Course Syllabus

Vv 570: Introduction to Engineering Numerical Analysis

Course Description

The course gives an introduction to the wide range of basic and advanced numerical approaches that might be used to solve engineering problems related to differential equations. The explanation of relevance, limitations and possible modifications of numerical methods is the primary focus of the course. Some convergence theorems and error estimates are discussed and proved. The course also provides practice in computer programming using MATLAB.

Instructor

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Office hour: Tuesday 14:00-16:00 or by appointment

Textbooks

1. Evans G., Blackledge J., Yardley P. Numerical methods for Partial Differential Equations. Springer-Verlag Berlin Heidelberg New York (any edition), ISBN 354076425X (2nd edition).
2. Chapra, Steven C., Raymond P. Canale. Numerical methods for engineers, 7th edition, 2015. McGraw-Hill Education, ISBN 978-0-07-339792-4.
3. Esfandiari, Ramin S. Numerical methods for engineers and scientists using MATLAB, 2nd edition, 2017. CRC Press, ISBN 978-1-4987-7742-1.
4. Sauer, Tim. Numerical analysis, 2nd ed, 2012. Pearson, ISBN-13: 978-0-321-78367-7.
5. Zhilin Li, Zhonghua Qiao, Tao Tang. Numerical solutions of differential equations. Introduction to finite difference and finite element methods, 2018, Cambridge University Press, ISBN 978-1-107-16322-5.

Course Prerequisites:

Grading Policy

Assignments/Projects	**20%**
Exams	**80%**: Midterm Exam I-**20%**, Midterm Exam II-**20%**, Final Exam -**40%**

Honor Code Policy

Honesty and trust are important. Students are responsible for familiarizing themselves with what is considered as a violation of honour code. Assignments/projects are to be solved by each student individually. Students are encouraged to discuss problems with other students, but students are advised not to show your written work to others. Copying someone else's work is a very serious violation of the honour code. _ Students may read resources on the Internet, such as articles on Wikipedia, Wolfram MathWorld or any other forums, but they are not allowed to post the original assignment question online and ask for answers. It is regarded as a violation of the honour code. Since it is impossible to list all conceivable instance of honour code violations, students have the responsibility to always act in a professional manner and to seek clarification from appropriate sources if their or another students conduct is suspected to be in conflict with the intended spirit of the honour code.

Teaching Schedule

Week	NO.	Date	Lectures and Exams	Comments
1	1	2018-09-10	Introduction. Taylor series and finite difference approximations.	
	2	2018-09-12	The first order Euler methods. Consistency, stability, convergence.	
2	3	2018-09-17	Single point methods. Error estimation and error control.	
	4	2018-09-19	Extrapolation and multipoint methods.	
3	5	2018-09-24	Systems of first-order ODEs. Stiff ODEs.	
	6	2018-09-26	The shooting (initial-value) method.	
4	7	2018-10-01	National holiday	
	8	2018-10-03	National holiday	
5	9	2018-10-08	The equilibrium (boundary-value) method.	
	10	2018-10-10	Higher-order methods and non-uniform grids.	
6	11	2018-10-15	**Midterm Exam I**	
	12	2018-10-17	Introduction to PDEs and classification of physical problems.	
7	13	2018-10-22	Approximation by finite differences, truncation error. The finite difference method for the Laplace (Poisson) equation.	
	14	2018-10-24	Consistency, stability, convergence.	

8	15	2018-10-29	Elliptic PDEs: iterative methods, derivative boundary conditions.	
	16	2018-10-31	Higher-order methods for elliptic PDEs.	
9	17	2018-11-05	Nonrectangular domains.	
	18	2018-11-07	Parabolic PDEs: finite difference methods, consistency, stability, convergence.	
10	19	2018-11-12	Parabolic PDEs: the Richardson and Dufort-Frankel methods. Implicit methods.	
	20	2018-11-14	Parabolic PDEs: nonlinear and multidimensional problems.	
11	21	2018-11-19	Hyperbolic PDEs: FTCS method and the Lax method	
	22	2018-11-21	**Midterm Exam II**	
12	23	2018-11-26	Introduction to finite element methods (FEMs): the Rayleigh-Ritz, collocation and Galerkin methods.	
	24	2018-11-28	FEM for boundary-value problems.	
13	25	2018-12-03	FEM for the Laplace equation.	
	26	2018-12-05	FEM for diffusion problems.	
14	27	2018-12-10	Review of advanced approaches in numerical solutions of differential equations.	
	28	2018-12-12	**Final Exam**	