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**AME 60614–Numerical Methods**
**Fall 2022**

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Office hours: when available               when available

Course web site: `https://www3.nd.edu/∼powers/ame.60614`

Course time and location: T-Th 12:30 PM-1:45 PM, 356A Fitzpatrick

Prerequisites: formally none, knowledge of undergraduate calculus through differential equations

Catalog description: "Interpolation, differentiation, integration, initial and boundary value problems for ordinary differential equations, solution methods for parabolic, hyperbolic and elliptic partial differential equations; applications to classical and current research problems in engineering and science. (Every fall)"

Comments: The course will consist of a survey of elements of numerical analysis. Topics will be as listed in the catalog with some additional material interspersed. A primary source will be the textbook from which the course notes draw heavily. The texts will serve as complements to the lecture notes, which are self-contained. I recommend, but do not require, that you purchase at least one of the texts available in the bookstore.

Required text

J. H. Ferziger, 1998, *Numerical Methods for Engineering Application*, Second Edition, John Wiley.

Recommended texts

A. Iserles, 2009, *A First Course in the Numerical Analysis of Differential Equations*, Second Edition, Cambridge.

W. H. Press, S. A. Teukolsky, W. T. Vetterling, and B. P. Flannery, 2007, *Numerical Recipes: The Art of Scientific Computing*, Cambridge. (also available in an online version, some software installation required, `http://www.nrbook.com`)

J. Stoer and R. Bulirsch, 2002, *Introduction to Numerical Analysis*, Springer.

R. D. Richtmyer and K. W. Morton, 1967, *Difference Methods for Initial-Value Problems*, Second Edition, Krieger.

Computing Hardware and Software

The course will require a significant use of a computing machine. For some large scale problems, use of a compiled language, such as `Fortran`, `C`, or `C++` will be required, as the problems are otherwise complete impractical to solve. Unless specifically stated otherwise, you may use any computing hardware and software you choose to solve the problems in this course; I will be able to best help those who use the campus linux system hardware along with the `Fortran` language, and `MATLAB` and `Mathematica` software. Many useful libraries are available on the campus linux system. Symbolic manipulation software such as `Mathematica` can

be useful, and its use is encouraged when appropriate; however, often these packages do not perform well on large scale numerical analysis. In such cases, use of a language such as `Fortran`, `C`, or `C++` is advantageous.

Required Work and Grading

Exams will be closed book, closed notes and held in class. The final exam will be comprehensive.

Three one page reports will be required. Use of the LaTeX text formatter is required for these. The first is trivial, and introduces students to LaTeX. The second two require reviews of the archival numerical literature.

Four detailed homework sets will be required. All work is to be submitted on `CANVAS` in `.pdf` form. The teaching assistant will have primary responsibility for each of the homework sets. All homework will be graded. Homework must be done on *one side only* of 8 1/2" by 11" *engineering* paper with no frayed edges. You should briefly restate the problem, state what method you used, describe if you used your own code or used a software tool, give a sketch if helpful, and give all necessary analysis, and place a box around any final answers. State any conclusions reached, limitations of your results, and give general comments when appropriate. Include copies of any original codes you wrote in appendices; such an appendix can be turned in on ordinary paper. Unless absolutely necessary, never give raw numerical output data. Neatness and effective communication are considered in grading as well as the final answer itself.

Plots are of particular importance in this course. A portion of your grade will depend on how efficiently and effectively graphical results are presented. Some rules follow. All plots must be computer generated. All plots must have axes labeled with units when appropriate. Large plots taking up a single page are not acceptable. Whenever possible, combine several curves onto one set of axes, especially when making direct comparisons of results. Use different line styles where appropriate. Reference to all plots must be made in the body of your homework

Grades will be assigned based on students' performance on examinations and homework. Pertinent information is as follows:

| | | |
|---|---|---|
| Report 1 | 1 | Thursday, 25 August 2022 |
| Homework 1 | 10 | Thursday, 15 September 2022 |
| Homework 2 | 10 | Thursday, 6 October 2022 |
| Report 2 | 2 | Thursday, 6 October 2022 |
| Midterm Exam | 20 | Thursday, 13 October 2022 |
| Homework 3 | 10 | Thursday, 10 November 2022 |
| Report 3 | 2 | Thursday, 10 November 2022 |
| Homework 4 | 10 | Thursday, 8 December 2022 |
| Final Exam | 35 | Friday, 16 December 2022, 10:30 AM-12:30 PM |
| **Total** | **100** | |

Honesty Policy

Academic honesty is expected. When confronted with an apparent violation, I will enforce the appropriate University regulations to the best of my ability. I will also try to make my expectations clear. By and large, though, these issues are out of my control and as such I do not seek out violations. Instead, I depend upon your basic integrity to prevent any problems.

In brief my expectations are as follows. I encourage you to freely discuss the homework amongst one another as you formulate your solutions *individually*. *Your* written work should represent *your* understanding of the problem. In practice this means copying (in whole or in part) another student's homework, exam, computer program, or paper is *not* permitted. If you choose to discuss your work with a colleague, it should be a discussion in which one teaches another or both work to a mutual understanding. As a counter-example,

it is not acceptable to give a friend your homework five minutes before class so that friend can copy your work. I also consider it unacceptable to copy work from a student who was in the class in a previous year. In your written reports, be careful to correctly use quotation marks for words that did not originate with you. Paraphrasing should be held to a minimum, but if used, the paraphrased section should be specifically identified and unambiguously cited. It is not sufficient to simply list a reference but not indicate where a specific quotation or paraphrase was employed. In addition all sources used should be fully cited. As is done in the scientific literature, you should *briefly* acknowledge in writing any significant discussions or interactions you had regarding the work you submit. As a general principle, I do not accept the justification that you were not sure of my intentions. If you feel you may be in an ethical grey area, then you should consult with me *before* acting.