

Skill Enhancement Paper

SEC-1: Computer Algebra Systems

Total Marks: 100 (Theory: 38, Internal Assessment: 12, and Practical: 50)

Workload: 2 Lectures, 4 Practicals (per week) **Credits:** 4 (2+2)

Duration: 14 Weeks (28 Hrs. Theory + 56 Hrs. Practical) **Examination:** 2 Hrs.

Course Objectives: This course aims at providing basic knowledge to Computer Algebra Systems (CAS) and their programming language in order to apply them for plotting functions, finding roots to polynomials, computing limits and other mathematical tools.

Course Learning Outcomes: This course will enable the students to:

- i) Use CAS as a calculator and for plotting functions.
- ii) Understand the role of CAS finding roots of polynomials and solving general equations.
- iii) Employ CAS for computing limits, derivatives, and computing definite and indefinite integrals.
- iv) Use CAS to understand matrix operations and to find eigenvalues of matrices.

Unit 1: Introduction to CAS and Graphics

Computer Algebra Systems (CAS), Use of a CAS as a calculator, Simple programming in a CAS; Computing and plotting functions in 2D, Customizing plots, Animating plots; Producing table of values, Working with piecewise defined functions, Combining graphics.

Unit 2: Applications in Algebra

Factoring, Expanding and finding roots of polynomials, Working with rational and trigonometric functions, Solving general equations.

Unit 3: Applications of Calculus

Computing limits, First and higher order derivatives, Maxima and minima, Integration, Computing definite and indefinite integrals.

Unit 4: Working with Matrices

Performing Gaussian elimination, Operations (transpose, determinant, and inverse), Minors and cofactors, Solving systems of linear equations, Rank and nullity of a matrix, Eigenvalue, eigenvector and diagonalization.

References:

1. Bindner, Donald & Erickson, Martin. (2011). *A Student's Guide to the Study, Practice, and Tools of Modern Mathematics*. CRC Press, Taylor & Francis Group, LLC.
2. Torrence, Bruce F., & Torrence, Eve A. (2009). *The Student's Introduction to Mathematica®: A Handbook for Precalculus, Calculus, and Linear Algebra* (2nd ed.). Cambridge University Press.

Note: Theoretical and Practical demonstration should be carried out *only in one* of the CAS: Mathematica/MATLAB/Maple/Maxima/Scilab or any other.

Practicals to be done in the Computer Lab using CAS Software:

[1] Chapter 12 (Exercises 1 to 4 and 8 to 12).

[2] Chapter 3 [Exercises 3.2 (1), 3.3 (1, 2 and 4), 3.4 (1 and 2), 3.5 (1 to 4), 3.6 (2 and 3)].

[2] Chapter 4 (Exercises 4.1, 4.2, 4.5, 4.7 and 4.9).

[2] Chapter 5 [Exercises 5.1 (1), 5.3, 5.5, 5.6 (1, 2 and 4), 5.10 (1 and 3), 5.11 (1 and 2)].

[2] Chapter 7 [Exercises 7.1 (1), 7.2, 7.3 (2), 7.4 (1) and 7.6].

Teaching Plan (Theory of SEC-1: Computer Algebra Systems):

Weeks 1 and 2: Computer Algebra Systems (CAS), Use of a CAS as a calculator, Simple programming in a CAS.

[1] Chapter 12 (Sections 12.1 to 12.5).

Weeks 3 to 5: Computing and plotting functions in 2D, Customizing plots, Animating plots, Producing table of values, Working with piecewise defined functions, Combining graphics.

[2] Chapter 1, Chapter 3 (Sections 3.1 to 3.6, and 3.8)

Weeks 6 to 8: Factoring, Expanding and finding roots of polynomials, Working with rational and trigonometric functions, Solving general equations.

[2] Chapter 4 (Sections 4.1 to 4.3, 4.5 to 4.7, and 4.9).

Weeks 9 to 11: Computing limits, First and higher order derivatives, Maxima and minima, Integration, computing definite and indefinite integrals.

[2] Chapter 5 (Sections 5.1, 5.3, 5.5, 5.6, 5.10, and 5.11).

Weeks 12 to 14: Performing Gaussian elimination, Operations (transpose, determinant, and inverse), Minors and cofactors, Solving systems of linear equations, Rank and nullity of a matrix, Eigenvalue, Eigenvector and diagonalization.

[2] Chapter 7 (Sections 7.1 to 7.4, and 7.6 to 7.8).

Facilitating the Achievement of Course Learning Outcomes

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
1.	Use CAS as a calculator and for plotting functions.	(i) Topics to be explained using CAS.	<ul style="list-style-type: none"> • Presentations and class discussions.
2.	Understand the role of CAS finding roots of polynomials and solving general equations.	(ii) Students be given homework/ assignments.	<ul style="list-style-type: none"> • Assignments and class tests.
3.	Employ CAS for computing limits, derivatives, and computing definite and indefinite integrals.	(iii) Students to be encouraged to look for new applications.	<ul style="list-style-type: none"> • Mid-term examinations. • Practical examinations.
4.	Use CAS to understand matrix operations and to find eigenvalues of matrices.		<ul style="list-style-type: none"> • End-term examinations.

Keywords: Computer Algebra Systems (CAS), CAS in graphics. CAS in algebra. CAS in calculus.