

| Course Name : Numerical Analysis |                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                       |                       |                    |         |      |
|----------------------------------|----------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|-----------------------|--------------------|---------|------|
| Course Code                      | Course Type                                                                                                          | Regular Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Lecture (hours/we ek) | Seminar (hours/we ek) | Lab. (hours/we ek) | Credits | ECTS |
| CMP 120                          | B                                                                                                                    | Spring                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 3.00                  | 1.00                  | 0.00               | 3.50    | 5.00 |
|                                  |                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                       |                       |                    |         |      |
| Lecturer                         |                                                                                                                      | Sofokli Garo, PhD                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                       |                       |                    |         |      |
| Assistant                        |                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                       |                       |                    |         |      |
| Course language                  |                                                                                                                      | Albanian                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                       |                       |                    |         |      |
| Course level                     |                                                                                                                      | Bachelor                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                       |                       |                    |         |      |
| Description                      |                                                                                                                      | Binary Numbers. Error analysis. Solving systems of linear equations: Gaussian Elimination, modification of Gaussian Elimination and L-U transformation. Solving non-linear equations and systems: Bisection, Newton, Secant methods and fixed point iteration. Interpolation : Lagrange approximation, Newton's polynomials and approximation of polynomials. Curve matching. Numerical differentiations; numerical integrations. Numerical optimizations. Numerical solutions of initial value and peak value problems.: Euler, Heun, Taylor, Runge-Kutta methods. |                       |                       |                    |         |      |
| Objectives                       |                                                                                                                      | Binary Numbers. Error analysis. Solving systems of linear equations: Gaussian Elimination, modification of Gaussian Elimination and L-U transformation. Solving non-linear equations and systems: Bisection, Newton, Secant methods and fixed point iteration. Interpolation : Lagrange approximation, Newton's polynomials and approximation of polynomials. Curve matching. Numerical differentiations; numerical integrations. Numerical optimizations. Numerical solutions of initial value and peak value problems.: Euler, Heun, Taylor, Runge-Kutta methods. |                       |                       |                    |         |      |
| Core Concepts                    |                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                       |                       |                    |         |      |
| Course Outline                   |                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                       |                       |                    |         |      |
| Week                             | Topic                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                       |                       |                    |         |      |
| 1                                | Binary Numbers                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                       |                       |                    |         |      |
| 2                                | Error Analysis                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                       |                       |                    |         |      |
| 3                                | Solving equations $x = g(x)$ . Bracketing methods, Newton's method, Secant method, and Fixed-point iteration methods |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                       |                       |                    |         |      |
| 4                                | Aitken's process and Steffensen's and Muller's methods                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                       |                       |                    |         |      |
| 5                                | Iteration for non-linear systems                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                       |                       |                    |         |      |
| 6                                | Iteration for non-linear systems                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                       |                       |                    |         |      |
| 7                                | Newton's method for non-linear systems                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                       |                       |                    |         |      |
| 8                                | Midterm Exam                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                       |                       |                    |         |      |
| 9                                | Solving non-linear equation systems. Gaussian elimination and L-U decomposition                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                       |                       |                    |         |      |
| 10                               | Solving linear equation systems. Modifications of the Gaussian elimination method                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                       |                       |                    |         |      |
| 11                               | Visualization of Matrices                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                       |                       |                    |         |      |
| 12                               | Newton Polynomials and Polynomial Approximation                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                       |                       |                    |         |      |
| 13                               | Numerical Integration. Trapezoidal and Simpson's methods                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                       |                       |                    |         |      |
| 14                               | Numerical Differentiation and Integration. Euler's Method                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                       |                       |                    |         |      |
| 15                               | Numerical Optimization                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                       |                       |                    |         |      |

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|--------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|------------------|---------------|
| 16                                                                       | Final Exam                                                                                    |                                                                                                                                   |                  |               |
| Prerequisites                                                            |                                                                                               | The student must attend the course at a minimum rate of 75%.                                                                      |                  |               |
| Literature                                                               |                                                                                               | • John H.Mathews, Numerical Methods using Matlab, Prentice-Hall International, 2004<br>• Analyze Numerike, Prof. Dr. Fatmir Hoxha |                  |               |
| References                                                               |                                                                                               | • Numerical Methods with C++ Programming. NITA H. SHAH PHI Learning Pvt. Ltd., 2008                                               |                  |               |
| Course Outcome                                                           |                                                                                               |                                                                                                                                   |                  |               |
| 1                                                                        | Understanding the difference between solving problems by hand and using a computer            |                                                                                                                                   |                  |               |
| 2                                                                        | Understanding the solutions of numerical methods and having a clear structure of an algorithm |                                                                                                                                   |                  |               |
| Course Evaluation                                                        |                                                                                               |                                                                                                                                   |                  |               |
| In-term Studies                                                          |                                                                                               | Quantity                                                                                                                          | Percentage       |               |
| Midterms                                                                 |                                                                                               | 1                                                                                                                                 | 30               |               |
| Quizzes                                                                  |                                                                                               | 0                                                                                                                                 | 0                |               |
| Projects                                                                 |                                                                                               | 0                                                                                                                                 | 0                |               |
| Term Projects                                                            |                                                                                               | 0                                                                                                                                 | 0                |               |
| Laboratory                                                               |                                                                                               | 0                                                                                                                                 | 0                |               |
| Class Participation                                                      |                                                                                               | 1                                                                                                                                 | 20               |               |
| Total in-term evaluation percent                                         |                                                                                               |                                                                                                                                   | 50               |               |
| Final exam percent                                                       |                                                                                               |                                                                                                                                   | 50               |               |
| Total                                                                    |                                                                                               |                                                                                                                                   | 100              |               |
| ECTS Workload (Based on Student Workload)                                |                                                                                               |                                                                                                                                   |                  |               |
| Activities                                                               |                                                                                               | Quantity                                                                                                                          | Duration (hours) | Total (hours) |
| Course duration (Including the exam week: 16x Total hours of the course) |                                                                                               | 16                                                                                                                                | 4                | 64            |
| Study hours outside the classroom (Preparation, Practice, etc.)          |                                                                                               | 14                                                                                                                                | 4                | 56            |
| Duties                                                                   |                                                                                               | 0                                                                                                                                 | 0                | 0             |
| Midterms                                                                 |                                                                                               | 1                                                                                                                                 | 5                | 5             |
| Final Exam                                                               |                                                                                               | 1                                                                                                                                 | 0                | 0             |
| Other                                                                    |                                                                                               | 0                                                                                                                                 | 0                | 0             |
| Total Work Load                                                          |                                                                                               |                                                                                                                                   |                  | 125           |
| Total Work Load / 25 (hours)                                             |                                                                                               |                                                                                                                                   |                  | 5.00          |
| ECTS                                                                     |                                                                                               |                                                                                                                                   |                  | 5.00          |