American University of Beirut
Faculty of Arts and Sciences
Department of Mathematics
Math 251: Numerical Computing – 3 credits
Prerequisites: Math 201 and CMPS 200 (or equivalent)
Summer 2017-2018

- **Course Instructors:**

Prof. Nabil Nassif(nn12@aub.edu.lb) – Section: 1
Dr. Dolly Fayyad (df07@aub.edu.lb) – Sections: 2,3
Mr. Hagop Karakazian (hk93@aub.edu.lb) – Section: 4

- **Schedule**

Section 1	1:30 - 2:45 pm	Bliss 205	**N. Nassif**
Section 2	1:30 - 2:45 pm	Nicely 105	**D. Fayyad**
Section 3	3:00 - 4:15 pm	Nicely 210	**D. Fayyad**
Section 4	3:00 - 4:15 pm	Nicely 320	**H. Karakazian**

- **Midterm and Matlab test**
  MIDTERM: Friday June 29 (Saturday June 30): 10:00 am - 12:00 pm
  MATLAB test (2 rounds): Friday July 20, in Bliss Labs: 5:00 pm - 7:00 pm

- **Grading** (over 100)
  1. Midterm: 40 %
  2. Final Exam: 40 %
  3. MATLAB Tests: 20 % (15% Lab Test + 5% within Midterm and Final)

N.B.
- If needed, there will be a curving for the final grades of the course only, relative to the group as a whole. The computed average should be around 78/100.
- There will be no make up for the Midterm. In case of absence, the student will get a grade ZERO
- All students are required to test all technical procedures related to the MATLAB test before the test.
  Students that miss that initiation will not be allowed to sit for the MATLAB test and will get a grade of zero.
- In case of absence for the MATLAB test, a written make up will be mandatory. Missing this make up will lead to a grade of zero.

- **Textbook:**
  "Numerical analysis and Scientific computing", by NASSIF N. and FAYYAD D. 1st edition. CRC Press, 2013.

- **Catalog Description**
  Techniques of Numerical Analysis: number representations and round-off errors, root finding, approximation of functions, integration, solving initial value problems, Monte-Carlo methods. Implementations and analysis of the algorithms will be stressed. Projects using MATLAB or a similar tool will be assigned.

- **Course Main Objectives**: This course is primarily addressed to students majoring in Computer Science, Mathematics, Engineering, Physics and Economics. Its main purpose is the introduction of mathematical and computational tools to handle basic numerical methods. The main tool for algorithms development is MATLAB, version 7.

- **Course Learning Outcomes**
  - Understand floating-point number representations, particularly those pertaining to IEEE simple and double-precision standards as being used in scientific computer environment such as MATLAB version 7.
  - Understand computer arithmetic as a source for generating round-off errors.
  - Learn to avoid algebraic expressions that may lead to loss of significant figures.
  - Understand the use of iterative methods for reaching accurate approximations to roots of a nonlinear equation. Study particularly Newton's method to solve non-polynomial equations.
  - Learn the basic Lagrange polynomial interpolation theorem and its applications.
  - Learn the efficiency of spline interpolation, particularly the Cubic spline.
  - Understand the basic principles for numerical differentiation and integration in view of obtaining highly convergent formulae through Richardson's extrapolation.
  - Study and practice the art of solving first-order scalar and vector ODEs through the use of one step Explicit Runge-Kutta methods of orders 1, 2, 3 and 4, based on numerical integration or with the use of Taylor series expansions.
  - Learn the use of Gauss elimination with or without partial pivoting to solve systems of linear equations.
  - Understand the PLU decomposition of a matrix and its applications.

- **Course Contents**
  Chapter 1: **Floating-point number representation**: Binary, Octal, Decimal, Hexadecimal Systems. IEEE Single and Double Precision Floating point systems. Rounding.
  Chapter 2: **Matrix computations: systems of linear equations and Gaussian procedures**. PLU decomposition of Matrices.
  Chapter 3: **Numerical Interpolation**: Interpolating polynomials. Quadratic and Cubic Splines.
  Chapter4: **Numerical Differentiation and Integration**. Difference formulae with Richardson's extrapolation for derivatives. Midpoint, Trapezoidal and Simpson's Rules with Romberg extrapolation for Numerical Integration.
  Chapter 5: **Numerical solutions of Scalar and Vector Ordinary Differential Equations. Explicit Runge-Kutta schemes.**
  Chapter 6: **Finding roots of non-linear equations**: Newton's method

- **University Rules regarding class attendance (Extracts from University Catalogue)**:
  - Students who miss more than **one-fifth of all sessions** will be penalized as follows:
    Penalty = 80 – percentage of attendance.
  - Students are expected to the **classes they are registered in. i.e., students are NOT allowed to switch into other sections under any circumstance.**
  - Students who withdraw or are dropped for excessive absence from a course receive a grade of "W".
  - Students who do not withdraw or cannot be dropped for excessive absence from a course will receive a grade of 40.
  - Students can withdraw from registered courses no later than 5 weeks.

- **University Policies**
  a. **Academic Integrity**:
     Please refer to AUB Student Code of Conduct: http://www.aub.edu.lb/pnp/generaluniversitypolicies/Documents/StudentCodeConduct/StudentCodeConduct.pdf , in particular section 1.1, which concerns academic misconduct including cheating, plagiarism, in-class disruption, and dishonesty. Please be aware that misconduct is vigorously prosecuted and that AUB has a zero tolerance policy. Course policy is that **credible evidence of cheating will result in course failure.**
  b. **Recommended Accessibility Statement to Acknowledge the Unique Learning Needs of Students with Disabilities:**
     AUB strives to make learning experiences as accessible as possible. If you anticipate or experience academic barriers due to a disability (including mental health, chronic or temporary medical conditions), please inform me immediately so that we can privately discuss options. In order to help establish reasonable accommodations and facilitate a smooth accommodations process, you are encouraged to contact the Accessible Education Office: accessibility@aub.edu.lb; +961-1-350000, x3246; West Hall, 314.
  c. **Non-Discrimination**
     AUB is committed to facilitating a campus free of all forms of discrimination including sex/gender-based harassment prohibited by Title IX. The University's non-discrimination policy applies to, and protects, all students, faculty, and staff. If you think you have experienced discrimination or harassment, including sexual misconduct, we encourage you to tell someone promptly. If you speak to a faculty or staff member about an issue such as harassment, sexual violence, or discrimination, the information will be kept as private as possible, however, faculty and designated staff are required to bring it to the attention of the University's Title IX Coordinator. Faculty can refer you to fully confidential resources, and you can find information and contacts at www.aub.edu.lb/titleix . To report an incident, contact the University's Title IX Coordinator Trudi Hodges at 01-350000 ext. 2514, or titleix@aub.edu.lb . An anonymous report may be submitted online via Ethics Point at www.aub.ethicspoint.com.

Timetable

Weeks		Content
Week 1 Week 2	June 4 – 5 – 6 – 7 June -11 – 12	FLOATING POINT ARITHMETIC IEEE Floating point systems Floating-point operations. Rounding errors
Week 2 Week 3	June 13 – 14 June 18 – 19	SYSTEMS OF LINEAR EQUATIONS Backward Substitution- Naïve Gauss reduction Partial and Scaled Partial pivoting LU decomposition: Determinant and Inverse of A
Week 3 Week 4	June 20 – 21 June 25 – 26 – 27	POLYNOMIAL and SPLINE INTERPOLATION Newton's polynomials. Divided Differences. Quadratic and Cubic Splines
Week 4 Week 5 Week 6	June 28 July 2 – 3 - 4 – 5 July 9	Midterm: End of Week 4 10:00 am - 12:00 pm NUMERICAL DIFFERENTIATION & INTEGRATION Forward, Backward and Central difference formulae Richardson Extrapolation Midpoint, Trapezoidal & Simpson's Rules Romberg formulae
Week 6 Week 7	July 10 – 11 – 12 July 16 – 17	ODEs: RUNGE-KUTTA Methods Numerical Integration: RK1 and RK2 (2 schemes) General 2^{nd} order RK with Taylor series RK3 and RK4 classical schemes Systems of n equations of 1st order ODEs.
Week 7	July 18 – 19	ROOT FINDING methods Bisection and Newton's method Matlab Test: End of Week 7