DISCIPLINE SYLLABUS

University	**UNIVERSITATEA DE VEST TIMISOARA**
Faculty	**PHYSICS**
Specialization	**PHYSICS AND TECHNOLOGY OF ADVANCED MATERIALS**

I.

Name of the discipline	**Relaxation processes in advanced materials**

II.

Structure (number of hours per week)							
Discipline code	**Semester**[2)]	Category[3)]	Credits	Course	Seminar	Laboratory	Project
PTAM 1203	**2**	**DS**	**5**	**2**	**-**	**1**	**-**

III.

Discipline status	Compulsory	Optional	Facultative
(se marchează cu x)	**X**		

IV.

Discipline responsible				
	Course	Seminar	Laboratory	Project
Name and surname	Catalin Nicolae Marin	-	Catalin Nicolae Marin	-
Institution	Universitatea de Vest	-	Universitatea de Vest	-
Department	Physics	-	Physics	-
Scientific degree	Dr.habil.	-	Dr.habil.	-
Academic degree	Associate Professor	-	Associate Professor	-

V.

Objective

- It aims to deepen the knowledge in the field of non-equilibrium processes, characterization of various relaxation processes in nanoparticles systems and presentation of some experimental methods to study the relaxation processes.

VI.

Contents	**No. of hours/ week**
VI.1. Course (chapters and main subjects)	
I. Preliminary notions 1.1. Stimulus, response, relaxation, characteristic times (examples and definitions) 1.2. Examples of relaxation processes in electric circuits 1.2.1. Relaxation process, characteristic time of RC and RL circuits 1.2.2. RLC resonant circuit 1.3. Fourier transform 1.4. Laplace transform	**6/3w**
II. Spectral properties of fluctuations around the equilibrium position 2.1. Mean value, autocorrelation function 2.2. Spectral density and the Wiener-Khinchin theorem 2.3. Fluctuation-dissipation theorem 2.4. Kubo's generalized equation	**4/2w**

III. Relaxation in systems subjected to time-dependent stimuli 3.1. Response function and decay function 3.2. The relation between the decay function and susceptibility 3.3. Examples of decay functions and dispersion relations 3.3.1. Debye decay function and Debye dispersion relation 3.3.2. Lorentz decay function and Lorentz dispersion relation 3.3.3. Landau-Lifshitz decay function and Landau-Lifshitz dispersion relation 3.4. Superposition principle and characteristic relaxation times of a relaxation process in systems with dispersion of relaxation time 3.5. Kramers-Kronig relations	**8/4w**
III. Examples of dielectric and magnetic relaxation processes 4.1. The ideal dielectric with displacement polarization 4.2. Dielectric relaxation in bi-stable model 4.3. Models for dielectric relaxation in heterogeneous systems (Maxwell-Wagner Sillars, Schwarz) 4.4. Fokker-Planck equation and Neel relaxation time 4.5. Langevin equation and the integral relaxation time	**10/5w**
VI.2. Seminar and laboratory subjects	
RC, RL and RLC circuits in transient regime – characteristic times	**2/1w**
Experimental determination of the response function	**2/1w**
Determination of the characteristic times of a relaxation process	**2/1w**
Experimental study of Jonscher law in granular systems	**2/1w**
Activation energy and characteristic times in semiconductors for which the electrical conductivity is dominated by thermally activated hopping	**2/1w**
Decay function method for the determination of the precessional decay time of the Landau-Lifshitz equation (with application to magnetic recording media)	**2/1w**
Interfacial polarization and dielectric relaxation in composite systems	**2/1w**

VII.

References
1. V. V. Daniel „Dielectric relaxation”, Academic Press, London, 1967 2. Radu Balescu, „Equilibrium and Nonequilibrium Statistical Mechanics”, A Wiley-Interscience Publication, John Wiley & Sons, New-York, 1975 3. Keizer Joel „Statistical Thermodinamics of Nonequilibrium Processes”, Ed. Springer, New-York, Berlin, Heidelberg, 1987 4. I. Grosu „Fizica starii condensate-functii de raspuns si efecte de dezordine” Presa Universitara Clujeana, Cluj-Napoca, 2000 5. W. T. Coffey „The effective eigenvalue method and applications to stochastic problems in conjunction with the nonlinear Langevin equation”, Advances in Chemical Physics: Modern Nonlinear Optics. Part 2, vol. 85, 1993 pp 667 – 792 6. B. K. P. Scaife „Principles of dielectrics”, Clarendon Press, Oxford, 1998 7. N. F. Mott, E. A. Davis, “Electronic processes in non-crystalline materials”, Clarendon Press, Oxford, 1971

VIII.

Activities	Teaching manner
Course	Video-projector and blackboard lecture (on-line or on-site depending on the pandemic situation)
Laboratory	Solving of practical problems and discussions related to the experimental study of relaxation processes (on-line or on-site depending on the pandemic situation)

IX.

Evaluation		
Activities	**Evaluation**	**% of final mark**
Exam	Oral examination is made - Knowledge for mark 5 Students must answer satisfactorily the issues of examination. - Knowledge for mark 10 Students must respond fully to the subjects of examination.	70%
Laboratory	- Knowledge for mark 5 The student must know the principles of some experimental methods used in the study of relaxation processes. The student must attend and actively participate in the laboratory activity. - Knowledge for mark 10 The student must be able to measure the complex magnetic susceptibility, the complex dielectric permittivity and to determine the characteristic times of the relaxation processes. The student must attend and actively participate in the laboratory activity.	30%
A percentage of 50% of the final grade is obtained from the ongoing evaluation (such as quizzes, end-of-chapter test and report or essay writing).		
Skills acquired by students: - The student must know the basic theoretical notions on the relaxation processes - The student must know the specific measurement techniques. - The student must know the practical implications of the relaxation processes.		

Date:
23.01.2022

Course responsible,
Dr. habil. C. N. Marin
Associate Professor
[redacted]

Date of approval in the department

Head of Department (Signature):

Dr. habil. C. N. Marin,
Associate Professor
[redacted]