

**Mathematics 465/565**  
Numerical Analysis I  
Fall 2009 (MWF 8:40-9:30, MG 124)

**Instructor:** Grady Wright

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**Office Hours:** MWTh 9:35am-10:35am, or by appointment

**Text:** B. Bradie, *A Friendly Introduction to Numerical Analysis*, 1<sup>st</sup> edition, Pearson Prentice Hall, 2006

**Website:** <http://math.boisestate.edu/~wright/courses/m565>

**Course description:** This is the first half of a year long introductory course on numerical analysis. The topics covered this semester include numerical methods for linear and nonlinear equations, interpolation, discrete Fourier analysis, approximation theory, numerical integration and differentiation. In the second semester (MATH 565), we cover more advanced numerical linear algebra topics (e.g. eigenvalues/eigenvectors, over/underdetermined linear systems, singular value decomposition), numerical methods for solving ordinary differential equations (ODEs) (both initial-value and boundary-value problems) and partial differential equations (PDEs).

**Prerequisites:** No previous experience in numerical analysis is necessary. However, knowledge of the following topics is required:

- Single and multivariable calculus (MATH 275)
- Linear algebra (MATH 301 or MATH 333)
- Computer programming (using, for example, C/C++, Java, Fortran, or MATLAB)

**Homework:** Homework is posted on the class website every other Friday. The problems involve a mix of theory and computing. Regarding the latter, please read the text below the **Programming** heading. Students register for MATH 565 (the graduate course) will be assigned more detailed problems and will be held to a higher standard than those in MATH 465.

Your submitted homework should show all necessary work you used to solve the problems; mathematical statements should be complete (or nearly complete) sentences; and the reasoning and logic underlying all arguments should be clearly spelled out. Computer programs should be included along with numerical results presented in a readable format (e.g., in a table with headings or in a plot with labels). Please see the document “How to Present your Work” on the course web page for tips on meeting these requirements. **Failure to adhere to the above requirements may result in a loss of points.**

Homework assignments are due at the end of class every other Friday. Late homework assignments are accepted up to three days beyond their due date. However, a 10% penalty is applied for each twenty four hour period they are late. This means that if an assignment is turned in after 9:30am on Friday, but before 9:30am on Saturday, then 10% is automatically deducted. Late homework assignments need to be brought to my office or, if you have the means, e-mailed to me. **Please indicate the date and time you put the homework in my box or I will assume it was turned in moments before I retrieved it from my box.**

**Teamwork:** Teamwork is part of the real world and therefore permitted (and encouraged) for all homework assignments (but not the exams). **Keep in mind that the purpose of teamwork is to enhance the learning effect, not to decrease the workload.** It is up to each team member to prevent abuse. Please observe the following rules:

- **No teams with more than two members!**
- Both members of the team must be registered for the same course number.
- If you work in a team then clearly state so and hand in just one set of answers. If you collaborate on some problems but not on others then **clearly state so** on your turned-in solution.
- In general, you can consult literature and people, but **you have to acknowledge all help so obtained** (except for the textbook or myself).

Homework solutions (taken from selected students' solutions) are posted on the course website once the grading has concluded.

**Grading Policy:** The final grade for the course is based on homework assignments, a midterm exam, and a final exam. The breakdown for the course grade is as follows:

- Homework and midterm: 70%
- Final (Wednesday, Dec. 16, 2009 8:00-10:00am): 30%

The midterm counts as two homework assignments. The lowest homework score is discarded (half of the midterm can be discarded).

**Programming:** I highly recommend that you use MATLAB for all programming assignments involving numerical computations. An important part of numerical analysis today is the use of commercial or public domain software packages for solving particular problems. In order to gain exposure to this side of numerical analysis, students need to practice using such packages. MATLAB offers the perfect opportunity for such practice; it is one of the most dominant commercial computing environments. The MATLAB language is intended to be easy to learn and use, while still being extremely powerful. Three other reasons for using MATLAB for the programming assignments is that: 1) The webpage for the book contains a MATLAB implementation of several algorithms discussed; 2) My examples and homework assignments will use MATLAB code; 3) I will help you debug your programs.

There is a freeware “clone” of MATLAB called Octave (<http://www.octave.org>) that is also suitable for doing your programming assignments. However, note that Octave does not contain all the wonderful functionality of MATLAB.

If you have not used MATLAB previously, help resources are available on the course website and from the instructor. MATLAB is available in the Undergraduate mathematics computing lab (as well as various other locations on campus). You can also purchase a student version of MATLAB for a heavily discounted price from the book store.

Problems involving symbolic computations can be done using *Maple* or *Mathematica*. The former is available in the Undergraduate student mathematics computing lab.

### **Important Dates:**

- **Sept. 4** – Last day to register; add classes; change from credit to audit or audit to credit; and last day to drop classes without a W and receive a refund (less \$25 processing fee) for Regular session classes.
- **Sept. 7** – Labor Day – **No Class**

- **Oct. 2** - Last day to drop classes with a W or completely withdrawl.
- **Nov. 23-29** – Thanksgiving break – **No Class**
- **Dec. 11** – Classes end
- **Dec. 16** – Final exam, 8:00-10:00am

**Material to Cover:** We will cover the following material (in roughly this order):

1. Introductory material (Ch. 1)
2. Linear equations (Ch. 3.0 – 3.9)
3. Nonlinear equations (Ch. 2.1 – 2.7, 3.10)
4. Interpolation and approximation (Ch. 5 and my notes)
5. Numerical differentiation and integration (Ch. 6)
6. Discrete Fourier analysis (my notes)

**References:**

- Atkinson, An Introduction to Numerical Analysis (John Wiley and Sons)
- Dahlquist and Björck, Numerical Methods (Dover reprint 2003)
- Henrici, Essentials of Numerical Analysis (John Wiley and Sons)
- Fröberg, Introduction to Numerical Analysis (Addison-Wesley)
- Trefethen and Bau, Numerical linear algebra (SIAM)
- Golub and Van Loan, Matrix Computations (Johns Hopkins University Press)
- Demmel, Applied Numerical Linear Algebra (SIAM)
- Fornberg, A Practical Guide to Pseudospectral methods (Cambridge University Press)

*The purpose of computing is insight, not numbers! –Richard Hamming*

*It would appear that we have reached the limits of what it is possible to achieve with computer technology, although one should be careful with such statements, as they tend to sound pretty silly in 5 years. – John Von Neumann (1949)*

*The badly named real number system is one of the triumphs of the human mind. It underlies the calculus and higher analysis to such a degree that we may forget how impossible it is to deal with real numbers in the real world of finite computers. But, however much the real number system simplifies analysis, practical computing must do without it. – George Forsythe*

*Without precise calculations we could fly right through a star or bounce too close to a supernova and that'd end your trip real quick, wouldn't it? –Hans Solo*