



## Course Syllabus: Finite Element Methods - AMCS 329

<b>Division</b>	Computer, Electrical and Mathematical Sciences & Engineering
<b>Course Number</b>	AMCS 329
<b>Course Title</b>	Finite Element Methods
<b>Academic Semester</b>	Spring
<b>Academic Year</b>	2017/2018
<b>Semester Start Date</b>	01/28/2018
<b>Semester End Date</b>	05/24/2018
<b>Class Schedule</b> (Days & Time)	01:00 PM - 02:30 PM   Mon Wed

### Instructor(s)

Name	Email	Phone	Office Location	Office Hours
Gabriel Christoph Wittum	gabriel.wittum@kaust.edu.sa	+966128080387		on appointment

### Teaching Assistant(s)

Name	Email
Dmitry Logashenko, Susanne Hllbacher	Dmitry Logashenko

### Course Information

<b>Comprehensive Course Description</b>	The AMCS 329 course is on finite elements and related discretisation methods. After an introduction into modelling with partial differential equations, we motivate discretisations by introducing finite differences. Thereafter, we give an overview of functional analysis results related with the topic. Then we introduce finite element methods and discuss the main properties of finite elements. Finally, we introduce finite volume methods and discuss them.
<b>Course Description from Program Guide</b>	An introduction to the mathematical theory of finite element methods and their applications to the solution of initial and boundary-value problems. A major component of the course will focus on the development of FE applications using the commercial software COMSOL Multiphysics to illustrate the fundamental features of the method. Topics of interest will cover classical problems in engineering and science.
<b>Goals and Objectives</b>	Understand, analyse, apply and develop discretisation schemes for partial differential equations, in particular finite element and finite volume methods.
<b>Required Knowledge</b>	Basic analysis courses and functional analysis.
<b>Reference Texts</b>	Hackbusch, Wolfgang: Elliptic Differential Equations, Theory and Numerical Treatment. Springer, Heidelberg, 2017 Wittum, Gabriel: Modelliong and Simulaiton 1 Discretisations for partial differential equations. Frankfurt.
<b>Method of evaluation</b>	<b>25.00%</b> - Homework /Assignments <b>75.00%</b> - Final exam
<b>Nature of the assignments</b>	Exercises. Solutions have to be worked out at home and handed in before the exercises are discussed in the course excercise. Exercises also include programming exercises.
<b>Course Policies</b>	Will be announced in the course
<b>Additional Information</b>	The course consists of 2 lectures, and one exercise/practical session per week. In the practical session, we train solving problems usig the UG 4 software.

## Tentative Course Schedule

*(Time, topic/emphasis & resources)*

Week	Lectures	Topic
1	Mon 01/29/2018 Wed 01/31/2018	Introduction, Types of partial differential equations
2	Mon 02/05/2018 Wed 02/07/2018	Finite difference methods
3	Mon 02/12/2018 Wed 02/14/2018	Stencils M Matrices
4	Mon 02/19/2018 Wed 02/21/2018	The system matrix of the discrete Poisson equation Convergence and stability of finite difference methods
5	Mon 02/26/2018 Wed 02/28/2018	The von Neumann problem, Upwinding and general finite differences for PDE of second order.
6	Mon 03/05/2018 Wed 03/07/2018	Weakness of the finite difference approach Functional analysis: Norms, spaces
7	Mon 03/12/2018 Wed 03/14/2018	Weak differentiability Sobolev spaces
8	Mon 03/19/2018 Wed 03/21/2018	Variational formulation Properties of elliptic PDE of second order.
9	Mon 03/26/2018 Wed 03/28/2018	Existence and uniqueness of the variational equality. weak solution
10	Mon 04/02/2018 Wed 04/04/2018	Galerkin methods Finite element methods
11	Mon 04/09/2018 Wed 04/11/2018	Convergence of finite element methods
12	Mon 04/16/2018 Wed 04/18/2018	Convergence of finite element methods 2
13	Mon 04/23/2018 Wed 04/25/2018	Petrov-Galerkin methods
14	Mon 04/30/2018 Wed 05/02/2018	Finite volume methods
15	Mon 05/07/2018 Wed 05/09/2018	Isomorphism of finite elements and finite volumes
16	Mon 05/14/2018 Wed 05/16/2018	Convergence of finite volume methods
17	Mon 05/21/2018 Wed 05/23/2018	Examples
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### Note

The instructor reserves the right to make changes to this syllabus as necessary.