MATH 441

Introduction to Numerical Analysis

Fall Semester 2014

MW 1:00PM - 2:15PM in Janet & Walter Sondheim 205

Instructor: **Bedřich Sousedík**
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Course web: http://userpages.umbc.edu/~sousedik/classes/441f14/
(All course material will be posted on my webpage, and grades will be on the Blackboard.)

Office Hours: MW: 2:30-3:30 in my office. I know that it might be inconvenient time for some of you, so don't be afraid to ask for an appointment other time. In particular I am quite good in answering e-mails (even late night).

Prerequisites: You must complete CMSC201 and Math225 and Math251 and Math301 with a grade of C or better before you can enroll in this class.

Topics to be covered: We will learn about methods and analysis of techniques used to resolve continuous mathematical problems on the computer. Topics of this course include: numerical linear algebra, interpolation, numerical differentiation and integration, solution of nonlinear equations, acceleration of convergence and numerical treatment of differential equations.

Textbooks:
Copies of the following books are on reserve in the library. These books are highly recommended as reference, but are not required. The intention is to cover the material of the course sufficiently well by the lectures, possibly complemented by specific reading assignments, for which you can use the reserve copies in the library.
Recommended textbooks:

1. Kendall E. Atkinson, An Introduction to Numerical Analysis, second edition, Wiley, 1989
   associated webpage: http://www.math.uiowa.edu/~atkinson/keabooks.html
2. Timothy Sauer, Numerical Analysis, second edition, Pearson 2011

Recommended book on Matlab:

1. Desmond J. Higham and Nicholas J. Higham, Matlab Guide, second edition, SIAM, 2005
   associated webpage: http://www.ma.man.ac.uk/~higham/mg

General overview:
Problems encountered in mathematics courses such as Calculus generally can be solved by paper and pencil, and yield nice, "closed form" answers in the form of numerical values, functions or formulas. In real world applications, however, problems are seldom so well behaved. For instance, integrals may be difficult or impossible to compute exactly, differential equations may have solutions that can only be expressed as infinite series, and systems of nonlinear equations may not have any solutions that can be found by hand. Consequently, a large proportion of problems that mathematicians, engineers, scientists and other professionals "solve" are only done numerically, using computer power. Math 441 introduces you to various types of such computational methods that can be used to tackle an array of mathematical problems (several of which you will have encountered before in other courses). It therefore provides an introduction to the field of "scientific computing."
A common characteristic of the methods mentioned above is that they are based on approximations of some sort: a numerical value may be replaced by a decimal expansion close to it, a function by a polynomial expansion, a problem by a "nearby" problem that is easier to solve. One of the key issues that we will learn in this course is how to analyze and control the resulting error in our computed answers. Our primary emphasis will be to gain an understanding of these methods through theoretical analysis.

We will also perform computer experiments in our quest to gain familiarity with these methods. Theoretical results are often "asymptotic" in nature - our goal will be to see whether these results are observed in practice. It is only through performing experiments that one can develop a "computational sixth sense" to decide when computer solutions are to be trusted and when not.

I recommend the professional software package Matlab. However you may wish to look into downloading the free software package Octave which is for the most part Matlab-compatible. To read about Matlab, you can read its expansive documentation or you may consider the book recommended above. For hands-on training in Matlab, you can consider the software workshops offered by CIRC, see http://www.umbc.edu/circ/workshops/fall14.html.

The main goals of the course are:

1. Learning computational methods that will solve problems (integration, differential equations, non-linear equations, etc.) approximately.
2. Understanding, analyzing and assessing the errors in approximate solutions obtained through these methods.
3. Gaining experience in performing numerical computations.
4. Writing and using your own computational programs.

How you will be evaluated:

Exams: There will be two in-class one hour exams, worth 50 points each, and a comprehensive 2 hour final exam, counting 100 points. The tentative dates of the tests and final exam are:

Test #1 – Monday October 6 (tentative)
Test #2 – Monday November 10 (tentative)
Final Exam – Wednesday December 17

Homework Assignments: There will be approximately 12 homework assignments. Homework for sections completed in any given week (M-W) will be due the next Wednesday (unless otherwise noted). Homework assignment will be graded and will be worth 15 points each. Your best 10 homework assignments will count for a total of 150 points. Please follow these guidelines in turning in homework assignments:

1. Please use only one side of paper when doing assignments.
2. All assignments should be done in pencil.
3. Show all work neatly since messy papers may not be graded.
4. Include graphs where appropriate. The graphs can either be a sketch or a computer printout with important information (axes, scale, intercepts, and important points) identified.
5. Staple your papers together.
6. Make sure that you do the assigned problems since no credit will be given for work on an incorrect problem.

Matlab Projects: There will be a project, which will be assigned later in the semester (before the end of October). You will choose two computer problems which I will offer, write a Matlab code solving the problems, write up a report (a single pdf file) and send it to me by e-mail along with the (well-documented) Matlab code (m-files), so that I could run it and reproduce the results on my computer. **The deadline is 11/30**, and no later work will be accepted. You may work in pairs, but each one of you must understand it and be prepared to eventually answer my questions. Please, in your report indicate the person you worked with (if any). **Copying someone's code or report will NOT be tolerated**.

Points Summary: You will be accumulating a possible 500 points during the semester.

Tests:	100 points (2 x 50)
Final Exam:	100 points
Matlab Project:	50 points
Homework Assignments:	150 points (best 10 assignments)
Total:	400 points

Grading Scale: Your final grade will be determined by the percentage of your points:

A 90.0 – 100%
B 80.0 – 89.9%
C 65.0 – 79.9%
D 50.0 – 64.9%
F below 50.0%

Late Work and Exam Makeup Policy:

Makeup Tests: I expect you to take all of the in class tests. If some emergency arises that causes you to miss a test, I will deal with it in such a way that you are not penalized. We will discuss the details if this happens. If at all possible, you must make arrangements with me beforehand, and I will ask for details regarding the emergency. If you miss a test without making prior arrangements, you will in all likelihood receive a zero. No makeup will be offered after the test has been passed back to the class.

Final Exam: Attendance at the final exam is mandatory. Having the final rescheduled is extremely rare and is not permitted for reasons such as a plane ticket that was purchased earlier or attendance at weddings. In all cases where a makeup is requested, you MUST MAKE ARRANGEMENTS BEFOREHAND if at all possible.

Late Homework Assignments: Unless you make prior arrangements, expect a 50% reduction in grade for any item turned in late. No assignments will be accepted more than a week later after the original due date.

Attendance: Regular attendance and participation are important to your success in any college course but particularly in mathematics.

I encourage students to work together on homework. However, it is expected that you turn in your own work expressed in your own words. Never copy someone else's work and do not allow someone else to copy your work. If there are duplications of portions of homework then both parties will receive a zero on the assignment.

UMBC Academic Integrity Policy: By enrolling in this course, each student assumes the responsibilities of an active participant in UMBC's scholarly community in which everyone's academic work and behavior are held to the highest standards of honesty. Cheating, fabrication, plagiarism, and helping others to commit these acts are all forms of academic dishonesty, and they are wrong. Academic misconduct could result in disciplinary action that may include, but is not limited to, suspension or dismissal. To read the full Student Academic Conduct Policy, consult the UMBC Student Handbook, the Faculty Handbook, the UMBC Integrity webpage http://www.umbc.edu/integrity, the UMBC Undergraduate Student Academic Conduct Policy for undergraduate students, or the University of Maryland Graduate School, Baltimore (UMGSB) Policy and Procedures for Student Academic Misconduct for graduate students.

UMBC Undergraduate Student Academic Conduct Policy:
http://www.umbc.edu/undergrad_ed/ai/documents/ACC2011.pdf

University of Maryland Graduate School, Baltimore (UMGSB) Policy and Procedures for Student Academic Misconduct: http://www.umbc.edu/gradschool/docs/01append4.pdf

Tentative outline of the semester:

The section numbers refer to Atkinson's book, however as mentioned previously, we will not use this book in lectures.

		Tentative Schedule	
WEEK	**DATES**	**SECTIONS**	**REMARKS**
1	8/27	Overview, Chapter 1	
2	9/1 9/3	Labor Day (no class) Chapter 1	
3	9/8 9/10	2.1 – 2.3 2.5	HW 1 due
4	9/15 9/17	2.10 – 2.11 2.5	
5	9/22 9/24	3.1 – 3.2 3.5	
6	9/29 10/1	3.6 – 3.8 5.1	
7	10/6 10/8	**Test #1** (Chapters 2 – 3.5) 5.2	
8	10/13 10/15	5.3 5.7 (idea, methods)	
9	10/20 10/22	5.7 (errors) 6.1	
10	10/27 10/29	6.2 – 6.3 6.4 – 6.5	
11	11/3 11/5	6.9 6.10	
12	11/10 11/12	**Test #2** (Chapters 5 – 6) 8.1	
13	11/17 11/19	8.2 4.1	
14	11/24 11/26	4.3 4.4	Computer projects due 11/30.

15	12/1 12/3	4.5 Review	
16	12/8 12/10	Review Study day (no class)	
17	12/15 12/17	no class **Final Exam**	1:00-3:00pm in our usual classroom

(We will cover some application if time allows)

***Note: The instructor reserves the right to adjust this tentative syllabus as needed throughout the semester.**