Spring 2016

Math 42201: Introduction to Numerical Computing 1

CRN 15429. Section 600 , MW: 3:30-4:15 pm, Main 213

* **Instructor:** Dr. Gro Hovhannisyan, Office: 440, Main Hall.

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* **Office Hours:**  MW: 4.15-5.15 pm other time by appointment
* **Text:** *Numerical Analysis*by Burden and Fairies (Brooks/Cole, 9th edition, ISBN-13: 978-0-538-73351-9)
* **Online Access:** This syllabus can be found at http://www.personal.kent.edu/~ghovhann/
* **Course Outline and Objectives:** Chapters 1, 2, 6, 7 and sections 8.1,10. 1, 10.2, 10.4 (some sections will be skipped**).** An introduction to numerical methods and software for solving many common scientific computing problems. Linear systems, least-squares data fitting, nonlinear equations and systems, and optimization problems.
* **Prerequisite:** **MATH 12003; and MATH 21001 or MATH 32051; and CS 10061 or CS 23021.**
* **Class requirement and expectations:** You need your own copy of the text book. Regular attendance and consistent studying are required through the term. You are remained responsible for making up what you missed.
* **Regular homework.** Regular homework assignments are given in the syllabus. The purpose of the homework and review session is to prepare you for tests. The homework won’t be collected and graded, but will be discussed in the class. A selection of homework problems will be graded for 100 regular points. These problems will be collected several times during the term (the exact dates will be announced in the class). If you have difficulties, try to get help in the Tutoring Center, or prepare your questions for homework discussions in class, or see me during office hours.
* **Exams.** There will be two 100-points tests and a comprehensive 100-point final exam. All exams are in class with closed books and notes. Make-ups are possible on exceptional basis and with a valid excuse.
* **Grade Distribution**
* **93% will guarantee an A (excellent) 90% will guarantee an A-**
* **87% will guarantee a B+ (very good) 83% will guarantee a B (good)**
* **80% will guarantee a B - 77% will guarantee a C+ (average)**
* **73% will guarantee a C 70% will guarantee a C-**
* **63% will guarantee a D+ 60% will guarantee a D (poor but passing)**
* **0-59.9% F (failure)**
* **Academic Honesty**: Use of the intellectual property of others without attributing it to them is considered a serious academic offense.  Cheating or plagiarism will result in a failing grade for the work or for the entire course.  Repeat offenses result in dismissal from the University. University guidelines require that all infractions be reported to the Student Conduct Officer on our campus.
* **Students with Disabilities:** University policy 3-01.3 requires that students with disabilities be provided reasonable accommodations to ensure their equal access to course content. If you have a documented disability and require accommodations, please contact the instructor at the beginning of the semester to make arrangements for necessary classroom adjustments. Please note, you must first verify your eligibility for these through Student Accessibility Services (contact 330-244-5047 or visit<http://stark.kent.edu/student/resources/accessibility.cfm>  for more information on registration procedures).
* **Tutoring:** Free, walk-in math tutoring is available 8 a.m. - 7 p.m. Monday through Thursday and 8 a.m. - 3 p.m. Friday in the Academic Success Center in the lower level of Campus Center.

**Math 42201. Spring 2016. MW 3:30-4:45 pm. Class Schedule:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  |  | **Section** | **Regular homework** |
|  | **Jan 20** | **W** | **1.2 Round-off Errors** | **1-15** |
|  | **Jan 25** | **M** | **1.2 Round-off Errors** |  |
|  | **Jan 27** | **W** | **1.3 Algorithms and convergence** | **1-9** |
|  | **Feb 1** | **M** | **1.4 Numerical software** |  |
|  | **Feb 3** | **W** | **2.1 The bisection method**  | **1-15 ODD** |
|  | **Feb 8** | **M** | **2.2 Fixed point iteration** | **1-10** |
|  | **Feb 10** | **W** | **2.3 Newton’s method** | **1-14** |
|  | **Feb 15** | **M** | **2.3 Newton’s method**  |  |
|  | **Feb 17** | **W** | **Review** |  |
|  | **Feb 22** | **M** | **Test 1** |  |
|  | **Feb 24** | **W** | **2.4 Error analysis**  | **1-11** |
|  | **Feb 29** | **M** | **6.1 Linear systems of equations** | **1-9** |
|  | **Mar 2** | **W** | **6.2 Pivoting strategies** | **1-9** |
|  | **Mar 7** | **M** | **6.3 Linear algebra and matrix inversion** | **1-9** |
|  | **Mar 9** | **W** | **6.4 The determinant of a matrix** | **1-9** |
|  | **Mar 14** | **M** | **6.5 Matrix factorization** | **1-7** |
|  | **Mar 16** | **W** | **Review** |  |
|  | **Mar 28** | **M** | **Test 2** |  |
|  | **Mar 30** | **W** | **7.1 Norms of vectors and matrices** | **1-13** |
|  | **Apr 4** | **M** | **7.2 Eigenvalues and eigenvectors** | **1-15** |
|  | **Apr 6** | **W** | **7.3 The Jacobi iterative technique** | **1-15 ODD** |
|  | **Apr 11** | **M** | **7.5 Error bounds** | **1-8** |
|  | **Apr 13** | **W** | **7.5 Error bounds** |  |
|  | **Apr 18** | **M** | **8.1 Discrete least squares approximation** | **1-9** |
|  | **Apr 20** | **W** | **10.1 Fixed points** | **1-7** |
|  | **Apr 25** | **M** | **10.2 Newton’s method** | **1-7** |
|  | **Apr 27** | **W** | **10.4 Steepest Descent techniques** | **1-3** |
|  | **May 2** | **M** | **Review** |  |
|  | **May 4** | **W** | **Review** |  |
|  | **May 11** | **W** | **Final exam 3:30 pm** |  |

**GOOD LUCK!**

Learning Outcomes for Introduction to Numerical Computing

Knowledge The students will know numerical methods for the solution of linear systems of equations, least-squares problems, ill-posed problems, polynomial interpolation, polynomial least-squares approximation, and their properties. Students will understand the properties of these methods and the effect of finite precision arithmetic on the computed solution.

Comprehension Students should know the matrix factorizations used in the numerical methods, including LU and QR factorization, and the singular value decomposition, how they are computed, how they can be applied, and how they can be implemented in Wolphram Mathematica. Students should be able to implement and apply the methods discussed in Wolphram Mathematica. They also should know how numbers are represented on a computer, and how this representation may affect the computed results.

Application The methods covered in the course are applied to a variety of problems, including GPS, information retrieval. Students solve these problems by writing Wolphram Mathematica code.

Analysis Students should know the mathematical background for the methods described as well as their properties. Synthesis The course forces students to apply and expand knowledge gained in Calc I, Calc II, and Linear Algebra. Evaluation Students should be able to solve problems in scientific computing by writing Wolphram Mathematica code using the methods discussed in the course. Students also should know properties of these methods and how they are derived.

Class Activities Discuss the methods, show their properties, and illustrate their performance.

Out of class Activities Do weekly homework assignment that involves analysis, application, and implementation in Wolphram Mathematica of the methods discussed.

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PRETEST 1

1. Compute the absolute error and relative error in approximations

of p=10π , p\*=1400.

1. Perform the following computations (1/3+3/11)-3/20
2. exactly,
3. using three-digit chopping arithmetic,
4. using three-digit rounding arithmetic
5. compute the relative errors:
6. Find 
7. Use three-digit rounding arithmetic to evaluate
8. f (0.1) where

b. Replace each exponential function with its third Maclaurin polynomial, and repeat part (a).

c. The actual value is *f (*0.1*)* = 2.003335000. Find the relative errors

1. Find the rates of convergence of 
2. How many multiplications and additions are required to determine a sum of the

form $\sum\_{i=1}^{n}\sum\_{j=1}^{i}a\_{i}b\_{j}$

1. Use a fixed point iteration method to solve  accurate within 1/100 on [1, 2]. Estimate the number of the iterations required.
2. Use 4steps of a bisection method to solve  on [2, 4], and find the absolute error. The root is x= 2.690647.
3. Use 4steps of a fixed-point method to solve  on [2,4] and find the absolute error.
4. Use 4steps of Newton method to solve  on [2, 4] and find the absolute error.
5. Use 4steps of the Secant method to solve  on [2, 4], and find the absolute error.

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Pretest 2

1. Show that  converges linearly to 0. How large must be n before



1. Show that  converges quadratically to 0
2. Construct a sequence that converges to 0 of order 3.
3. Given the system x-y+az=-2, -x+2y-az=3 ax+y+z=2 Find values of a for which the system has no solution, infinitely many solutions. Find the solution assuming that the unique solution exists.
4. Use the Gauss elimination to solve x/4+y/5+z/6=9, x/3+y/4+z/5=8, x/2+y+2z=8
5. Find the inverse of



1. Find the row interchanges that are required to solve

5x+y-6z=7, 2x+y-z=8, 6x+12y+z=9 by scale partial pivoting

1. Find A=PtLU factorization for



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Final study guide

1. Find the and  norms of the matrix



1. Find the spectral radius of the matrix



1. Find the first two iterations of the Jacobi method using x0=0 for the system

  

1. Compute the condition number of the matrix



1. Construct the least squares polynomial of degree 1 for the data

|  |  |  |  |
| --- | --- | --- | --- |
| 4 | 6 | 8 | 10 |
| 12 | 8 | 6 | 4 |

1. Show that G has a unique fixed point in [-1,1] x [-1,1] x [-1,1]



1. Apply fixed point method to approximate the solution of Example 6 within 10-5 in the norm
2. Use 3 steps of Newton’s method to solve on [0, 2] x [-2,0] x[0,2] ,,
3. Use the method of Steepest Descent with TOL =0.05 to solve , 
4. Find A=PtLU factorization for



1. Use 4steps of a bisection method to solve  on [2,4], and find the absolute error. The root is x= 2.690647.
2. Find the row interchanges that are required to solve

5x+y-6z=7, 2x+y-z=8, 6x+12y+z=9 by scale partial pivoting