General Course Information

instructor: Professor Dennis M. Kochmann
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office hours: Thursdays, 3-4 pm, LEE N201

TAs:

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TA office hours: Tuesdays, 12-1 pm, LEE N203

class website: mm.ethz.ch/teaching.html

class: Tuesdays, 10:15 – 11:45 pm, LEE C104
Thursdays, 1:15 – 2:45 pm, LEE C104

exercise: Exercises will be integrated into the lectures (on average one hour per week).

programming tutorials: During the first weeks of classes, exercises will consist of tutorials as an introduction to programming in C++, which will be helpful for the coding tasks of all projects (topics include data types, classes, templates, references & pointers, etc.)
You are encouraged to bring your laptops to the exercises to follow along.

textbook: There is no required textbook, the following books are useful references:

Continuum Mechanics:
· Tadmor, E.B., Miller, R.E., Elliot, R.E., Continuum Mechanics and Thermodynamics.
Finite Element Analysis:
· Cook, R. D., et al., Concepts and applications of finite element analysis.
· Reddy, J. N., An introduction to the finite element method.
· FEA course notes by Prof. Papadopoulos (Berkeley) are available online.

notes: Lecture notes will be posted online. However, it is recommended to take your own notes.

projects: Six two-week computational projects are spread across the semester (see syllabus).
Details will be discussed in class. Projects are posted online Thursdays after class.
Completed projects should be turned in in LEE N203 in due time.

collaboration policy: You are encouraged to discuss project problems and solution strategies with each other, while ultimately coding and solving the problems must be done by everyone on their own.
Projects with several names on them and late submissions will not be accepted.
Codes will be checked carefully for duplications.

grading: The final grade is based on the individual project grades. The five best (out of six) projects count, each making up 20% of the final grade. There will be no exams.

Tentative Syllabus

date	L/E*	**topics**	**sections**†
19.09.17	L	introduction, notation, vectors and tensors	1
21.09.17	L	continuum mechanics overview (cont.'d)	1
26.09.17	E	account setup, software introduction, etc.	see guide
28.09.17	L	continuum mechanics overview (cont.'d)	1
		28.09.17: **project 1** posted	
03.10.17	E	coding in C++: functions, classes, pointers	see guide
05.10.17	L	computational mechanics, direct methods	2
10.10.17	L	variational calculus	3
12.10.17	E	coding in C++: classes, templates, matrices	
		12.10.17: **project 1** due, **project 2** posted	
17.10.17	L	variational calculus, indirect methods	3-4
19.10.17	L	strong and weak forms, mechanical and thermal problems	4-5
24.10.17	L	interpolation spaces, finite element method	6-7
26.10.17	L	polynomial interpolation	8
		26.10.17: **project 2** due, **project 3** posted	
31.10.17	L	simplicial elements	9
02.11.17	E	finite element review, element implementation 7-10	
07.11.17	L	numerical quadrature	11
09.11.17	L	finite element implementation, assembly operations	12-13
		09.11.17: **project 3** due, **project 4** posted	
14.11.17	L	solvers, boundary conditions	14-15
16.11.17	L/E	solvers (cont.'d)	15
21.11.17	L	element types and deficiencies	16
23.11.17	L/E	error analysis, convergence, adaptivity	16
		23.11.17: **project 4** due, **project 5** posted	
28.11.17	L	dynamics: mass matrices, variational formulation	17
30.11.17	E	static solvers, boundary conditions	
05.12.17	L	explicit and implicit dynamics	17
07.12.17	L	explicit and implicit dynamics	17
		07.12.17: **project 5** due, **project 6** posted	
12.12.17	L	vibrations, modal decomposition	17
14.12.17	E	dynamic solvers and initial boundary value problems	
19.12.17	L	inelasticity	17
21.12.17	L	review and summary, multiscale modeling	18
		10.01.18: **project 6** due	

* L = lecture, E = exercise
† Sections refer to the lecture notes.

Course Contents:

Function spaces, linear spaces. Variational principles. Finite element analysis. Variational problems in linear and finite kinematics. Time integration, initial boundary value problems. Elasticity and inelasticity. Constitutive modeling. Error estimation. Accuracy, stability and convergence. Iterative solution methods. Adaptive strategies.

Projects:

1. Tensors, indicial notation; mesh generation (as an intro to C++ and Paraview).
2. Linear and hyperelastic material models, derivative test.
3. Nonlinear bar element implementation.
4. Simplicial elements.
5. Assembler, solver, boundary value problems.
6. Dynamics, initial boundary value problems.