Universidad Carlos III de Madrid

SUBJECT: Numerical Methods in PDEs			
MASTER DEGREE IN MATHEMATICAL ENGINEERING	ECTS: 6	YEAR: 1	QUARTER: 1

WEEK	SESSION	DESCRIPTION OF EACH SESSION	DESCRIPTION	CLASS HOURS
1	1	Finite difference approximations, Scalar model equations, Finite difference formulas. Spatial difference operators and the method of lines.		1.5
1	2	Discussion and Problem Solving		1.5
2	3	The semidiscrete Fourier transform, Interpolation and sinc functions.The discrete Fourier transform.		1.5
2	4	Discussion and Problem Solving		1.5
3	5	Fourier analysis of finite difference formulas. Fourier analysis of vector and multistep formulas.		1.5
3	6	Discussion and Problem Solving		1.5
4	7	Finite differences for hyperbolic equations. A scalar transport problem .An a priori estimate. Systems of linear hyperbolic equations. The wave equation. The finite difference method, Discretization of the scalar equation. Discretization of linear hyperbolic system, Boundary treatment,		1.5
4	8	Discussion and Problem Solving		1.5
5	9	Finite differences for hyperbolic equations. Analysis of the finite difference methods, Consistency and convergence. Stability. Von Neumann analysis and amplification coefficients. Dissipation and dispersion.		1.5
5	10	Discussion and Problem Solving		1.5
6	11	The Galerkin finite element method for elliptic problems. Approximation via the Galerkin method. Analysis of the Galerkin method. Existence and uniqueness. Stability. Convergence.		1.5

6	12	Discussion and Problem Solving		1.5
7	13	The finite element method in the one-dimensional case. The approximation with linear finite elements. Interpolation operator and interpolation error. Estimate of the finite element error in the H1. Finite elements, simplices and barycentric coordinates. An abstract definition of finite element in the Lagrangian Case.		1.5
7	14	Discussion and Problem Solving		1.5
8	15	The finite element method in the multi-dimensional case. Finite element solution of the Poisson problem. Conditioning of the stiffness matrix.		1.5
8	16	Discussion and Problem Solving		1.5
9	17	Estimate of the approximation error in the energy norm. Estimate of the approximation error in the L2 norm.		1.5
9	18	Discussion and Problem Solving		1.5
10	19	Parabolic equations Weak formulation and its approximation A priori estimates. Convergence analysis of the semi-discrete problem. Stability analysis of the -method. Convergence analysis of the -method.		1.5
10	20	Discussion and Problem Solving		1.5
11	21	The spectral Galerkin method for elliptic problems. Orthogonal polynomials and Gaussian numerical integration .10.3 G-NI methods in one dimension, Algebraic interpretation of the G-NI method.		1.5
11	22	Discussion and Problem Solving		1.5
12	23	Conditioning of the stiffness matrix in the G-NI method. Equivalence between G-NI and collocation methods. G-NI for parabolic equations.		1.5
12	24	Discussion and Problem Solving		1.5
13	25	Students presentations.		1.5
13	26	Discussion and Problem Solving		1.5

14	27	Students presentations.		1.5
14	28	Discussion and Problem Solving		1.5