European School of Antennas

Coordinators: J. Mosig (Planar, EPFL) P-S Kildal (Conformal, CHALMERS)

EPFL (ID 35)

J. Mosig

CHALMERS (ID 29)

P-S Kildal

Name of the course	**Analysis of planar and conformal antennas**	Type			
		M	D	A/D	A
					■
Place	EPFL- Lausanne	Date: Feb. 27, March 3, 2006			

Summary (2000 words)

This course will first cover the theoretical aspect of the analysis and design of planar and conformal antennas. The first half of the course will deal with the fundamentals of the mathematical and electromagnetic models being used for the analysis of printed antennas. The static and quasistatic cases will be first discussed as a very useful introduction to the full-wave (dynamic) formulation . The second half will cover analysis methods for antennas embedded in multilayer structures of planar, circular cylindrical and spherical types, with real life applications.

1) Fundamental of integral equations for printed antennas.
Differential equations for Electromagnetics. Field equivalence principles. Surface and Volume formulations. Integral Equations formulations: electric, magnetic, combined and mixed potential types. Applications to printed and multilayered structures. Free space and dielectric Green's functions. Approximations and efficient numerical evaluation of Green's functions. The asymptotic far field values. Discretization of the problem. Boundary elements and the Method of Moments. Pre-processing: meshers, basis and test functions. Matrix filling: multidimensional quadrature rules. Linear system solvers. Iterative and multilevel approaches. Post-processing: from field to circuit (macroscopic) quantities. Vertical electric currents and via-holes. Equivalent magnetic currrents. Thin and thick slots. Some case studies: static capacitances, full-wave input impedances and radiation patterns of multilevel printed structures on planar multilayered substrates including cavity backed antennas.

2) Analysis methods for conformal antennas of planar, circular cylindrical and spherical types
The analysis is based on using the moment method in the spectral domain. The Green's functions of the multilayer structure are constructed numerically by division in homogeneous subregions and using equivalence principle. The latter is a general approach applicable to multi-region problems of other kinds as well. Therefore, the course also gives an introduction to how general and complex structures can be divided in subregions that can be analyzed independently and efficiently by making use of the appropriate symmetries of each subregion. The lectures will therefore include definitions of different canonical structures with certain symmetries. For large structures the uniform geometrical theory of diffraction is an appropriate method. Antennas embedded in cylindrical structures of arbitrary cross section will also be treated.

The course will throughout contain examples of practical planar and conformal antennas and discussions of their application. The main focus of the lectures will include both the basic formulation and the structuring of the field problems into manageable sub-problems and presentation of results, avoiding detailed mathematics

Involved institutions	EPFL-CHALMERS-ERICSSON-KUL-KTH					
Structure of the course	Lectures	Self study & Assignments	Computer exercise	Total	Credits	Assessment typology
	20h	20h	40h	80h	5 ECTS	Attendance: 1 cr Assignements: 1 cr Computer exercise: 3 cr Small exam via the web.

Teachers	Name	Organization	Title
	J. Mosig	EPFL	Prof.
	P-S Kildal	CHALMERS	Prof.
	Z. Sipus	CHALMERS	Prof.
	G. Vandenbosch	KUL	Prof.
	S. Raffaelli	ERICSSON	PhD
	P. Persson	KTH	PhD
	A. Djordjevic **(Invited EPFL)**	U. of Belgrade	Prof.

Availability of dedicated structures	College rooms		Dedicated Labs		Classrooms		Computer rooms		Canteen	
	yes	no	yes	no	yes	no	yes	no	yes	no
		■	■		■		■		■	

SCHEDULE

Monday: Planar

Hour	Topic	Lecturer
08-10		EPFL
10-12	Self study, assignments and plenary discussion	
12-14	Lunch	
14-16		EPFL
16-18	Self study, assignments and plenary discussion	

Tuesday: Planar

Hour	Topic	Lecturer
08-10		EPFL
10-12	Self study, assignments and plenary discussion	
12-14	Lunch	
14-16		EPFL
16-18	Self study, assignments and plenary discussion	

Wednesday: Planar + structure definitions + spectral domain approaches

Hour	Topic	Lecturer
08-10	The main ideas behind the MAGMAS software	G. Vandenbosch
10-12	Self study, assignments and plenary discussion	
12-14	Lunch	
14-16	Structure definitions, canonical structures, spectral domain methods.	P-S. Kildal
16-18	Self study, assignments and plenary discussion	

Thursday: Spectral domain analysis and applications

Hour	Topic	Lecturer
08-10	Spectral domain methods obtained by 1D and 2D Fourier transformations in three coordinate systems. Spectral Green's functions. Generalized asymptote extraction.	Z. Sipus P-S. Kildal

10-12	Self study, assignments and plenary discussion	
12-14	Lunch	
14-16	Analysis and design of patch and waveguide arrays embedded in cylindrical and spherical multilayer structures	Z. Sipus
16-18	Self study, assignments and plenary discussion	

Friday: Conformal applications

Hour	Topic	Lecturer
08-10	UTD and practical conformal arrays	P. Persson
10-12	Self study, assignments and plenary discussion	
12-14	Lunch	
14-16	Practical aspects when designing conformal arrays	S. Raffaelli P. Persson
16-18	Self study, assignments and plenary discussion	