SYLLABUS

1. Information about the study programme

1.1 Institution of higher education	West University of Timisoara
1.2 Faculty	PHYSICS and MATHEMATICS
1.3 Department of	PHYSICS
1.4 Field of study	PHYSICS
1.5 Study cycle	MASTER
1.6 Study programme	METODE AVANSATE DE CERCETARE IN FIZICA/ ADVANCED RESEARCH METHODS IN PHYSICS

2. Information about the subject/discipline

2.1 Name	**Magnetic materials** ARMP 1104						
2.2 Course coordinator	Dr. Nicoleta Stefu, Associate Professor						
2.3 Seminar coordinator	Dr. Nicoleta Stefu, Associate Professor						
2.4 Year of study	1	**2.5 Semester**	1	**2.6 Type of assessment**	E[1]	**2.7 Type of discipline**	DS, DOP

3. Total estimated time (hours of teaching per semester)[2]

3.1 Number of hours per week	**3**	**3.2 course**	**2**	**3.3 seminar/laboratory**	**1**
3.4 Total hours in the curriculum	**42**	**3.5 course**	**28**	**3.6 seminar/laboratory**	**14**

Distribution of time:	**hours**
Study based on Instructions, course materials, bibliography and notes	60
Additional documentation library, specialized electronic platforms / field	30
Training seminars / laboratories, homework, essays, portfolios and essays	40
Tutoring	
Examinations[3]	**3**
Other activities	

3.7 Total hours of individual study	**130**
3.8 Total hours per semester[4]	**175**
3.9 Number of credits	**7**

[1] According to article 37, paragraph (1) of the Higher Education Law no. 199/2023, with subsequent amendments and additions, "the academic success of a student during a study program is determined by verifying the acquisition of the expected learning outcomes through exam-type evaluations and evaluation throughout the semester".

[2] The total number of contact hours and individual study hours will be aligned with the number of credits allocated to the course. One credit corresponds to a total between 25 and 30 hours of teaching activities and individual study. At the level of academic departments may establish, by discipline categories, the exact equivalence between one credit and the number of hours.

[3] The hours corresponding to examinations are added only to the point 3.8 – The total hours per semester, not to be added to the point 3.7 – Total hours of individual study.

[4] Total hours per semester = total hours in the curriculum + total hours of individual study + hours allocated to examinations.

4. Prerequisites (where applicable)

4.1 of curriculum	• Mathematics - Analysis • Electricity and magnetism • Differential and integral calculus • Physics of the atom
4.2 of skills	• General competencies: the ability of analysis and synthesis; accumulation of basic general knowledge; proper use of terminology in physics and computer science in written and oral communication in English; Basic Skills PC operating; ability to work independently and in teams. • Professional Skills: identification and proper use of the main physical laws and principles in a given context; use of software packages for data analysis and processing.

5. Conditions (where applicable)

5.1 for the course	Laptop + projector+ whiteboard
5.2 for the seminar	• Devices from the lab of Magnetic Materials • PC. • Each seminar activity will be done in small groups (3-4 students) on the topics described in the seminar section.

6. Discipline objectives - expected learning outcomes which contribute to the completion and passing the discipline

Knowledge	• to know the advanced notions in the field of Physics, which involves a critical understanding of theories and principles • to know the language specific to the field • to know physical phenomena and interpret them by formulating hypotheses and operationalizing key concepts and the appropriate use of laboratory equipment to know the constructive and operating principles of the equipment for obtaining and characterizing materials and to explain how to use it
Skills	• to compare the theoretical results provided by the specialized literature with those of an experiment carried out within a professional project • To describe physical systems using specific theories and tools (experimental and theoretical models, algorithms, schemes, etc.) • to apply the principles and laws of physics in solving theoretical or practical problems, under conditions of qualified assistance • to characterize the specific properties of some materials taking into account the field in which they are used to identify the most appropriate methods to develop new materials with well-defined properties

Responsibility and autonomy	• participate in some concrete physics experiments • to critically analyze a specialized report, scientific communication with a medium degree of difficulty in the field of physics • to be autonomous in the context of handling laboratory equipment, including in situations requiring an interdisciplinary approach to autonomously use information sources and resources for communication and assisted professional training (Internet portals, specialized software applications, databases, online courses, etc.) both in Romanian and in a language of international circulation

7. Contents

The platform through which the course materials in electronic format and other learning/bibliographic resources can be accessed:_elearning.uvt.ro

7.1 Course	Teaching methods	Comments
Lecture 1. (4 hours) Introductory lecture. Chapter 1. Magnetic materials. Angular momenta; Magnetic Moments	Lecture, introductory conversation, heuristic conversation, illustration, use of analogies and algorithms.	• The lecture will be interactive; learning is facilitated by engaging the students in conversation episodes, capture of attention, updating the knowledge previous acquired and systematization / fixing of new knowledge **Compulsory reading:** ***Lecture notes 1*** available on e-learning platform **Optional supplementary material:** [1] Pages 87-90 [4] pages 62-67 **Video** This lecture is part of 8.02 Physics II: Electricity and Magnetism, as taught in Spring 2002 by Dr. Walter Lewin at MIT. https://www.youtube.com/watch?v=TJGRatHJgEI
Lecture 2 (4 hours) Magnetic Moment and its Energy in a Magnetic Field; Definitions of Magnetization and Magnetic Susceptibility; Classification of Magnetic Materials; Diamagnetism; Paramagnetism. The Langevin Function of Magnetization and the Curie Law	Lecture, conversation, mathematical calculation, fixing and deepening knowledge Building a mind map	**Compulsory reading:** ***Lecture notes 2*** available on e-learning platform **Optional supplementary material:** [1] Pages 90-99 [4] pages 104-106
Lecture 3 (4 hours) **The Brillouin Function of Magnetization and the Curie Law; Magnetic Ordered State; Weiss molecular field theory (the classical theory); Generalization of Weiss molecular field theory; Magnetism and hysteresis**	Lecture, conversation, mathematical calculation, fixing and deepening knowledge	**Compulsory reading:** ***Lecture notes 3*** available on e-learning platform **Optional supplementary material:** [1] Pages 117-128 [2] pages 53-59 [4] pages 107-110

Lecture 4 (4 hours) The quantum theory of ferromagnetism. The Heitler –London model. The Heisenberg-Dirac hamiltonian. The exchange interaction ; Magnetism and hysteresis. **Chapter 2. Magnetic anisotropy. Anisotropy**	Lecture, conversation, mathematical calculation, fixing and deepening knowledge	**Compulsory reading:** ***Lecture notes 4*** available on e-learning platform **Optional supplementary material:** [1] Pages 197 [2] pages 63-65 [4] pages 168
Lecture 5 (4 hours) **Crystallographic anisotropy; Shape anisotropy; Induced anisotropy. Magnetostriction; Other ferromagnetic phenomena (magneto-caloric, magneto-resistance, magneto-optic)**	Lecture, conversation, mathematical calculation, fixing and deepening knowledge	**Compulsory reading:** ***Lecture notes 5*** available on e-learning platform **Optional supplementary material:** [1] Pages 198-204 [2] pages 63-65 [4] pages 169-187
Lecture 6 (4 hours) **Chapter 3. Magnetization dynamics** **Larmor precession. Electron paramagnetic resonance; Bloch equations. Magnetic resonance. Magnetic relaxation; Ferromagnetic resonance ; Antiferromagnetic resonance**	Lecture, conversation, mathematical calculation, fixing and deepening knowledge	**Compulsory reading:** ***Lecture notes 6*** available on e-learning platform **Optional supplementary material:** [1] Pages 428-435 [4] pages 305-325
Lecture 7 (4 hours) **Chapter 4. Magnetic nanoparticle systems and applications** **Characteristic length scales; Small particles ; Quantum dots and molecular clusters; Bulk nanostructures; Ferrofluids; Magneto-rheological and magneto-elastic systems; Smart materials**	Lecture, conversation, retaining and deepening knowledge conversation	**Compulsory reading:** ***Lecture notes 7*** available on e-learning platform **Optional supplementary material:** **[3] pages 177-189** [4] pages 264-268, 293-300

Bibliography:

1. B. D. Cullity, C. D. Graham, **Introduction To Magnetic Materials**, IEEE Press, Wiley, 2009
2. Peter Mohn, **Magnetism In The Solid State,** An Introduction, Corrected Second Printing, 2006, Springer
3. Nicola Spaldin, **Magnetic Materials, Fundamentals And Applications,** Cambridge University Press, 2011

J.M.D. Coey, **Magnetism and magnetic materials**, Cambridge University Press, 2010.

7.2. Seminar	Teaching methods	Comments
Seminar 1. (1 hour) **Methods for measuring the magnetic susceptibility**	Discussion on various methods for measuring the magnetic susceptibility and magnetic permeability	Compulsory reading: ***Laboratory notes*** available on the e-learning platform
Seminar 2. (2 Hours) **Determination of the saturation magnetisation and of the dimension of the particles of a ferofluid by means of magnetisation curve.**	Data processing and interpretation of the results. Students will work in small groups (3-4 students). Will read and discuss the article in bibliography, will be given a set of measurements and will follow the algorithm described in article and do the	**Compulsory bibliography:** I. Hrianca, I. Malaescu, C. N. Marin, **N. Stefu**, *Magnetic relaxation processes in radio-frequency field for dispersed monodomenic particles*, Analele Uiversitatii de Vest din Timisoara, Vol. XXXVI, Seria Stiinte Fizice (1997) 17

	calculations presented there, using the appropriate software. In the end they will present their work and the results, discussing the differences between their results and the ones presented in the article.	
Seminar 3. (2 hours) **Determination of particle dimension by means of Neel and Brown relaxation times in suspensions of magnetic nanoparticles.**	Data processing and interpretation of the results. Students will work in small groups (3-4 students). Will read and discuss the article in bibliography, will be given a set of measurements and will follow the algorithm described in article and do the calculations presented there, using the appropriate software. In the end they will present their work and the results, discussing the differences between their results and the ones presented in the article.	**Compulsory bibliography:** I. Malaescu, L. Gabor, F. Claici, **N. Stefu**, *"Preparation of ferrofluids with magnetite and mixed ferrite particles and characterization in a radiofrequency field",* Analele Uiversitatii de Vest din Timisoara, Vol. XXXVIII, Seria Stiinte Fizice (1998) 90
Seminar 4. (2 hours) **Determination of the magnetic properties of the ferrofluid from resonance measurements**	Data processing and interpretation of the results. Students will work in small groups (3-4 students). Will read and discuss the article in bibliography, will be given a set of measurements and will follow the algorithm described in article and do the calculations presented there, using the appropriate software. In the end they will present their work and the results, discussing the differences between their results and the ones presented in the article.	**Compulsory bibliography:** I. Hrianca, I. Malaescu, **N. Stefu,** F. Claici, *Behavior in Radiofrequency Field and Magnetic Resonance of Ferrofluids,* Analele Universitatii de Vest din Timisoara, Vol. XL, Seria Stiinte Fizice, (1999)
Seminar 5. (2 hours) **Determination of anisotropy constant by means of magnetic resonance**	Data processing and interpretation of the results. Students will work in small groups (3-4 students). Will read and discuss the article in bibliography, will be given a set of measurements and will follow the algorithm described in article and do the calculations presented there, using the appropriate software. In the end they will present their work and the results, discussing the differences	**Compulsory bibliography:** P.C.Fannin, C.N.Marin, I. Malaescu, **N.Stefu,** *"An investigation of the microscopic and macroscopic properties of magnetic fluids",* **Physica B: Condensed Matter**, Volume 388, Issues 1-2, Pages 1-440 (15 January 2007) *Pages 87-92*

	between their results and the ones presented in the article.	
Seminar 6 (2 hours) **Study of the anisotropy constant and Lande factor by means of static and dynamic measurements in ferrofluids with mixed ferrite particles**	Data processing and interpretation of the results. Students will work in small groups (3-4 students). Will read and discuss the article in bibliography, will be given a set of measurements and will follow the algorithm described in article and do the calculations presented there, using the appropriate software. In the end they will present their work and the results, discussing the differences between their results and the ones presented in the article.	**Compulsory bibliography:** I. Malaescu, **N. Stefu**, L. Gabor, *Relaxation Process and Ferromagnetic Resonance Investigation of Ferrofluids with Mn – Zn and Mn – Fe Mixed Ferrite Particles,* **J. Magn. Magn. Mater** , 234 (2001) 299-305
Seminar 7. (3 hours) **Determination of the microwave specific loss power of magnetic fluids subjected to a static magnetic field**	Data processing and interpretation of the results. Students will work in small groups (3-4 students). Will read and discuss the article in bibliography, will be given a set of measurements and will follow the algorithm described in article and do the calculations presented there, using the appropriate software. In the end they will present their work and the results, discussing the differences between their results and the ones presented in the article.	**Compulsory bibliography:** P.C.Fannin, I. Malaescu, C.N.Marin, **N.Stefu,** *Microwave specific loss power of magnetic fluids subjected to static magnetic field,* Eur. Phys. J. E., 27, 145-148 (2008)

Bibliography

1. I. Hrianca, I. Malaescu, C. N. Marin, **N. Stefu**, *Magnetic relaxation processes in radio-frequency field for dispersed monodomenic particles*, Analele Uiversitatii de Vest din Timisoara, Vol. XXXVI, Seria Stiinte Fizice (1997) 17
2. I. Malaescu, L. Gabor, F. Claici, **N. Stefu**, *"Preparation of ferrofluids with magnetite and mixed ferrite particles and characterization in a radiofrequency field",* Analele Uiversitatii de Vest din Timisoara, Vol. XXXVIII, Seria Stiinte Fizice (1998) 90
3. I. Hrianca, I. Malaescu, **N. Stefu,** F. Claici, *Behavior in Radiofrequency Field and Magnetic Resonance of Ferrofluids,* Analele Universitatii de Vest din Timisoara, Vol. XL, Seria Stiinte Fizice, (1999)
4. P.C.Fannin, C.N.Marin, I. Malaescu, **N.Stefu,** *"An investigation of the microscopic and macroscopic properties of magnetic fluids",* **Physica B: Condensed Matter**, Volume 388, Issues 1-2, Pages 1-440 (15 January 2007) *Pages 87-92*
5. I. Malaescu, **N. Stefu**, L. Gabor, *Relaxation Process and Ferromagnetic Resonance Investigation of Ferrofluids with Mn – Zn and Mn – Fe Mixed Ferrite Particles,* **J. Magn. Magn. Mater** , 234 (2001) 299-305

P.C.Fannin, I. Malaescu, C.N.Marin, **N.Stefu,** *Microwave specific loss power of magnetic fluids subjected to static magnetic field,* Eur. Phys. J. E., 27, 145-148 (2008)

8. Corroboration of the course contents with the epistemic expectations of the community representative, professional associations and representative employers of the programme itself

9. Use of tools based on generative artificial intelligence

To complete the tasks defined in the assessment section, the use of generative AII tools is **not** permitted.
The most well-known examples of generative AII tools include, but are not limited to: ChatGPT, Google Gemini, Copilot for text, or MidJourney for images.
Each student will specify, in a statement written separately for each assignment, that they did not use AI tools in solving the assesment. The statement will be included by the student at the beginning of the submitted assignment.

10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of the final mark
10.4 Course	- the clarity, logic and scientific level of the presentation will be evaluated; - correctness of the answers to the questions will be evaluated - The ability of explaining the studied magnetic phenomena will be evaluated	*Summative assessment* - Oral examination based on an essay on a topic discussed in class, presented in English	**70%**
10.5 Seminar	- After each seminar activity, each student will present a report in English and will be evaluated as follows: -his/her work in the group will be assessed - the correctness of results obtained after processing the data will be discussed and evaluated - the problems that occurred and the way they were solved during the activity will be evaluated - the discussion on the correlation with the results presented in the article will be evaluated.	*Formative assessment:* - continuous	**30%**
10.6 Minimum performance standards			
Mark 5 corresponds to the minimum accumulated knowledge, i.e. for the student capacity to: Correctly answer 3 questions from the theoretical part (in final evaluation), mark 5 in seminar.			

Date of submission:

15.09.2026

Titular of the course:
Associate Professor Dr. Nicoleta STEFU
[redacted]

Date of approval in department:

Seminary titular:
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