Syllabus for BINF690 *Numerical Methods for Bioinformatics*

Course title: Numerical Methods for Bioinformatics
Course number: BINF690
Instructor name: Dmitri Klimov
Semester and year: Fall 2025
Course credits: 3
Class meeting day/time/modality: Mondays, 4:30 pm - 7:10 pm, online via zoom
Class website: Canvas 74531.202570 BINF-690-DL1 (Fall 2025)
Class zoom invitation: Provided via email and/or included in class modules on Canvas
Instructor email address: dklimov@gmu.edu (preferred way of communication)
Instructor telephone number: 703-993-8395
Instructor office location: Colgan Hall, Rm 328B, Science and Technology Campus
Instructor office hours: By appointment (email to arrange zoom meeting or to speak over the telephone)

Course Description and Goals

The course introduces the foundations of computational techniques for solving scientific problems. The practical implementation of numerical techniques for "real-life" problems in computational biology is emphasized. Students will develop an ability to convert a quantitative problem into computer program.

Prerequisites: Calculus and knowledge of programming language. An understanding of the basic concepts of linear algebra and introductory differential equations is helpful.

Required Reading

Required textbook: *Numerical Methods for Engineers* by Chapra and Canale, 5 through 8th editions. The price of Kindle 8th edition is $82 on Amazon.

Course Policies

Grading schema (percentage): A+ (>100), A (90-100), B (80-89), C (<80). Percentages are not rounded to the closest whole number.

Grade weights and grading policy: Students will be graded on the basis of homework (30% weight), midterm in-class exam (open book policy) (25% weight), final take-home exam (25% weight), and class participation (20% weight). For each problem or assignment, students will earn up to one point. Homeworks are weighted equally independent of the number of problems in the homework. Class participation implies asking questions during lectures.

Campus Closure: If the campus closes or class is canceled due to weather or other concerns, students should check Canvas and/or contact instructor for updates on how to continue learning and information about any changes to events or assignments.

Participation and make-up work: In case of illness or quarantine, please contact the instructor to set up a plan for make-up work. Late assignments will not be accepted unless due to emergency, illness, quarantine, work-related or other documented reasons.

Course Recordings: All synchronous meetings in this class will be recorded to provide necessary information for students in this class. Recordings will be stored on Zoom cloud and will only be accessible to students taking this course during this semester.

Other considerations: If there are any schedule issues related to religious holidays, please inform the instructor during the first week of class. Completion of regular weekly homework is expected to take several hours.

Course Learning Outcomes

By the end of this course, students will be able to

1. apply various algorithms to solving numerical problems in computational biology
2. appraise theoretical foundations of algorithms
3. develop practical skills for writing computer programs solving numerical problems
4. perform basic computer simulations

Course Logistics

The course uses Canvas for distributing lecture materials, submission of homework, and grading.

To access Canvas

1. Go to https://canvas.gmu.edu
2. Login using your Mason ID and password.
3. Click on the 'Courses" tab.
4. Select "Numerical Methods for Bioinformatics BINF-690-DL1 (Fall 2025)" in the list of courses.

The course uses Zoom for online meetings. The Zoom invitation information is provided via email but is also included as module items.

Technology Requirements for the Course

Software and Hardware: This course uses Canvas as a learning management system available at https://canvas.gmu.edu. This course uses web-conferencing Zoom software for online meetings. Students are required to have regular, reliable access to a computer

with an updated operating system (recommended: Windows 10 or 11 or Mac OSX 10.13 or higher) and a stable broadband Internet connection (cable modem, DSL, satellite broadband, etc.). In addition, students are required to have a device with a functional camera and microphone. A larger screen is recommended for better visibility of course material. In an emergency, students can connect through a telephone call, but video connection is the expected norm.

Note: If you are using an employer-provided computer or corporate office for class attendance, please verify with your systems administrators that you will be able to install the necessary applications and that system or corporate firewalls do not block access to any sites or media types.

Course-specific Hardware/Software: Students are expected to have access to any programming language suitable for scientific calculations (C, Fortran, perl, python, etc.).

Technical Help: If you have difficulty with accessing Canvas or Zoom, please contact the ITS Support Center at 703.993.8870 or support@gmu.edu. If you have trouble with using the features in Canvas, email courses@gmu.edu.

Common Polices Addendum

The course follows Common Policies Addendum available at https://stearnscenter.gmu.edu/home/gmu-common-course-policies/. Further information on policies is provided below.

Student Responsibilities

Mason Email: Students are responsible for the content of university communications sent to their George Mason University email account and are required to activate their account and check it regularly. All communication from the university, college, school, and program will be sent to students solely through their Mason email account.

Students with disabilities: Students with disabilities who seek accommodations in a course must be registered with the George Mason University Disability Services and inform their instructor, in writing, at the beginning of the semester [See Disability Services website: https://ds.gmu.edu/].

Academic integrity: Students must be responsible for their own work, and students and faculty must take on the responsibility of dealing explicitly with violations. The tenet must be a foundation of our university culture [See Academic Standards website: https://academicstandards.gmu.edu/].

Academic Standards Code and Virtual Classroom Conduct: Students must adhere to the guidelines of the George Mason University Academic Standards Code [See Academic Standards Code website: https://academicstandards.gmu.edu/academic-standards-code/].

Use of AI tools: Use of generative AI (e.g., ChatGPT) for coding is not allowed. If students use these tools for other purposes than coding, they must follow GMU academic standards and make appropriate citations.

Academic Honesty Policy of the course: Students are expected to follow the Honor Code. Academic dishonesty will not be tolerated in this class. Exams, assignments, and homework must reflect individual work. If you have difficulty with them, discuss it with the instructor.

University policies: Students must follow the university policies [See University Policy website: https://universitypolicy.gmu.edu].

Responsible use of computing: Students must follow the university policy for Responsible Use of Computing [See University Policy website: https://universitypolicy.gmu.edu/policies/responsible-use-of-computing].

University calendar: Students should consult the current Academic Calendar [See University Calendar website: https://www2.gmu.edu/academics/academic-calendar].

University catalog: Students should use the current university catalog [See University Catalog website: https://catalog.gmu.edu].

Student Services

Writing center: The George Mason University Writing Center staff provides a variety of resources and services (e.g., tutoring, workshops, writing guides, handbooks) intended to support students as they work to construct and share knowledge through writing. (See Writing Center website: https://writingcenter.gmu.edu). ESL Help: The program was designed specifically for students whose first language is not English who feel they might benefit from additional, targeted support over the course of an entire semester.

University libraries: University Libraries provide resources for distance learning students [See Library website: http://library.gmu.edu/for/online].

Counseling and Psychological Services: The George Mason University Counseling and Psychological Services (CAPS) staff consists of professional counseling and clinical psychologists, social workers, and counselors who offer a wide range of services (e.g., individual and group counseling, workshops and outreach programs) to enhance students' personal experience and academic performance [See Counseling and Psychological Services website: https://caps.gmu.edu].

Family Educational Rights and Privacy Act (FERPA): The Family Educational Rights and Privacy Act of 1974 (FERPA), also known as the "Buckley Amendment," is a federal law that gives protection to student educational records and provides students with certain rights [See Registrar's Office website: https://registrar.gmu.edu/ferpa/].

Course Materials and Student Privacy

Video recordings of class meetings that are shared only with the instructors and students officially enrolled in a class do not violate FERPA or any other privacy expectation. Video recordings that only include the instructor (no student names, images, voices, or identifiable texts) may be shared without violating FERPA (but see University Policies: Privacy, for some qualifications and recommendations). All course materials posted to Canvas or other course site are private to this class; by federal law, any materials that identify specific students (via their name, voice, or image) must not be shared with anyone not enrolled in this class.

Video conferencing or recordings: Video recordings - whether made by instructors or students - of class meetings that include audio, visual, or textual information from other students are private and must not be shared outside the class. Live video conference meetings that include audio, textual, or visual information from other students must be viewed privately and not shared with others in your household or recorded and shared outside the class.

Course schedule for Fall 2025

Lecture 1, Aug 25
Numerical methods in science. Programming and implementation of numerical methods (Chapters 1-3).

Lecture 2, Sep 8
Taylor series. Error propagation (Chapter 4).

Lecture 3, Sep 15
Roots of equations (Chapters 5 and 6).

Lecture 4, Sep 22
Linear algebraic equations (Chapter 9)

Lecture 5, Sep 29
Optimization and minimization (Chapters 13 and 14).

Lecture 6, Oct 6
Curve fitting (Chapters 17 and 18).

Lecture 7, Oct 20
Midterm classroom exam.

Lecture 8, Oct 27
Numerical differentiation and integration (Chapters 21 and 22).

Lecture 9, Nov 3
Solution of ordinary differential equations (Chapter 25).

Lecture 10, Nov 10
Boundary-value and eigenvalue problems (Chapter 27).

Lecture 11, Nov 17
Numerical methods: Molecular dynamics (online lecture notes).

Lecture 12, Nov 24
Numerical methods: Monte Carlo algorithm (online lecture notes).

Lecture 13, Dec 1
Molecular simulations: Errors and results (online lecture notes).

Lecture 14, Dec 8
Advanced numerical techniques (online lecture notes).

Notes:
1. Each lecture is a 2 ½ hour presentation with a 10-minute break.

2. The chapters refer to the class textbook *Numerical Methods for Engineers* by Chapra and Canale.
3. Final exam will be held during exam week.