SUBJECT: Computational techniques for differential equations			
MASTER: Computational and Applied Mathematics	ECTS: 6	COURSE: 1	TERM: 1

WEEKLY PLANNING					
WEEK	SESSION	SESSION CONTENT	STUDENT WORK DURING WEEK		
			DESCRIPTION	LECTURE HOURS	STUDENT WORK (Max. 7h per week)
1	1	**1. FINITE DIFFERENCE METHOD** 1.1 Introduction to Finite Difference Approximations *Deriving finite difference approximations; Truncation errors;* 1.2 Finite Difference Methods for Steady States and Boundary Value Problems *Finite differences for BVP; Local truncation error; Global error;*	Sections 1 & 2 [LeVeque]	1.66	
1	2	(*) Discussion of select exercises	(**) Problem solving for selected exercises	1.66	6.5
2	3	1.2 Finite Difference Methods for Steady States and Boundary Value Problems *Stability; Consistency; Convergence; L2 Stability; Boundary conditions; Existence and uniqueness*	Section 2 [LeVeque]	1.66	
2	4	(*) Discussion of select exercises	(**) Problem solving for selected exercises	1.66	6.5
3	5	1.3 Finite Difference Methods for Linear Elliptic Equations *The 5-point stencil for the Laplacian; Ordering the unknowns and equations; Accuracy and stability; The 9-point Laplacian; Solving the linear system*	Section 3 [LeVeque]	1.66	
3	6	**Practice Assignment: Lab 1** (*) Discussion of select exercises	(**) Problem solving for selected exercises	1.66	6.5
4	7	1.4 Finite Difference Methods for Diffusion Equations and Parabolic Problems *Local truncation errors and order of accuracy; Method of lines discretizations; Stability theory; Stiffness of the heat equation; Convergence; Von Neumann analysis; Multidimensional problems; The locally one-dimensional method; Other discretizations*	Section 9 [LeVeque]	1.66	
4	8	(*) Discussion of select exercises	(**) Problem solving for selected exercises	1.66	6.5

5	9	1.5 Finite difference methods for linear advection equation *Advection; Method of lines discretization; The Lax-Wendroff method; Upwind methods; Von Neumann analysis; Characteristic tracing and interpolation; The Courant–Friedrichs–Lewy condition*	Section 10 [LeVeque]	1.66	
5	10	**Practice Assignment: Lab 2** (*) Discussion of select exercises	(**) Problem solving for selected exercises	1.66	6.5
6	11	**2. THE FINITE ELEMENT METHOD IN 1D** *Piecewise Polynomial Spaces: Interpolation; L2-Projection; Computer Implementation* *Two-point Boundary Value Problem: Variational Formulation; Finite Element Approximation; Derivation of a Linear System of Equations; Basic Algorithm to Compute the Finite Element Solutio; A Priori Error Estimate.*	Sections 1 & 2 [Larson&Bengzon]	1.66	
6	12	(*) Discussion of select exercises	(**) Problem solving for selected exercises	1.66	6.5
7	13	*Examples: Stationary Heat Equation; Deformation of a Bar; Variable Coefficients* *Computer Implementation: Assembly of the Stiffness Matrix and Load Vector; A Finite Element Solver for a General Two-Point Boundary Value Problem* *Adaptive Finite Element Methods: A Posteriori Error Estimate; Adaptive Mesh Refinement*	Section 2 [Larson&Bengzon]	1.66	
7	14	**Practice Assignment: Lab 3** (*) Discussion of select exercises	(**) Problem solving for selected exercises	1.66	6.5
8	*15*	**3. THE FINITE ELEMENT METHOD IN 2D** *Piecewise Polynomial Approximation in 2D: Meshes; Piecewise Polynomial Spaces; Interpolation; L2-Projection; Quadrature and Numerical Integration; Computer Implementation*	Section 3 [Larson&Bengzon]	1.66	
8	16	(*) Discussion of select exercises	(**) Problem solving for selected exercises	1.66	6.5
9	17	*Green's Formula; The Finite Element Method for Poisson's Equation: Poisson's Equation Variational Formulation; Finite Element Approximation; Derivation of a Linear System of Equations; Basic Algorithm to Compute the Finite Element Solution*	Section 4 [Larson&Bengzon]	1.66	
9	18	(*) Discussion of select exercises	(**) Problem solving for selected exercises	1.66	6.5
10	19	*Basic Analysis of the Finite Element Method: Existence and Uniqueness of the Finite Element Solution; A Priori Error Estimates; Properties of the Stiffness Matrix*	Section 4 [Larson&Bengzon]	1.66	

		Examples: *A Model Problem with Variable Coefficients; Dirichlet Problem; Neumann Problem; Eigenvalue Problem* *Computer Implementation*: *Assembly of the Stiffness Matrix; Assembling the Boundary Conditions* *Adaptive Finite Element Methods*: *A Posteriori Error Estimate; Adaptive Mesh Refinement*			
10	20	**Practice Assignment: Lab 4** (*) Discussion of select exercises	(**) Problem solving for selected exercises	1.66	6.5
11	21	**4. SPECTRAL METHODS FOR PERIODIC PROBLEMS** 4.1 Differentiation Matrices 4.2 Unbounded Grids: The Semi-Discrete Fourier Transform	Sections 1 & 2 [Trefethen]	1.66	
11	22	(*) Discussion of select exercises	(**) Problem solving for selected exercises	1.66	6.5
12	23	4.3 Periodic Grids: The DFT and FFT 4.4 Smoothness and Spectral Accuracy	Sections 3 & 4 [Trefethen]	1.66	
12	24	(*) Discussion of select exercises	(**) Problem solving for selected exercises	1.66	6.5
13	25	**5. SPECTRAL METHODS FOR NON PERIODIC PROBLEMS** 5.1 Polynomial Interpolation and Clustered Grids 5.2 Chebyshev Differentiation Matrices	Sections 5 & 6 [Trefethen]	1.66	
13	26	(*) Discussion of select exercises	(**) Problem solving for selected exercises	1.66	6.5
14	27	5.3 Boundary Value Problems 5.4 Time-dependent problems and stability regions	Sections 7 & 10 [Trefethen]	1.66	
14	28	**Practice Assignment: Lab 5** (*) Discussion of select exercises	(**) Problem solving for selected exercises	1.66	6.5
SUBTOTAL				46.48+91=137.48	

15-17	27	Extra sessions, tutorials, etc Preparation for final exam			12.52
TOTAL				150	

(*) Discussion from selected exercises from the course collection that correspond to the previous lecture.
(**) Problem solving for selected exercises from the course collection that correspond to the previous lecture.