COs:	Program Outcomes Code																		
	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s
CO 1: Use matrices to solve linear systems.		D				D	D		D	E	E					D			
CO 2: Compute determinants of square matrices.		D				D	D		D	E	E					D			
CO 3: Discuss the properties and results related to vectors spaces and subspaces.		D				D	E		D	E	E					D			
CO 4: Represent linear transformations and quadratic forms with matrices, and describe properties of these functions based on the matrix representation.		D				D	E		D	E	E					D			
CO 5: Determine eigenvalues and associated eigenvectors of a matrix/linear transformation.		D				D	E		D	E	E					D			
CO 6: Use the Gram-Schmidt orthonormalization process to construct an orthonormal basis for a given inner product space.		D				D	E		D	E	E					D			

Legend: *I* – Introductory, *E* – Enabling, *D* – Demonstrative

Each letter indicates the expected level of competency that each CO should provide for each PO.

11. Course Content and Plan					
Week	Topics	Learning Outcomes	Teaching and Learning Activities		Assessment Tasks
			Teaching Activities	Learning Activities	
Class Orientation					
1	OBE Course Syllabus VSU Vision Mission, and Quality Policy Statement Class Policies Requirements Grading System and	1. State the basic information regarding the course offering. 2. State the VSU Vision, Mission, and Quality Policy. 3. Identify the	Online Mode: Initiate virtual meeting Conduct online orientation	Online Mode: Participation in the virtual meeting Familiarization of	Quiz (Essay)

	<p>Activities</p> <p>Learning Guide / Instructional Workbook / Laboratory Manual</p> <p>Submission of requirements</p> <p>Values Integration: Open-mindedness and proper netiquette</p>	<p>class requirements.</p> <p>4. Convey his/her expectation of the course</p> <p>5. Discuss the course policies.</p>	<p>Answer students questions and clarifications</p>	<p>the virtual classroom</p> <p>Asking of questions</p> <p>Setting of expectations</p> <p>Class interaction</p> <p>Sharing of Ideas</p> <p>Feedbacks</p> <p>Offline Mode:</p> <p>Independent study of the Learning Guide</p>	
CO 1: Use matrices to solve linear systems.					
1-3	<p>Module 1: Linear Equations and Matrices</p> <p>Lesson 1.1: Systems of Linear Equations</p> <p>Lesson 1.2: Matrices, Matrix Operations, and their Algebraic Properties</p> <p>Lesson 1.3: Echelon Form of a Matrix and Solving Linear Systems</p> <p>Lesson 1.4: Elementary Matrices and an Algorithm for Finding the Inverse of a Matrix</p>	<p>1. Solve a system of linear equations in n variables using elimination.</p> <p>2. Determine whether a system of linear equations is consistent or inconsistent.</p> <p>3. Perform matrix operations.</p> <p>4. Determine a matrix in row-echelon form or reduced row-echelon form.</p> <p>5. Discuss the properties of matrices and matrix operations.</p>	<p>Online Mode:</p> <p>Upload learning modules to the VSUEE/V C</p> <p>Give supplementary materials in the virtual classroom</p> <p>Give quizzes, problem sets, and</p>	<p>Online Mode:</p> <p>Participation in the virtual meeting</p> <p>Asking of questions</p> <p>Class interaction</p> <p>Sharing of Ideas</p> <p>Feedbacks</p> <p>Online/Offline</p>	<p>Module Pretest</p> <p>Exercise Set (Computation, analysis, and proving)</p> <p>Quiz (Objective Type)</p> <p>Long Exam 1</p> <p>Schedule: TBA</p>

	Values Integration: Patience and watchfulness	6. Use elementary row operations to solve a linear system. 7. Write an augmented or coefficient matrix from a system of linear equations, or translate a matrix into a system of linear equations. 8. Solve a system of linear equations using Gaussian elimination and Gauss-Jordan Reduction. 9. Define inverse of a matrix. 10. Find the inverse of a matrix (if it exists). 11. Use properties of inverse matrices. 12. Use the inverse of a matrix to solve a system of linear equations.	exams	Mode: Self-study Individual inquiry Do learning tasks for Module 1	
CO 2: Compute determinants of square matrices.					
7-8	Module 2: Determinants and their Properties Lesson 2.1: Definitions and Properties of Determinants Lesson 2.2: Cofactor Expansion and Finding the Inverse of a Matrix Using Determinants Lesson 2.3:	1. Define the determinant of a matrix. 2. Discuss the properties of the determinant. 3. Find the determinant of a matrix using the properties of the determinant. 4. Compute the determinant of a matrix by	Online Mode: Upload learning modules to the VSUEE/V C Give supplementary materials	Online Mode: Participation in the virtual meeting Asking of questions Class interaction	Module Pretest Exercise Set (Computation, analysis, and proving) Quiz 2 (Objective Type) Module

	<p>Cramer's Rule</p> <p>Values Integration: Patience and watchfulness</p>	<p>cofactor expansion.</p> <p>5. Use determinant to find the inverse of a matrix.</p> <p>6. Use Cramer's Rule to solve a system of linear equations.</p>	<p>in the virtual classroom</p> <p>Give quizzes, problem sets, and exams</p>	<p>Sharing of Ideas</p> <p>Feedbacks</p> <p>Online/Offline Mode:</p> <p>Self-study</p> <p>Individual inquiry</p> <p>Do learning tasks for Module 2</p>	<p>Posttest</p> <p>Long Exam 2</p> <p>Schedule: TBA</p>
CO 3: Discuss the properties and results related to vectors spaces and subspaces.					
9-11	<p>Module 3: Vector Spaces</p> <p>Lesson 3.1: Vector Spaces: Definitions and Examples</p> <p>Lesson 3.2: Subspaces</p> <p>Lesson 3.3: Linear Combination and Spanning Sets and Linear Independence</p> <p>Lesson 3.4: Basis and Dimension and The Rank of a Matrix</p> <p>Values Integration: Open-mindedness and teachability</p>	<p>1. Define a vector space and recognize some important vector spaces.</p> <p>2. Show that a given set is not a vector space.</p> <p>3. Determine whether a subset W of a vector space V is a subspace of V.</p> <p>4. Determine subspaces of \mathbb{R}^n.</p> <p>5. Write a linear combination of a set of vectors in a vector space.</p> <p>6. Determine whether a set of vectors in a vector space V is a spanning set of V.</p> <p>7. Determine whether a set of vectors in a vector space V is linearly independent.</p> <p>8. Recognize</p>	<p>Online Mode:</p> <p>Upload learning modules to the VSUEE/V C</p> <p>Give supplementary materials in the virtual classroom</p> <p>Give quizzes, problem sets, and exams</p>	<p>Online Mode:</p> <p>Participation in the virtual meeting</p> <p>Asking of questions</p> <p>Class interaction</p> <p>Sharing of Ideas</p> <p>Feedbacks</p> <p>Self-study</p> <p>Individual inquiry</p> <p>Do learning tasks for Module 3</p>	<p>Exercise Set (Computation, analysis, and proving)</p> <p>Quiz (Objective Type)</p> <p>Long Exam 3</p> <p>Schedule: TBA</p>

		bases in a vector space. 9. Find the dimension of a vector space. 10. Find a basis for the row space, a basis for the column space, and the rank of a matrix. 11. Find the nullspace of a matrix.			
CO4: Represent linear transformations and quadratic forms with matrices, and describe properties of these functions based on the matrix representation.					
12-13	Module 4: Linear Transformations Lesson 4.1: Linear Transformations: Definitions and Examples Lesson 4.2: The Kernel, Range, Nullity, and Rank of a Linear Transformation Lesson 4.3: Matrix of a Linear Transformation Lesson 4.4: Similarity Values Integration: Understanding, tolerance, and inclusion	1. Find the image and preimage of a function. 2. Show that a function is a linear transformation, and find a linear transformation. 3. Find the kernel of a linear transformation. 4. Find a basis for the range, the rank, and the nullity of a linear transformation. 5. Determine whether a linear transformation is one-to-one or onto. 6. Determine whether vector spaces are isomorphic. 7. Find the standard matrix for a linear transformation. 8. Find the standard matrix for the composition of linear transformations and find the inverse of an	Online Mode: Upload learning modules to the VSUEE/V C Give supplementary materials in the virtual classroom Give quizzes, problem sets, and exams	Online Mode: Participation in the virtual meeting Asking of questions Class interaction Sharing of Ideas Feedbacks Self-study Individual inquiry Do learning tasks for Module 4	Exercise Set (Computation, analysis, and proving) Quiz (Objective Type) Module Posttest Long Exam 4 Schedule: TBA

		invertible linear transformation. 9. Find the matrix for a linear transformation relative to a nonstandard basis.			
CO 5: Determine eigenvalues and associated eigenvectors of a matrix/linear transformation.					
14-15	Module 5: Eigenvalues and Eigenvectors Lesson 5.1: Linear Eigenvalues and Eigenvectors Lesson 5.2: Diagonalization of Symmetric Matrices Lesson 5.3: Quadratic Forms and Positive Definite Matrices Values Integration: Understanding, tolerance, and inclusion	1. Verify eigenvalues and corresponding eigenvectors. 2. Find eigenvalues and corresponding eigenspaces. 3. Use the characteristic equation to find eigenvalues and eigenvectors, and find the eigenvalues and eigenvectors of a triangular matrix. 4. Find the eigenvalues and eigenvectors of a linear transformation. 5. Diagonalize a symmetric matrix.	Online Mode: Upload learning modules to the VSUEE/V C Give supplementary materials in the virtual classroom Give quizzes, problem sets, and exams	Online Mode: Participation in the virtual meeting Asking of questions Class interaction Sharing of Ideas Feedbacks Self-study Individual inquiry Do learning tasks for Module 5	Exercise Set (Computation, analysis, and proving) Quiz (Objective Type)
CO 6: Use the Gram-Schmidt orthonormalization process to construct an orthonormal basis for a given inner product space.					
16-17	Module 6: Inner Product Spaces Lesson 6.1: Inner Product Spaces Lesson 6.2: Orthogonal Basis Gram-Schmidt	1. Find the length of a vector and find a unit vector. 2. Find the distance between two vectors. 3. Find a dot product and	Online Mode: Upload learning modules to the VSUEE/V	Online Mode: Participation in the virtual meeting Asking of	Exercise Set (Computation, analysis, and proving)

	Orthogonalization Values Integration: Understanding, tolerance, and inclusion	the angle between two vectors, determine orthogonality, and verify the Cauchy-Schwarz Inequality, the triangle inequality, and the Pythagorean Theorem. 4. Use a matrix product to represent a dot product. 5. Determine whether a function defines an inner product. 6. Show that a set of vectors is orthogonal and forms an orthonormal basis. 7. Represent a vector relative to an orthonormal basis. 8. Apply the Gram-Schmidt orthonormalization process.	C Give supplementary materials in the virtual classroom Give quizzes, problem sets, and exams Offline Mode: Printed Learning Guide (independent study)	questions Class interaction Sharing of Ideas Feedbacks Self-study Individual inquiry Do learning tasks for Module 6	Quiz (Objective type) Long Exam 5 (covers CO5 and CO6)
18	Final Examination				
* VSUEE/VC – VSU E-Learning Environment/ Virtual Classroom					
12. Life-long Learning Opportunities In this subject, students will learn the value of hard work, dedication, patience, and being independent as they progress in acquiring knowledge and skills in solving individually various mathematical concepts, principles, and applications inside and outside the classroom. They will also learn the importance of independence and individual inquiry as they continue to learn with minimal supervision of the faculty. The gained knowledge, skills, and attitudes from this subject will become a catalyst of success in their future endeavors as statisticians.					
13. Contribution of Course to Meeting the Professional Component (%)					
General Education:		0%			
Core Course					
Mathematics and Computing:		100%			
Statistics:		0%			
Thesis/Professional Exposure:		0%			

14. References and Other Learning Resources

A. Textbook(s)/ E-Books

Kolman, B., & Hill, D. R. (2008). *Elementary Linear Algebra* (9th ed.). Upper Saddle River, New Jersey 07458: Pearson Education, Inc.

Larson, R. (2016). *Elementary Linear Algebra* (8th ed.). Brooks/Cole, Cengage Learning.

B. Other Learning Resources

Andrilli, S. & Hecker, D., (2016)., *Elementary Linear Algebra* (5th ed.), Academic Press.

Anton, Howard, Rorres, C. & Kaul, A. (2019). *Elementary Linear Algebra: Applications Version* (12th ed.), Wiley.

Anton, Howard (2013). *Elementary Linear Algebra* (11th ed.), Wiley.

Friedberg, Stephen, Arnold Insel, & Lawrence Spence, (2018). *Linear Algebra* (5th ed.) Pearson.

Hoffman, K. and Kunze, R., (1977). *Linear Algebra*, (2nd ed.), Prentice Hall, Inc.

Lang, S., (1971). *Linear Algebra*, (2nd ed.), Addison-Wesley Publishing Co., Inc.

Lay, David C., (2014). *Linear Algebra and Its Applications*, (4th ed.), Pearson Education Limited.

Lipshchutz, S., (1991). *Schaum's Outline of Theory and Problems of Linear Algebra*, (2nd ed.), McGraw-Hill.

Nering, E.D., (1970). *Linear Algebra and Matrix Theory*, (2nd ed.), John Wiley and Sons, Inc.

Strang, Gilbert (2006). *Linear Algebra and Its Applications* (4th ed.), Cengage Learning.

Item No,	Assessment Tasks	Percentage Contribution (1)	No. of Times in the Semester (2)	Individual Task % Contribution (1/2)
1	Exercise Set (ES)	20%	6	6.67%/PE
3	Quizzes	20%	5	4%/Q
3	Long Examinations (LE)	60%	5	12%/LE
		100%		

COs	Assessment Tasks	Weight in Percent	Minimum Average for Satisfactory Rating	Target and Standards
CO 1	ES 1	6.67%	60 %	
	Q 1	4%		
	LE 1	12%		
CO 2	ES 2	6.67%	60 %	
	Q 2	4%		
	LE 2	12%		

CO 3	ES 3	6.67%	60 %	At least 70% of the students have at least a 60% score
	Q 3	4%		
	LE 3	12%		
CO 4	ES 4	6.67%	60 %	
	Q 4	4%		
	LE 4	12%		
CO 5	ES 5	6.67%	60 %	
	Q 5	4%		
CO 6	ES 6	6.67%	60 %	
	Q 6	4%		
	LE 5	12%		
TOTAL		100%		

Grading System (Passing: 60%)

Range	Grade	Range	Grade
96-100	1.00	68 - 71	2.50
92-95	1.25	64 - 67	2.75
88-91	1.50	60 - 63	3.00
84-87	1.75	50 - 59	3.25
80-83	2.00	40 - 49	3.50
76-79	2.25	30 - 39	4.00
72-75	2.50	01 - 29	5.00

16. Course Policies

- The official virtual classroom is VSU E-Learning Portal (<https://elearning.vsu.edu.ph>). A class orientation will be done concerning the use and navigation of the platform.
- ZOOM or Google Meet will be used for web-conferencing and real-time class meetings. The username and password link will be posted in VSU E-Learning Portal or emailed to your respective email addresses.
- Attending the virtual meeting is highly encouraged but not compulsory. If you cannot attend due to internet connection limitations, there is no problem. Just keep up with the lessons by watching the online class recording and doing all the necessary exercises that are required of you.
- The virtual meeting is our avenue for synchronous learning. Class interaction and participation are encouraged; sharing ideas, giving feedback on your outputs, and other related concerns will be done during this time.
- All written outputs should be submitted in pdf format and sent through the VSU E-Learning Portal.
- Quizzes are set on VSU E-Learning Portal. All quizzes are announced and will open and close on the agreed schedule. The schedule of quizzes will be announced in advance by the faculty.
- In the submission of activities, ON-TIME submission is encouraged. At least one week will be given for you to work on your exercises.
- Long examinations and term examinations are required and will be done through the VSU E-Learning Portal.

- i. If you have any inquiries/clarifications, you may contact the course instructor during the official class schedule; or the official online consultation schedule (9:00 – 11:00 AM, MWF).
- j. All students are reminded to observe all policies, regulations, and rules of the university and other related laws of the land and are advised to read, understand, and practice the provisions of the VSU Student Manual.
- k. Lastly, as we embark on this "new normal," let us have an open mind and heart as we adjust to this new way of delivering the teaching-learning process and still aim for quality education.

This class policy serves as our written agreement for the whole semester. If there are any changes to enhance the class learning opportunity within the semester, they will be communicated accordingly.

17. Course Materials and Facilities Available

Virtual Classroom which contains learning materials, learning resources, learning tasks, assessment tasks, etc.

18. Revision History

Revision number	Date of Revision	Date of implementation	Highlights of Revision
00		October 5, 2020	
		August 23, 2021	Updated department information. Updated timeline and grading system.

19. Preparation

Prepared by	Name	Signature	Date Signed
	EUSEBIO R. LINA, JR.		12/15/2020

III. INSTRUCTOR/PROFESSOR INFORMATION

1. Name of Instructor/Professor	Eusebio R. Lina, Jr.
2. Office and Department	Department of Mathematics
3. Telephone/Mobile Numbers	09293697060
4. Email Address	eusebio.lina@vsu.edu.ph
5. Consultation Time	9:00 – 11:00 MWF

20. Department Instructional Materials Review Committee:

Committee	Name	Signature	Date Signed
Member:	JORGE S. VALENZONA		
Member:	LEOMARICH F. CASINILLO		
Member:	RAYMUND M. IGCASAMA		
Chairperson:	DIVINA L . VALENZONA		

	Name	Signature	Date Signed
Verified by:	MA. THERESA P. LORETO Dean, CAS		
Validated by:	NANCY D. ABUNDA Head, OIMD		

Note:

- 1) The number of POs will depend on each degree program offered
- 2) COs and Relationship to POs
 - a. (I) - **Introductory** – an Introductory Course to an outcome
 - b. (E) - **Enabling** – an Enabling Course or a course that strengthens the outcome
 - c. (D) - **Demonstrated** – a Demonstrative Course or a course demonstrating an outcome.

Distribution of copies: OIMD, College, Department, Faculty, and ODQA