National University of Copsta Rica (UNA)
School of Informatics
Sillabus 2024-I

1. COURSE

MA102. Linear Algebra (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	MA102. Linear Algebra
2.2 Semester	:	3^{er} Semestre.
2.3 Credits	:	4
2.4 Horas	:	4 HT;
2.5 Duration of the period	:	16 weeks
2.6 Type of course	:	Mandatory
2.7 Learning modality	:	Face to face
2.8 Prerrequisites	:	MA101. Calculus. (2^{nd} Sem) MA101. Calculus. (2^{nd} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

This course introduces the first concepts of linear algebra as well as numerical methods with an emphasis on problem solving with the Scilab open source libe package. Mathematical theory is limited to fundamentals, while effective application for problem solving is privileged. In each subject, a few methods of relevance for engineering are taught. Knowledge of these methods prepares students for the search for more advanced alternatives, if required.

5. GOALS

- Ability to apply knowledge about Mathematics.
- Ability to apply engineering knowledge.
- Ability to apply the modern knowledge, techniques, skills and tools of modern engineering to the practice of engineering

6. COMPETENCES

1) Analyze a complex computing problem and to apply principles of computing and other relevant disciplines to identify solutions. (**Assessment**)

6) Apply computer science theory and software development fundamentals to produce computing-based solutions. (**Assessment**)

7. TOPICS

Unit 1: Introduction (18)	
Competences Expected:	
Topics	**Learning Outcomes**
• Importance of linear algebra and numerical methods. Examples.	• Be able to understand the basic concepts and importance of Linear Algebra and Numerical Methods.
Readings : [AR14], [CC15]	

<table>
<tr><td colspan="2">Unit 2: Linear Algebra (14)</td></tr>
<tr><td colspan="2">Competences Expected:</td></tr>
<tr><td>Topics</td><td>Learning Outcomes</td></tr>
<tr><td>

Elementary matrix algebra and determinants
Null space and exact solutions of systems of linear equations Ax=b:

Tridiagonal and triangular systems and Gaussian elimination with and without pivoting.
LU factorization and Crout algorithm.

Basics on eigenvalues and eigenvectors:

Characteristic polynomials.
Algebraic and geometric multiplicities.

Least squares estimation.
Linear transformations.

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Understanding the basics concepts of Linear Algebra.
Solve properly linear transformations problems.

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<tr><td colspan="2">Readings : [AR14], [CC15]</td></tr>
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Unit 3: Numerical methods (22)	
Competences Expected:	
Topics	**Learning Outcomes**
• Basics on solutions of systems of linear equations Ax=b: Jacobi and Gauss Seidel methods. • Application of matrix factorizations to the solution of linear systems (singular value decomposition, QR, Cholesky) Numerical computation of null space, rank and condition number. • Root finding: – Bisection. – Fixed-point iteration. – Newton-Raphson methods. • Basics on interpolation: – Newton and Lagrange polynomial interpolations – Spline interpolation • Basics on numerical differentiation and Taylor approximation • Basics on numerical integration: – Trapezium, midpoint and Simpson rule – Gaussian quadrature • Basics on numerical solutions to ODEs: – Finite differences; Euler and Runge-Kutta methods – Converting higher order ODEs into a system of low order ODEs – Runge-Kutta methods for systems of equations – Single shooting method • Short introduction to optimization techniques: overview on linear programming, bounded linear systems, quadratic programming, gradient descent.	• Understanding the basics concepts of Numerical Methods. • Applying the most frequent methods for the resolution of mathematical problems. • Implementing and applying numerical algorithms for the solution of mathematical problems using the Scilab open-source computational package. • Applying Scilab for the solution of mathematical problems and for plotting graphs.
Readings : [AR14], [CC15]	

8. WORKPLAN

8.1 Methodology

Individual and team participation is encouraged to present their ideas, motivating them with additional points in the different stages of the course evaluation.

8.2 Theory Sessions

The theory sessions are held in master classes with activities including active learning and roleplay to allow students to internalize the concepts.

8.3 Practical Sessions

The practical sessions are held in class where a series of exercises and/or practical concepts are developed through problem solving, problem solving, specific exercises and/or in application contexts.

9. EVALUATION SYSTEM

********* EVALUATION MISSING ********

10. BASIC BIBLIOGRAPHY

[AR14] H. Anton and C. Rorres. *Elementary Linear Algebra, Applications Version.* 11th. Wiley, 2014.

[CC15] S.C. Chapra and R.P. Canale. *Numerical Methods for Engineers,* 7th. Vol. 1. McGraw-Hill, 12015.