COURSE OUTLINE

1. Data about the study programme

1.1 Higher education institution	Transilvania University of Brașov
1.2 Faculty	Materials Science and Engineering
1.3 Department	Materials Science
1.4 Field of study[1)]	Materials Engineering
1.5 Study level[2)]	Master
1.6 Study programme/ Qualification	Materials Science, Engineering, and Management

2. Data about the course

2.1 Name of course			Introduction to materials science					
2.2 Course convenor			Prof. dr. Eng. Daniel Cristea					
2.3 ~~Seminar~~/ ~~laboratory~~/ project convenor			Prof. dr. Eng. Daniel Cristea					
2.4 Study year	1	2.5 Semester	1	2.6 Evaluation type	E	2.7 Course status	Content[3)]	FC
							Attendance type[4)]	CPC

3. Total estimated time (hours of teaching activities per semester)

3.1 Number of hours per week	**4**	out of which: 3.2 lecture	**2**	3.3 seminar/ laboratory/ project	**0/0/2**
3.4 Total number of hours in the curriculum	56	out of which: 3.5 lecture	28	3.6 seminar/ laboratory/ project	0/0/28

Time allocation	hours
Study of textbooks, course support, bibliography and notes	30
Additional documentation in libraries, specialized electronic platforms, and field research	30
Preparation of seminars/ laboratories/ projects, homework, papers, portfolios, and essays	30
Tutorial	
Examinations	4
Other activities....................................	

3.7 Total number of hours of student activity	94
3.8 Total number per semester	150
3.9 Number of credits[5)]	5

4. Prerequisites (if applicable)

4.1 curriculum-related	•
4.2 competences-related	• The student/graduate analyzes and explains theoretical and experimental results related to the production/obtaining, processing, characterization, and testing of materials. • The student/graduate selects and applies basic concepts, principles, and methods from the field for calculations related to the design, production, processing, and management of engineering materials. • The student/graduate selects and uses bibliographic sources specific to the field.

5. Conditions (if applicable)

5.1 for course development	• Participation in the course; prior review of the indicated bibliographic references to engage in dialogue with the professor on specific topics.

5.2 for seminar/ laboratory/ project development	• Participation in the project activities; review of the indicated bibliographic references. • The deadline for submitting and presenting the project work is set by the course instructor, in agreement with the students.

6. Specific competences and learning outcomes

Cp.1. Use of modern concepts and theories in the field of advanced materials (ESCO - evaluates the suitability of metal types for specific applications; manipulates metals; works in metal production teams)

Knowledge

L.O. 1.1. The graduate defines modern concepts and theories in the field of advanced materials.

L.O. 1.2. The graduate describes how materials engineering products and processes have a positive impact on global and social issues, using modern concepts and theories in the field of advanced materials.

Skills

L.O. 1.3. The graduate analyses data obtained from the use of the structure-property relationship for the characteristics of different types of materials and especially metallic, polymer, ceramic and composite materials.

L.O. 1.4. The graduate can identify opportunities and design strategies in solving needs in the field of materials engineering.

Responsibility and autonomy

L.O. 1.5. The graduate has autonomy in learning.

L.O. 1.6. The graduate autonomously integrates concepts and theories in materials engineering into new contexts in the workplace.

Cp.3. Application of modern analytical techniques adapted to the field of advanced materials and related fields (ESCO - performs laboratory tests; prepares samples for analysis; performs sample analysis; uses chemical analysis equipment; applies laboratory safety procedures; performs metallurgical structural analysis)

Knowledge

L.O. 3.1. The graduate has a deep understanding of various modern analytical techniques, adapted to the field of advanced materials and related fields.

L.O. 3.2. The graduate uses various modelling, simulation and optimization software techniques and applications, adapted to the field of advanced materials and related fields.

L.O. 3.3. The graduate can collect, interpret and analyze data that is specific to the application of modern analytical techniques to extract relevant conclusions in the field of advanced materials and related fields.

Skills

L.O. 3.4. The graduate can design and analyze experiments appropriate to modern analytical techniques in the field of advanced materials and related fields, incorporating statistical procedures.

L.O. 3.5. The graduate can use modelling, simulation and optimization software programs to develop and evaluate new materials.

Responsibility and autonomy

L.O. 3.6. The graduate ensures the rigor of the analysis through judicious selection of data and methods.

L.O. 3.7. The graduate assumes responsibility for the validity of the conclusions resulting from the data analysis.

Transversal competences and learning outcomes

Ct.3. Permanent information and documentation in his/her field of activity and related fields, in correlation with the needs of the labor market (ESCO - demonstrates a desire to learn; manages personal development.)

L.O. 3.1. The graduate can identify continuous training opportunities and use them effectively for personal development in their field or related activities and domains, in correlation with labor market needs.

L.O. 3.2. The graduate can develop original models to accurately describe real processes specific to materials engineering, based on thorough individual study.

L.O. 3.3. The graduate is capable of objectively and effectively self-assessing their professional activity, thereby gaining an overall understanding of their own knowledge, with a strong emphasis on continuous information gathering and documentation in their field of activity.

7. Course objectives (resulting from the specific competences to be acquired)

7.1 General course objective	• Assimilation of introductory information and knowledge related to materials science.
7.2 Specific objectives	• The aim of the course is to provide concrete information regarding the general aspects of materials science. • Understanding the structure and properties of the most commonly used material categories. • Ways to modify the properties of the main classes of materials: metals, ceramics, polymers and composites. • Material selection criteria for a specific application.

8. Content

8.1 Course	Teaching methods	Number of hours	Remarks
Introduction to materials science and engineering. Material classification criteria and their properties. Material structure levels. Materials processing operations	Lecture Explanation Conversation Problematization Case studies	2	
Atomic and molecular structure of materials. Influence of chemical bond type on material properties. Crystalline and amorphous materials. Crystallization systems		4	
Phase transitions of materials. Allotropy and polymorphism. Physical properties of materials. Diffusion.		4	
Ferrous alloys. Carbon steels, alloy steels and cast irons. Steels with special properties. Classification, types and general properties.		4	
Non-ferrous alloys of aluminum, magnesium, copper, titanium, and zinc. Superalloys.		3	
Heat treatments applied to ferrous metal materials. Quenching, tempering, annealing. Thermochemical treatments.		3	
Ceramic materials. Obtaining and shaping technologies. Structure, properties and applications		2	
Polymeric materials. Synthesis and processing techniques. Structure, properties and applications		2	
Composite materials. Production and processing techniques. Structure, properties, design and applications		4	

Bibliography			
1. Callister Jr. W.D., Rethwisch D.G. Materials Science and Engineering: An Introduction 10th Edition. Wiley Ltd., 2020, New York, U.S.A 2. Brian S. Mitchell - Materials Engineering and Science. Wiley, 2023 3. Askeland, D R & Wright, W J - Essentials of Materials Science & Engineering 4. Michael F. Ashby - Materials Selection in Mechanical Design. Butterworth-Heinemann, 5th Ed, 2018.			
8.3 Project			
A project paper is prepared on a pre-established topic related to the course content (or from the field of materials science and engineering as an extension of this topic).	• Completion of the individual assignment • Periodic presentation (during project sessions) of the progress in completing the assignment	28	
Bibliography 1. Callister Jr. W.D., Rethwisch D.G. Materials Science and Engineering: An Introduction 10th Edition. Wiley Ltd., 2020, New York, U.S.A 2. Brian S. Mitchell - Materials Engineering and Science. Wiley, 2023 3. Askeland, D R & Wright, W J - Essentials of Materials Science & Engineering 4. Michael F. Ashby - Materials Selection in Mechanical Design. Butterworth-Heinemann, 5th Ed, 2018. 5. Online resources.			

9. Correlation of course content with the demands of the labor market (epistemic communities, professional associations, potential employers in the field of study)

The curriculum aligns with the needs of representative employers in the field of materials engineering and is consistent with similar study programs offered by major universities both nationally and internationally. The content of the discipline complies with current academic trends and ensures high relevance of the skills transmitted to students. The content reflects the methods and theories accepted by the scientific community and is consistent with state-of-the-art approaches, allowing students to form a solid and up-to-date scientific basis.

10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of the final grade
10.1 Course	Acquired knowledge: understanding theoretical concepts and correct use of specific terminology	Ongoing assessment (during interactive courses) and final oral examination	60%
10.2 Project	Thematic project	Verification and final defense	40%
10.6 Minimal performance standard			
Achieving at least 50% of the points allocated for the course and project activities. The student must demonstrate knowledge of the basic notions of materials science and engineering and the ability to differentiate the main categories of materials, their properties and their uses.			

This course outline was certified in the Department Board meeting on …./…../…….. and approved in the Faculty Board meeting on …./…../……..

Prof. dr. Eng. Alexandru PASCU **………………………………………………………………………** **Dean**	**Assoc. Prof. dr. Eng. Camelia GABOR** **……………………………………………………………………………………………………** **Head of Department**
Prof. dr. Eng. Daniel CRISTEA **……………………………………………………………………** **Course holder**	**Prof. dr. Eng. Daniel CRISTEA** **……………………………………………………………………** **Holder of project**

Note:

1) Field of study – select one of the following options: Bachelor / Master / Doctorate (to be filled in according to the forceful classification list for study programmes);

2) Study level – choose from among: Bachelor / Master / Doctorate;

3) Course status (content) – for the Bachelor level, select one of the following options: **FC** (fundamental course) / **DC** (course in the study domain)/ **SC** (specialty course)/ **CC** (complementary course); for the Master level, select one of the following options: **PC** (proficiency course)/ SC (synthesis course)/ **AC** (advanced course);

4) Course status (attendance type) – select one of the following options: **CPC** (compulsory course)/ **EC** (elective course)/ **NCPC** (non-compulsory course);

5) One credit is the equivalent of 30 study hours (teaching activities and individual study).

COURSE OUTLINE

1. Data about the study programme

1.1 Higher education institution	Transilvania University of Brașov
1.2 Faculty	Materials Science and Engineering
1.3 Department	Materials Science
1.4 Field of study[1)]	Materials Engineering
1.5 Study level[2)]	Master
1.6 Study programme/ Qualification	Materials Science, Engineering, and Management (in English)

2. Data about the course

2.1 Name of course	Criteria for materials selection							
2.2 Course convenor	Prof. dr. eng. Miloșan Ioan							
2.3 Seminar/ laboratory/ project convenor	Prof. dr. eng. Miloșan Ioan							
2.4 Study year	I	2.5 Semester	I	2.6 Evaluation type	E	2.7 Course status	Content[3)]	FC
							Attendance type[4)]	CPC

3. Total estimated time (hours of teaching activities per semester)

3.1 Number of hours per week	**4**	out of which: 3.2 lecture	**2**	3.3 seminar/ laboratory/ project	**0/0/2**
3.4 Total number of hours in the curriculum	56	out of which: 3.5 lecture	28	3.6 seminar/ laboratory/ project	28

Time allocation	hours
Study of textbooks, course support, bibliography and notes	50
Additional documentation in libraries, specialized electronic platforms, and field research	44
Preparation of seminars/ laboratories/ projects, homework, papers, portfolios, and essays	20
Tutorial	5
Examinations	5
Other activities....................................	

3.7 Total number of hours of student activity	124
3.8 Total number per semester	180
3.9 Number of credits[5)]	6

4. Prerequisites (if applicable)

4.1 curriculum-related	•
4.2 competences-related	•

5. Conditions (if applicable)

5.1 for course development	• Classroom, blackboard, computer, video projector
5.2 for seminar/ laboratory/ project development	• Seminar room, blackboard, computer, video projector

6. Specific competences and learning outcomes

Professional competences	**Cp.1. Use of modern concepts and theories in the field of advanced materials** (ESCO - evaluates the suitability of metal types for specific applications; manipulates metals; works in metal production teams) ***Knowledge*** L.O. 1.1. The graduate defines modern concepts and theories in the field of advanced materials. L.O. 1.2. The graduate describes how materials engineering products and processes have a positive impact on global and social issues, using modern concepts and theories in the field of advanced materials. ***Skills*** L.O. 1.3. The graduate analyses data obtained from the use of the structure-property relationship for the characteristics of different types of materials and especially metallic, polymer, ceramic and composite materials. L.O. 1.4. The graduate can identify opportunities and design strategies in solving needs in the field of materials engineering. ***Responsibility and autonomy*** L.O. 1.5. The graduate has autonomy in learning. L.O. 1.6. The graduate autonomously integrates concepts and theories in materials engineering into new contexts in the workplace. **Cp.2. Identifying and defining a research topic in the field of advanced materials and developing a plan to achieve the proposed objectives** (ESCO - approaches problems critically; develops materials testing procedures; presents reports on test results) ***Knowledge*** L.O. 2.1. The graduate can identify and define a topic of actuality or of maximum necessity in the field of advanced materials through the criterial materials selection. L.O. 2.2. The graduate can identify, define and develop a specific plan for processing advanced materials according to technological parameters in achieving the proposed objectives. ***Skills*** L.O. 2.3. The graduate can develop a plan for selecting appropriate tools for advanced materials processing, using them safely to achieve the proposed objectives. L.O. 2.4. The graduate can use modern tools and techniques to modify, characterize and measure the properties of materials and to design processes according to accepted standards. ***Responsibility and autonomy*** L.O. 2.5. The student/graduate selects and uses bibliographic sources specific to the field. L.O. 2.6. The student/graduate demonstrates autonomy in learning on issues specific to the field. **Cp.5. Applying the principles of scientific research specific to the field and carrying out an oral/written communication, through which the results are presented, in a clear and convincing manner.** (ESCO - conducts scientific research; tests materials; develops advanced materials). ***Knowledge*** L.O. 5.1. The graduate knows how to apply the principles of scientific research specific to the field and to communicate clearly and concisely, both in writing and orally, regarding the results obtained by applying the principles of scientific research specific to the field of advanced materials and related fields. ***Skills*** L.O. 5.2. The graduate can apply the principles of scientific research specific to the field by acquiring the ability to perceive, understand and promote quality and creativity in research and communication of the results obtained. L.O. 5.3. The graduate can develop skills as a researcher and good communicator in the field of materials

	engineering by applying the principles of scientific research by extracting relevant conclusions from the research carried out. L.O. 5.4. The graduate knows how to correctly communicate the results of analyses and calculations carried out in scientific research, thus explaining the correctness of the proposed solutions. *Responsibility and autonomy* L.O. 5.5. The graduate assumes the intellectual paternity of his/her own research and respects the deontological norms. L.O. 5.6. The graduate demonstrates autonomy in the dissemination of knowledge by initiating and managing the publication process.
Transversal competences	**Ct.1. Performing complex professional tasks, respecting the norms of professional ethics and moral conduct, following a personal work plan established based on individual study** (ESCO - applies scientific, technological and engineering knowledge; develops strategies for solving problems.) L.O. 1.1. The graduate can perform complex professional tasks while observing the rules of professional ethics and moral conduct, following a self-established work plan based on individual study. L.O. 1.2. The graduate can identify continuous training opportunities and using them effectively for personal development in carrying out complex professional tasks, following a self-established work plan based on individual study. L.O. 1.3. The graduate is capable of recognizing, understanding, and promoting quality and creativity in performing complex professional tasks. L.O. 1.4. The graduate knows the occupational health and safety regulations, thus ensuring safe working conditions for themselves and for the team they are part of. **Ct.3. Permanent information and documentation in his/her field of activity and related fields, in correlation with the needs of the labor market** (ESCO - demonstrates a desire to learn; manages personal development.) L.O. 3.1. The graduate can identify continuous training opportunities and use them effectively for personal development in their field or related activities and domains, in correlation with labor market needs. L.O. 3.2. The graduate can develop original models to accurately describe real processes specific to materials engineering, based on thorough individual study. L.O. 3.3. The graduate is capable of objectively and effectively self-assessing their professional activity, thereby gaining an overall understanding of their own knowledge, with a strong emphasis on continuous information gathering and documentation in their field of activity.

7. Course objectives (resulting from the specific competences to be acquired)

7.1 General course objective	• Training skills to optimize material choice in the product design process
7.2 Specific objectives	• Assimilation of theoretical knowledge and solving calculations regarding the optimization of material choice in the design process of a product

8. Content

8.1 Course	Teaching methods	Number of hours	Remarks
Classification and properties of materials. Aspects of the design process. Morphology of design.	Interactive course, case studies, and practical exercises to develop analytical and problem-solving skills criteria for materials selection	2	
Material selection criteria: functional, technological, economic, ergonomic, environmental, recycling, et al.		4	
Functional analysis of the product, hierarchy of functions, morphological analysis of surfaces		4	
Materials selection techniques. Material selection, material groups and subgroups, Ashby diagram		4	
Methods used in optimizing material selection (matrix calculation, value analysis, optimal value method, et al.)		4	
Determining possible materials for making a product, establishing the property matrix and choosing the optimal material, studying the influence of alloying elements and processing techniques, value analysis to establish the function/cost ratio.		6	
The choice of material, technological process and testing techniques for products specific to given fields.		4	

Bibliography

1. Ashby, M.F. (2024) Materials Selection in Mechanical Design, Sixth edition, Butterworth-Heinemann Linacre House, Jordan Hill, Oxford, England, 2024.
2. Ashby, M.F, Shercliff, H. and Cebon, D. (2023) Introduction to Materials Science and Engineering A Design-led approach. Butterworth-Heinemann, Oxford, ISBN: 9780081023990.
3. Ashby, M.F, (2023) Materials and Sustainable Development , 2nd edition, Butterworth-Heinemann Ltd, Oxford, ISBN: 978-0-`323-98361-7
4. Ali Jahan, Kevin L Edwards, Marjan Bahraminasa. (2016) Multi-criteria Decision Analysis for Supporting the Selection of Engineering Materials in Product Design, 2nd Edition, , Butterworth-Heinemann, Oxford, England.
5. Miloşan I. (2001). Alloys with special properties (Aliaje cu proprietăți speciale), E.D.P. Bucharest, ISBN 973-30-2651-4, 136 pag., 2001.

8.2 Project	Teaching-learning methods	Number of hours	Remarks
Presentation of individual project topics	• Independent research and data collection. • Problem-solving and	2	
Establishing the specific stages of making a product, drawing up the technological flow		2	

Functional analysis and hierarchy of functions for a given benchmark	analytical exercises • Completion of the individual assignment • Periodic presentation (during project sessions) of the progress in completing the assignment	2	
Morphological analysis of surfaces for the given landmark		2	
Determining the material family according to Ashby diagrams		2	
Establishing the property matrix and prioritizing properties		2	
Material selection using the optimal values method		4	
Choosing and designing the technological execution process and drawing up the technological flow		4	
Determining the cost of the product and the correlation between value in use and cost		2	
Product testing and verification techniques. Aspects regarding streamlining the product design, execution and testing process		2	
Oral presentations of individual projects and peer feedback.		4	

Bibliography

1. Ashby, M.F. (2024) Materials Selection in Mechanical Design, Sixth edition, Butterworth-Heinemann Linacre House, Jordan Hill, Oxford, England, 2024.
2. Ali Jahan, Kevin L Edwards, Marjan Bahraminasa. (2016) Multi-criteria Decision Analysis for Supporting the Selection of Engineering Materials in Product Design, 2nd Edition, , Butterworth-Heinemann, Oxford, England.

9. Correlation of course content with the demands of the labour market (epistemic communities, professional associations, potential employers in the field of study)

The concepts taught alongside practical laboratory work and specific calculations for the optimal choice of industrial material necessary for the manufacture of a certain reference, are corroborated with the expectations of representatives of epistemic communities, professional associations and representative employers in the field related to the program and the curriculum is consistent with similar study programs offered by major universities in the country and abroad.

10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of the final grade
10.4 Course	Knowledge of the criteria for choosing materials to make a specific product.	Written exam with subjective items	70 %
10.5 Project	Knowledge of techniques for optimizing the choice of materials for a given product according to the thematic project.	Evaluation of individual projects and final defense	30 %
10.6 Minimal performance standard			
• The minimum exam score is 5. • Knowledge of techniques for choosing the optimal material, the design and execution process of a given product			

This course outline was certified in the Department Board meeting on …./…../…….. and approved in the Faculty Board meeting on …./…../……..

Prof. Dr. Eng. Alexandru PASCU **…………………………………………………………………………** **Dean**	**Assoc. Prof. Dr. Eng. Camelia GABOR** **……………………………………………………………………………………………** **Head of Department**
Prof. Dr. Eng. Ioan MILOȘAN **Course holder**	**Prof. Dr. Eng. Ioan MILOȘAN** **Holder of seminar/ laboratory/ project**

Note:

1) Field of study – select one of the following options: Bachelor / Master / Doctorat (to be filled in according to the forceful classification list for study programmes);

2) Study level – choose from among: Bachelor / Master / Doctorat;

3) Course status (content) – for the Bachelor level, select one of the following options: **FC** (fundamental course) / **DC** (course in the study domain)/ **SC** (speciality course)/ **CC** (complementary course); for the Master level, select one of the following options: **PC** (proficiency course)/ SC (synthesis course)/ **AC** (advanced course);

4) Course status (attendance type) – select one of the following options: **CPC** (compulsory course)/ **EC** (elective course)/ **NCPC** (non-compulsory course);

5) One credit is the equivalent of 30 study hours (teaching activities and individual study).

COURSE OUTLINE

1. Data about the study programme

1.1 Higher education institution	Transilvania University of Brașov
1.2 Faculty	Materials Science and Engineering
1.3 Department	Materials Science
1.4 Field of study[1)]	Materials Engineering
1.5 Study level[2)]	Master
1.6 Study programme/ Qualification	Materials Science, Engineering, and Management (in English)

2. Data about the course

2.1 Name of course	Process modelling, simulation, and optimization								
2.2 Course convenor	Prof. dr. eng. Miloșan Ioan								
2.3 Seminar/ laboratory/ project convenor	Prof. dr. eng. Miloșan Ioan								
2.4 Study year	I	2.5 Semester	I	2.6 Evaluation type	E	2.7 Course status	Content[3)]	SC
							Attendance type[4)]	CPC

3. Total estimated time (hours of teaching activities per semester)

3.1 Number of hours per week	**4**	out of which: 3.2 lecture	**2**	3.3 seminar/ laboratory/ project	**2/0/0**
3.4 Total number of hours in the curriculum	56	out of which: 3.5 lecture	28	3.6 seminar/ laboratory/ project	28

Time allocation	hours
Study of textbooks, course support, bibliography and notes	50
Additional documentation in libraries, specialized electronic platforms, and field research	44
Preparation of seminars/ laboratories/ projects, homework, papers, portfolios, and essays	20
Tutorial	5
Examinations	5
Other activities....................................	

3.7 Total number of hours of student activity	124
3.8 Total number per semester	180
3.9 Number of credits[5)]	6

4. Prerequisites (if applicable)

4.1 curriculum-related	•
4.2 competences-related	•

5. Conditions (if applicable)

5.1 for course development	• Classroom, blackboard, computer, video projector
5.2 for seminar/ laboratory/ project development	• Seminar room, blackboard, computer, video projector

6. Specific competences and learning outcomes

Professional competences	**Cp.1. Use of modern concepts and theories in the field of advanced materials** (ESCO - evaluates the suitability of metal types for specific applications; manipulates metals; works in metal production teams) ***Knowledge*** L.O. 1.1. The graduate defines modern concepts and theories in the field of advanced materials. L.O. 1.2. The graduate describes how materials engineering products and processes have a positive impact on global and social issues, using modern concepts and theories in the field of advanced materials. ***Skills*** L.O. 1.3. The graduate analyses data obtained from the use of the structure-property relationship for the characteristics of different types of materials and especially metallic, polymer, ceramic and composite materials. L.O. 1.4. The graduate can identify opportunities and design strategies in solving needs in the field of materials engineering. ***Responsibility and autonomy*** L.O. 1.5. The graduate has autonomy in learning. L.O. 1.6. The graduate autonomously integrates concepts and theories in materials engineering into new contexts in the workplace. **Cp.2. Identifying and defining a research topic in the field of advanced materials and developing a plan to achieve the proposed objectives** (ESCO - approaches problems critically; develops materials testing procedures; presents reports on test results) ***Knowledge*** L.O. 2.1. The graduate can identify and define a topic of actuality or of maximum necessity in the field of advanced materials through the criterial materials selection. L.O. 2.2. The graduate can identify, define and develop a specific plan for processing advanced materials according to technological parameters in achieving the proposed objectives. ***Skills*** L.O. 2.3. The graduate can develop a plan for selecting appropriate tools for advanced materials processing, using them safely to achieve the proposed objectives. L.O. 2.4. The graduate can use modern tools and techniques to modify, characterize and measure the properties of materials and to design processes according to accepted standards. ***Responsibility and autonomy*** L.O. 2.5. The student/graduate selects and uses bibliographic sources specific to the field. L.O. 2.6. The student/graduate demonstrates autonomy in learning on issues specific to the field. **Cp.5. Applying the principles of scientific research specific to the field and carrying out an oral/written communication, through which the results are presented, in a clear and convincing manner.** (ESCO - conducts scientific research; tests materials; develops advanced materials). ***Knowledge*** L.O. 5.1. The graduate knows how to apply the principles of scientific research specific to the field and to communicate clearly and concisely, both in writing and orally, regarding the results obtained by applying the principles of scientific research specific to the field of advanced materials and related fields. ***Skills*** L.O. 5.2. The graduate can apply the principles of scientific research specific to the field by acquiring the ability to perceive, understand and promote quality and creativity in research and communication of the results obtained. L.O. 5.3. The graduate can develop skills as a researcher and good communicator in the field of materials

	engineering by applying the principles of scientific research by extracting relevant conclusions from the research carried out. L.O. 5.4. The graduate knows how to correctly communicate the results of analyses and calculations carried out in scientific research, thus explaining the correctness of the proposed solutions. *Responsibility and autonomy* L.O. 5.5. The graduate assumes the intellectual paternity of his/her own research and respects the deontological norms. L.O. 5.6. The graduate demonstrates autonomy in the dissemination of knowledge by initiating and managing the publication process.
Transversal competences	**Ct.1. Performing complex professional tasks, respecting the norms of professional ethics and moral conduct, following a personal work plan established based on individual study** (ESCO - applies scientific, technological and engineering knowledge; develops strategies for solving problems.) L.O. 1.1. The graduate can perform complex professional tasks while observing the rules of professional ethics and moral conduct, following a self-established work plan based on individual study. L.O. 1.2. The graduate can identify continuous training opportunities and using them effectively for personal development in carrying out complex professional tasks, following a self-established work plan based on individual study. L.O. 1.3. The graduate is capable of recognizing, understanding, and promoting quality and creativity in performing complex professional tasks. L.O. 1.4. The graduate knows the occupational health and safety regulations, thus ensuring safe working conditions for themselves and for the team they are part of. **Ct.3. Permanent information and documentation in his/her field of activity and related fields, in correlation with the needs of the labor market** (ESCO - demonstrates a desire to learn; manages personal development.) L.O. 3.1. The graduate can identify continuous training opportunities and use them effectively for personal development in their field or related activities and domains, in correlation with labor market needs. L.O. 3.2. The graduate can develop original models to accurately describe real processes specific to materials engineering, based on thorough individual study. L.O. 3.3. The graduate is capable of objectively and effectively self-assessing their professional activity, thereby gaining an overall understanding of their own knowledge, with a strong emphasis on continuous information gathering and documentation in their field of activity.

7. Course objectives (resulting from the specific competences to be acquired)

7.1 General course objective	• Training skills to ◘ initiate future specialists in the complex issues of modeling, simulation and optimization of processes specific to materials engineering.

7.2 Specific objectives	• Assimilation of theoretical knowledge and solving calculations regarding the statistical processing of experimental data; mathematical modeling of industrial processes; simulation and optimization of processes specific to materials engineering. • Assimilation of knowledge regarding the use of specific modeling, simulation and optimization software used in materials engineering

8. Content

8.1 Course	Teaching methods	Number of hours	Remarks
Introductory notions. Modeling, simulation and optimization of industrial processes.	Interactive course, case studies, and practical exercises to develop analytical and problem-solving skills criteria for modeling, simulation and optimization software used in materials engineering	2	
Calculation of statistical parameters. Verification of statistical parameters. Student's test and Fisher's test.		4	
Mathematical modeling through classical experiment		6	
Modeling of industrial processes through active experimentation (2k and 3k). Statistical verification of coefficients, determination of the concordance of the mathematical model.		4	
Simulation of industrial processes. Use of specific software.		6	
Dynamic optimization. Optimization under industrial conditions. techniques, value analysis to establish the function/cost ratio.		6	

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1. Grossmann, E.I. (2021) Advanced Optimization for Process Systems Engineering.2 nd ed. Cambridge University Press, ISBN: 9781108831659
2. Cesar De Prada, C., Pantelides, C. and Pitarch, J.L (2019). Process Modelling and Simulation. Printed Edition of the Special Issue Published in Processes (MDPI). ISBN 978-3-03921-455-6
3. Bortz, M., Asprion, N (2022). Simulation and Optimization in Process Engineering. The Benefit of Mathematical Methods in Applications of the Chemical Industry. 1st Edition, Imprint: Elsevier. ISBN: 9780323850438
4. Luyben, L. W. (1996). Process modeling, simulation and control for chemical engineers. International Edition McGraw-Hill Company. ISBN: 0-07-039159-9
5. Milosan, I. (2015). Mathematical modeling by using a C++ software, Scientific Research & Education in the Air Force - AFASES 2015, v. 2, ISSN 2247-3173, p. 631-638.
6. Milosan, I. (2015). Optimization of Industrial Processes using a Special Software. Scientific Research & Education in the Air Force - AFASES Vol. 2, p. 639-644, ISSN 2247-3173.

8.2 Project	Teaching-learning methods	Number of hours	Remarks
Presentation of the laboratory topic. Presentation of specific OSH notions	Presentation, individual work, case studies and practical exercises to develop analytical and problem-solving skills in process modelling, simulation, and	2	
Statistical processing of experimental data specific to the field of materials engineering. Removal of abnormal results using tests: r_{max}/r_{min}, Chauvenet, Romanowski. et. al.		4	
Mathematical modeling through classical		4	

experiments and active experiments of domain-specific data	optimization		
Using OriginPro software (Data analysis and Graphing Software) to plot specific graphs of the analyzed experimental data.		6	
Practical applications of computer simulation of the analyzed technological process.		4	
Optimization under industrial conditions of the analyzed process using linear programming.		6	
Recoveries and termination of the laboratory situation		2	

Bibliography

Grossmann, E.I. (2021) *Advanced Optimization for Process Systems Engineering*.2nd ed. Cambridge University Press, ISBN: 9781108831659

Cesar De Prada, C., Pantelides, C. and Pitarch, J.L (2019). *Process Modelling and Simulation*. Printed Edition of the Special Issue Published in Processes (MDPI). ISBN 978-3-03921-455-6

Bortz, M., Asprion, N (2022). *Simulation and Optimization in Process Engineering. The Benefit of Mathematical Methods in Applications of the Chemical Industry.* 1st Edition, Imprint: Elsevier. ISBN: 9780323850438

Luyben, L. W. (1996). *Process modeling, simulation and control for chemical engineers*. International Edition McGraw-Hill Company. ISBN: 0-07-039159-9

9. Correlation of course content with the demands of the labour market (epistemic communities, professional associations, potential employers in the field of study)

The concepts taught, along with the performance of calculations specific to the modeling, simulation and optimization of industrial processes, are corroborated with the expectations of representatives of epistemic communities, professional associations and representative employers in the field related to the program.

10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of the final grade
10.4 Course	Applications of mathematical statistics to the processing and interpretation of experimental data	Written exam with subjective items	20 %
	Mathematical modeling through classical and active experimentation		25 %
	Simulation and optimization under industrial conditions.		25 %
10.5 Laboratory	Calculations specific to mathematical modeling of industrial processes	Ongoing evaluation with subjective items Evaluation of individual projects and final defense	15 %
	Calculations specific to optimization and simulation under industrial conditions.		15 %
10.6 Minimal performance standard			
• Performing mathematical modeling of industrial processes • Performing simulation and optimization under industrial conditions.			

This course outline was certified in the Department Board meeting on …./…../…….. and approved in the Faculty Board meeting on …./…../……..

Prof. Dr. Eng. Alexandru PASCU **…………………………………………………………………………** **Dean**	**Assoc. Prof. Dr. Eng. Camelia GABOR** **………………………………………………………………………………………………………** **Head of Department**
Prof. Dr. Eng. Ioan MILOȘAN **Course holder**	**Prof. Dr. Eng. Ioan MILOȘAN** **Holder of seminar/ laboratory/ project**

Note:

1) Field of study – select one of the following options: Bachelor / Master / Doctorat (to be filled in according to the forceful classification list for study programmes);

2) Study level – choose from among: Bachelor / Master / Doctorat;

3) Course status (content) – for the Bachelor level, select one of the following options: **FC** (fundamental course) / **DC** (course in the study domain)/ **SC** (speciality course)/ **CC** (complementary course); for the Master level, select one of the following options: **PC** (proficiency course)/ SC (synthesis course)/ **AC** (advanced course);

4) Course status (attendance type) – select one of the following options: **CPC** (compulsory course)/ **EC** (elective course)/ **NCPC** (non-compulsory course);

5) One credit is the equivalent of 30 study hours (teaching activities and individual study).

COURSE OUTLINE

1. Data about the study programme

1.1 Higher education institution	Transilvania University of Brașov
1.2 Faculty	Materials Science and Engineering
1.3 Department	Materials Science
1.4 Field of study[1)]	Materials Engineering
1.5 Study level[2)]	Master
1.6 Study programme/ Qualification	Materials Science, Engineering, and Management

2. Data about the course

2.1 Name of course	Ethics and academic integrity							
2.2 Course convenor	Prof. dr. eng. Daniel Cristea							
2.3 Seminar/ laboratory/ project convenor	Prof. dr. eng. Daniel Cristea							
2.4 Study year	1	2.5 Semester	I	2.6 Evaluation type	V	2.7 Course status	Content[3)]	CC
							Attendance type[4)]	CPC

3. Total estimated time (hours of teaching activities per semester)

3.1 Number of hours per week	**3**	out of which: 3.2 lecture	**2**	3.3 seminar/ laboratory/ project	**1**
3.4 Total number of hours in the curriculum	42	out of which: 3.5 lecture	28	3.6 seminar/ laboratory/ project	14

Time allocation	hours
Study of textbooks, course support, bibliography and notes	28
Additional documentation in libraries, specialized electronic platforms, and field research	4
Preparation of seminars/ laboratories/ projects, homework, papers, portfolios, and essays	14
Tutorial	
Examinations	2
Other activities…………………………….	

3.7 Total number of hours of student activity	48
3.8 Total number per semester	90
3.9 Number of credits[5)]	3

4. Prerequisites (if applicable)

4.1 curriculum-related	•
4.2 competences-related	•

5. Conditions (if applicable)

5.1 for course development	• Participation in the course; prior review of the indicated bibliographic references in order to engage in dialogue with the professor on specific topics. Absence of disruptive factors.
5.2 for seminar/ laboratory/ project development	• Participation in the project; review of the indicated bibliographic references.

6. Specific competences and learning outcomes

Professional competences	**Cp.1. Use of modern concepts and theories in the field of advanced materials** (ESCO - evaluates the suitability of metal types for specific applications; manipulates metals; works in metal production teams) ***Knowledge*** L.O. 1.1. The graduate defines modern concepts and theories in the field of advanced materials. L.O. 1.2. The graduate describes how materials engineering products and processes have a positive impact on global and social issues, using modern concepts and theories in the field of advanced materials. ***Skills*** L.O. 1.3. The graduate analyses data obtained from the use of the structure-property relationship for the characteristics of different types of materials and especially metallic, polymer, ceramic and composite materials. L.O. 1.4. The graduate can identify opportunities and design strategies in solving needs in the field of materials engineering. ***Responsibility and autonomy*** L.O. 1.5. The graduate has autonomy in learning. L.O. 1.6. The graduate autonomously integrates concepts and theories in materials engineering into new contexts in the workplace. **Cp.2. Identifying and defining a research topic in the field of advanced materials and developing a plan to achieve the proposed objectives** (ESCO - approaches problems critically; develops materials testing procedures; presents reports on test results) ***Knowledge*** L.O. 2.1. The graduate can identify and define a topic of actuality or of maximum necessity in the field of advanced materials through the criterial materials selection. L.O. 2.2. The graduate can identify, define and develop a specific plan for processing advanced materials according to technological parameters in achieving the proposed objectives. ***Skills*** L.O. 2.3. The graduate can develop a plan for selecting appropriate tools for advanced materials processing, using them safely to achieve the proposed objectives. L.O. 2.4. The graduate can use modern tools and techniques to modify, characterize and measure the properties of materials and to design processes according to accepted standards. ***Responsibility and autonomy*** L.O. 2.5. The student/graduate selects and uses bibliographic sources specific to the field. L.O. 2.6. The student/graduate demonstrates autonomy in learning on issues specific to the field. **Cp.3. Application of modern analytical techniques adapted to the field of advanced materials and related fields** (ESCO - performs laboratory tests; prepares samples for analysis; performs sample analysis; uses chemical analysis equipment; applies laboratory safety procedures; performs

	metallurgical structural analysis) ***Knowledge*** L.O. 3.1. The graduate has a deep understanding of various modern analytical techniques, adapted to the field of advanced materials and related fields. L.O. 3.2. The graduate uses various modelling, simulation and optimization software techniques and applications, adapted to the field of advanced materials and related fields. L.O. 3.3. The graduate can collect, interpret and analyze data that is specific to the application of modern analytical techniques to extract relevant conclusions in the field of advanced materials and related fields. ***Skills*** L.O. 3.4. The graduate can design and analyze experiments appropriate to modern analytical techniques in the field of advanced materials and related fields, incorporating statistical procedures. L.O. 3.5. The graduate can use modelling, simulation and optimization software programs to develop and evaluate new materials. ***Responsibility and autonomy*** L.O. 3.6. The graduate ensures the rigor of the analysis through judicious selection of data and methods. L.O. 3.7. The graduate assumes responsibility for the validity of the conclusions resulting from the data analysis.
Transversal competences	**Ct.1. Performing complex professional tasks, respecting the norms of professional ethics and moral conduct, following a personal work plan established based on individual study** (ESCO - applies scientific, technological and engineering knowledge; develops strategies for solving problems.) L.O. 1.1. The graduate can perform complex professional tasks while observing the rules of professional ethics and moral conduct, following a self-established work plan based on individual study. L.O. 1.2. The graduate can identify continuous training opportunities and using them effectively for personal development in carrying out complex professional tasks, following a self-established work plan based on individual study. L.O. 1.3. The graduate is capable of recognizing, understanding, and promoting quality and creativity in performing complex professional tasks. L.O. 1.4. The graduate knows the occupational health and safety regulations, thus ensuring safe working conditions for themselves and for the team they are part of. **Ct.2. Planning, monitoring and assuming the professional tasks of a subordinate professional group(s)** (ESCO - has teamwork capacity; demonstrates organizational skills) L.O. 2.1. The graduate can plan and monitor the execution of complex professional tasks carried out by a group or subordinate professional teams. L.O. 2.2. The graduate can take responsibility for the consequences of decisions made while coordinating complex professional activities carried out by a group or subordinate professional teams.

7. Course objectives (resulting from the specific competences to be acquired)

7.1 General course objective	• Acquiring specific concepts of ethics and academic integrity for their application in developing a responsible professional career.
7.2 Specific objectives	• Developing the ability to understand and value the main viewpoints regarding academic ethics; • Developing skills for identifying and solving problems with ethical implications (ethical dilemmas); • Acquiring knowledge related to academic writing.

8. Content

8.1 Course	Teaching methods	Number of hours	Remarks
Presentation of the topics. Definition of ethics, integrity, interdisciplinary approaches.	Lecture, interactive course, debate	2	
The great ethical traditions. Theoretical ethics and applied ethics. Ethical dilemmas.		6	
Ethical issues and the internet.		4	
Applied ethics. The psychology of morality.		4	
Professional ethical codes.		4	
Institutional integrity culture. Academic writing.		8	
Bibliography 1. Sarah Elaine Eaton, (2024). Second Handbook of Academic Integrity, Springer 2. Connie Strittmatter, Virginia K Bratton (2016) Teaching Plagiarism Prevention to College Students: An Ethics-Based Approach, Rowman & Littlefield Publishers			
8.2 Project	**Teaching-learning methods**	**Number of hours**	**Remarks**
A paper is to be prepared on a pre-established topic related to the course theme	Teamwork, brainstorming, debate	14	
Bibliography 1. Sarah Elaine Eaton, (2024). Second Handbook of Academic Integrity, Springer 2. Connie Strittmatter, Virginia K Bratton (2016) Teaching Plagiarism Prevention to College Students: An Ethics-Based Approach, Rowman & Littlefield Publishers			

9. Correlation of course content with the demands of the labour market (epistemic communities, professional associations, potential employers in the field of study)

The curriculum is in line with the needs of representative employers in the field of advanced materials engineering and management.

10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of the final grade
10.4 Course	Continuous activity and course participation. Participation in debates.	Ongoing assessment	10 %

	Written exam (complex test): • correct use of specific terms and course concepts; • Writing an essay demonstrating the acquisition of ethics and academic integrity concepts.	Summative assessment	60 %
10.5 Project	Continuous activity and project participation: • active participation in the project – relevant contributions, pertinent questions, engagement in debates; • collaboration in team tasks and supporting one's own viewpoints. Completion of applied tasks: • correct completion of assignments and applications proposed during project sessions; Quality of answers: • correct use of specific terminology; • logical argumentation and analytical coherence;	Ongoing assessment	30 %
10.6 Minimal performance standard			
• To achieve a grade of 5, students must demonstrate an understanding of the concept of academic ethics and integrity within the academic environment, as well as knowledge of academic writing rules and the concept of plagiarism.			

This course outline was certified in the Department Board meeting on …./…../…….. and approved in the Faculty Board meeting on …./…../……..

Prof. dr. eng. Alexandru PASCU ………………………………………………………………………… **Dean**	**Assoc. Prof. dr. eng. Camelia GABOR** …………………………………………………………………………………………………… **Head of Department**
Prof. dr. eng. Daniel CRISTEA ………………………………………………………………………… **Course holder**	**Prof. dr. eng. Daniel CRISTEA** …………………………………………………………………………………………………… **Holder of seminar/ laboratory/ project**

Note:

1) Field of study – select one of the following options: Bachelor / Master / Doctorat (to be filled in according to the forceful classification list for study programmes);

2) Study level – choose from among: Bachelor / Master / Doctorat;

3) Course status (content) – for the Bachelor level, select one of the following options: **FC** (fundamental course) / **DC** (course in the study domain)/ **SC** (speciality course)/ **CC** (complementary course); for the Master level, select one of the following options: **PC** (proficiency course)/ SC (synthesis course)/ **AC** (advanced course);

4) Course status (attendance type) – select one of the following options: **CPC** (compulsory course)/ **EC** (elective course)/ **NCPC** (non-compulsory course);

5) One credit is the equivalent of 30 study hours (teaching activities and individual study).

COURSE OUTLINE

1. Data about the study programme

1.1 Higher education institution	Transilvania University of Brasov
1.2 Faculty	Materials Science and Engineering
1.3 Department	Materials Science
1.4 Field of study[1)]	Materials engineering
1.5 Study level[2)]	Master
1.6 Study programme/ Qualification	Materials Science, Engineering and Management

2. Data about the course

2.1 Name of course	Fundamentals of solid-state phase transformations							
2.2 Course convenor	Professor dr. eng. Daniel Munteanu							
2.3 Seminar/ laboratory/ project convenor	Professor dr. eng. Maria Stoicanescu							
2.4 Study year	1	2.5 Semester	2	2.6 Evaluation type	E	2.7 Course status	Content[3)]	FC
							Attendance type[4)]	CPC

3. Total estimated time (hours of teaching activities per semester)

3.1 Number of hours per week	**3**	out of which: 3.2 lecture	**2**	3.3 seminar/ laboratory/ project	**1**
3.4 Total number of hours in the curriculum	42	out of which: 3.5 lecture	28	3.6 seminar/ laboratory/ project	14
Time allocation					hours
Study of textbooks, course support, bibliography and notes					35
Additional documentation in libraries, specialized electronic platforms, and field research					15
Preparation of seminars/ laboratories/ projects, homework, papers, portfolios, and essays					20
Tutorial					4
Examinations					4
Other activities....................................					

3.7 Total number of hours of student activity	78
3.8 Total number per semester	120
3.9 Number of credits[5)]	4

4. Prerequisites (if applicable)

4.1 curriculum-related	Graduate standing and a graduate course in thermodynamics and materials science and engineering.
4.2 competences-related	•

5. Conditions (if applicable)

5.1 for course development	Classroom, blackboard, chalk, computer, video projector, flipchart
5.2 for seminar/ laboratory/ project development	•

6. Specific competences and learning outcomes

Professional competences	**Cp1. Use of modern concepts and theories in the field of advanced materials** *Knowledge:* L.O. 1.1 The graduate defines modern concepts and theories in the field of advanced materials. *Skills:* L.O. 1.4 The graduate can identify opportunities and design strategies in solving needs in the field of materials engineering. *Responsibility and autonomy:* L.O. 1.6 The graduate autonomously integrates concepts and theories in materials engineering into new contexts in the workplace. **Cp.2. Identifying and defining a research topic in the field of advanced materials and developing a plan to achieve the proposed objectives** *Knowledge:* L.O. 2.1 The graduate can identify and define a topic of actuality or of maximum necessity in the field of advanced materials through the criterial materials selection. *Skills:* L.O. 2.4 The graduate can use modern tools and techniques to modify, characterize and measure the properties of materials and to design processes according to accepted standards. *Responsibility and autonomy:* L.O. 2.5 The student/graduate selects and uses bibliographic sources specific to the field. **Cp.3. Application of modern analytical techniques adapted to the field of advanced materials and related fields** *Knowledge:* L.O. 3.3 The graduate can collect, interpret and analyze data that is specific to the application of modern analytical techniques to extract relevant conclusions in the field of advanced materials and related fields. *Skills:* L.O. 3.4 The graduate can design and analyze experiments appropriate to modern analytical techniques in the field of advanced materials and related fields, incorporating statistical procedures. *Responsibility and autonomy:* L.O. 3.7 The graduate assumes responsibility for the validity of the conclusions resulting from the data analysis. **Cp.5. Applying the principles of scientific research specific to the field and carrying out an oral/written communication, through which the results are presented, in a clear and convincing manner** *Knowledge:* L.O. 5.1 The graduate knows how to apply the principles of scientific research specific to the field and to communicate clearly and concisely, both in writing and orally, regarding the results obtained by applying the principles of scientific research specific to the field of advanced materials and related fields. *Skills:* L.O. 5.3 The graduate can develop skills as a researcher and good communicator in the field of materials engineering by applying the principles of scientific research by extracting relevant conclusions from the research carried out. *Responsibility and autonomy:* L.O. 5.6 The graduate demonstrates autonomy in the dissemination of knowledge by initiating and managing the publication process.
Transversal competences	**Ct.3. Permanent information and documentation in his/her field of activity and related fields, in correlation with the needs of the labor market** L.O. 3.2. The graduate can develop original models to accurately describe real processes specific to materials engineering, based on thorough individual study.

7. Course objectives (resulting from the specific competences to be acquired)

7.1 General course objective	To develop the knowledge regarding the base of phase transformations in solid materials: thermo-dynamics, kinetics, diffusion theory, structures and properties of interfaces.
7.2 Specific objectives	1. to explain phase transformations in solid materials, transformations of different order, homogeneous and heterogeneous reactions, nucleation and growth, classification of trans-formations, activated processes, coherence at nucleation, facetted growth, effect of structure of interfaces, mathematical background of diffusion, exact and approximate solutions; 2. to characterize and comment the main types of phase equilibrium diagrams (qualitative and quantitative analysis);

	3. to explain the theoretical background of the solid-state transformations based on diffusion; 4. to explain the theoretical background of the solid-state transformations without diffusion;

8. Content

8.1 Course	Teaching methods	Number of hours	Remarks
1. General aspects on solid-state phase transformations thermodynamics (equilibrium in thermodynamic systems, single-component systems, bi-component systems, thermodynamic equilibrium in heterogeneous systems).	PPT presentation, collaborative learning	4	
2. Qualitative and quantitative interpretation of phase equilibrium diagrams (binary isomorphic systems, binary eutectic systems, peritectic and eutectoid systems, phase law – Gibbs, Fe-C system).	PPT presentation, collaborative learning	4	
3. Diffusion processes in metals and alloys (the diffusion process discussed by the free energy state, atomic mechanisms of diffusion, diffusion laws (Fick) – stationary and non-stationary conditions).	PPT presentation, collaborative learning	6	
4. Solid-state phase transformations based on diffusion processes (homogeneous nucleation, heterogeneous nucleation, precipitates growth, kinetics of solid phase transformations – Johnson-Mehl-Avrami equation models, Temperature-Time-Transformation (TTT) diagrams, precipitation of age hardenable alloys, ferrite precipitation from austenite, eutectoid transformations, massive solid-state transformations).	PPT presentation, collaborative learning	10	
5. Martensitic transformation (characteristics of diffusionless transformation, martensite crystallography, martensite nucleation theories, martensite growth, tempering of ferrous martensite).	PPT presentation, collaborative learning	4	

Bibliography:

[1]. D.A. Porter, K.E. Easterling, M.Y. Sherif, Phase Transformations in Metals and Alloys, third edition, CRC Press – Taylor and Francis Group, 2009.

[2]. D.A. Porter, K.E. Easterling, M.Y. Sherif, Phase Transformations in Metals and Alloys, fourth edition, CRC Press – Taylor and Francis Group, 2022.

[3]. W.A. Soffa, D.E. Laughlin, 8 - Diffusional Phase Transformations in the Solid State, Physical Metallurgy (Fifth edition) 2014, Elsevier, pp. 851-1020.

[4]. A. Khawam, D.R. Flanagan, Solid-State Kinetic Models: Basics and Mathematical Fundamentals**,** *J. Phys. Chem. B,* 2006, 110, 35, 17315–17328.

8.2 Seminar/ laboratory/ project	Teaching-learning methods	Number of hours	Remarks
Laboratory topic presentation. The rule of the horizontal and the lever	Practical work	2	

Equilibrium and non-equilibrium structures of steels, metallographic aspects	Practical work	2	
Determination of critical transformation points by dilatometric method upon heating and cooling, determination of activation energy	Practical work	2	
Studying the decomposition of supersaturated solid solutions in the Al-Si (Al-Cu) system using a dilatometer, determining the activation energy	Practical work	2	
Determination of the activation energy of transformations in an alloy using thermal analysis (DSC/TGA)	Practical work	2	
Transformations in real material systems	Practical work	2	
Laboratory recoveries	Practical work	2	

Bibliography

[1]. D.A. Porter, K.E. Easterling, M.Y. Sherif, Phase Transformations in Metals and Alloys, third edition, CRC Press – Taylor and Francis Group, 2009.

[2]. D.A. Porter, K.E. Easterling, M.Y. Sherif, Phase Transformations in Metals and Alloys, fourth edition, CRC Press – Taylor and Francis Group, 2022.

[3]. W.A. Soffa, D.E. Laughlin, 8 - Diffusional Phase Transformations in the Solid State, Physical Metallurgy (Fifth edition) 2014, Elsevier, pp. 851-1020.

[4]. A. Khawam, D.R. Flanagan, Solid-State Kinetic Models: Basics and Mathematical Fundamentals**,** *J. Phys. Chem. B,* 2006, 110, 35, 17315–17328.

9. Correlation of course content with the demands of the labour market (epistemic communities, professional associations, potential employers in the field of study)

The course perfectly meets the demands of the labor market in the area of materials engineering, practically establishing the fundamental elements associated with the technological processes of hot processing (in the solid state) of metals and alloys.

10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of the final grade
10.4 Course	Level of mastery of the theoretical knowledge taught	Oral exam and quiz	75%
10.5 Seminar/ laboratory/ project	Level of mastery of the theoretical and practical knowledge aquired	Laboratory colloquium exam	25%
10.6 Minimal performance standard			
- Participation in the exam is conditional on completing all laboratory work and passing the laboratory colloquium with a minimum grade of 5. - Correctly solving at least 50% of the exam topics.			

This course outline was certified in the Department Board meeting on …./…../…….. and approved in the Faculty Board meeting on …./…../……..

Professor dr. eng. Alexandru PASCU **Dean**	**Associate professor dr. eng. Camelia GABOR** **Head of Department**
Professor dr. eng. Daniel MUNTEANU **Course holder**	**Professor dr. eng. Maria STOICĂNESCU** **Holder of seminar/ laboratory/ project**

Note:

1) Field of study – select one of the following options: Bachelor / Master / Doctorat (to be filled in according to the forceful classification list for study programmes);

2) Study level – choose from among: Bachelor / Master / Doctorat;

3) Course status (content) – for the Bachelor level, select one of the following options: **FC** (fundamental course) / **DC** (course in the study domain)/ **SC** (speciality course)/ **CC** (complementary course); for the Master level, select one of the following options: **PC** (proficiency course)/ SC (synthesis course)/ **AC** (advanced course);

4) Course status (attendance type) – select one of the following options: **CPC** (compulsory course)/ **EC** (elective course)/ **NCPC** (non-compulsory course);

5) One credit is the equivalent of 25 study hours (teaching activities and individual study).

COURSE OUTLINE

1. Data about the study programme

1.1 Higher education institution	Transilvania University of Brașov
1.2 Faculty	Materials Science and Engineering
1.3 Department	Materials Science
1.4 Field of study[1)]	Materials Engineering
1.5 Study level[2)]	Master
1.6 Study programme/ Qualification	Materials Science, Engineering, and Management

2. Data about the course

2.1 Name of course	Advanced characterization methods							
2.2 Course convenor	Prof. dr. eng. Daniel Cristea							
2.3 Seminar/ laboratory/ project convenor	Lect. dr. eng. Andreea Crisbășan							
2.4 Study year	1	2.5 Semester	II	2.6 Evaluation type	E	2.7 Course status	Content[3)]	SC
							Attendance type[4)]	CPC

3. Total estimated time (hours of teaching activities per semester)

3.1 Number of hours per week	**4**	out of which: 3.2 lecture	**2**	3.3 seminar/ laboratory/ project	**2**
3.4 Total number of hours in the curriculum	56	out of which: 3.5 lecture	28	3.6 seminar/ laboratory/ project	28
Time allocation					hours
Study of textbooks, course support, bibliography and notes					46
Additional documentation in libraries, specialized electronic platforms, and field research					46
Preparation of seminars/ laboratories/ projects, homework, papers, portfolios, and essays					28
Tutorial					
Examinations					4
Other activities....................................					

3.7 Total number of hours of student activity	124
3.8 Total number per semester	180
3.9 Number of credits[5)]	6

4. Prerequisites (if applicable)

4.1 curriculum-related	• Attendance to the course: Introduction to Materials Science
4.2 competences-related	• Basic concepts of materials science

5. Conditions (if applicable)

5.1 for course development	• Participation in the course; prior review of the indicated bibliographic references in order to engage in dialogue with the professor on specific topics. Absence of disruptive factors.
5.2 for seminar/ laboratory/ project development	• Participation in the laboratory activitites; review of the indicated bibliographic references.

6. Specific competences and learning outcomes

Professional competences	**Cp.1. Use of modern concepts and theories in the field of advanced materials** (ESCO - evaluates the suitability of metal types for specific applications; manipulates metals; works in metal production teams) ***Knowledge*** L.O. 1.1. The graduate defines modern concepts and theories in the field of advanced materials. L.O. 1.2. The graduate describes how materials engineering products and processes have a positive impact on global and social issues, using modern concepts and theories in the field of advanced materials. ***Skills*** L.O. 1.3. The graduate analyses data obtained from the use of the structure-property relationship for the characteristics of different types of materials and especially metallic, polymer, ceramic and composite materials. L.O. 1.4. The graduate can identify opportunities and design strategies in solving needs in the field of materials engineering. ***Responsibility and autonomy*** L.O. 1.5. The graduate has autonomy in learning. L.O. 1.6. The graduate autonomously integrates concepts and theories in materials engineering into new contexts in the workplace. **Cp.3. Application of modern analytical techniques adapted to the field of advanced materials and related fields** (ESCO - performs laboratory tests; prepares samples for analysis; performs sample analysis; uses chemical analysis equipment; applies laboratory safety procedures; performs metallurgical structural analysis) ***Knowledge*** L.O. 3.1. The graduate has a deep understanding of various modern analytical techniques, adapted to the field of advanced materials and related fields. L.O. 3.2. The graduate uses various modelling, simulation and optimization software techniques and applications, adapted to the field of advanced materials and related fields. L.O. 3.3. The graduate can collect, interpret and analyze data that is specific to the application of modern analytical techniques to extract relevant conclusions in the field of advanced materials and related fields. ***Skills*** L.O. 3.4. The graduate can design and analyze experiments appropriate to modern analytical techniques in the field of advanced materials and related fields, incorporating statistical procedures. L.O. 3.5. The graduate can use modelling, simulation and optimization software programs to develop and evaluate new materials. ***Responsibility and autonomy*** L.O. 3.6. The graduate ensures the rigor of the analysis through judicious selection of data and

	methods. L.O. 3.7. The graduate assumes responsibility for the validity of the conclusions resulting from the data analysis.
Transversal competences	**Ct.1. Performing complex professional tasks, respecting the norms of professional ethics and moral conduct, following a personal work plan established based on individual study** (ESCO - applies scientific, technological and engineering knowledge; develops strategies for solving problems.) L.O. 1.1. The graduate can perform complex professional tasks while observing the rules of professional ethics and moral conduct, following a self-established work plan based on individual study. L.O. 1.2. The graduate can identify continuous training opportunities and using them effectively for personal development in carrying out complex professional tasks, following a self-established work plan based on individual study. L.O. 1.3. The graduate is capable of recognizing, understanding, and promoting quality and creativity in performing complex professional tasks. L.O. 1.4. The graduate knows the occupational health and safety regulations, thus ensuring safe working conditions for themselves and for the team they are part of.

7. Course objectives (resulting from the specific competences to be acquired)

7.1 General course objective	• Developing skills in investigating and characterizing materials, and in evaluating and interpreting the obtained experimental data.
7.2 Specific objectives	• Understanding how to approach a physicochemical analysis (sample preparation, selection of the physicochemical analysis method); • Proper use of equipment and investigation methods; • Developing the ability to analyze and interpret experimental data.

8. Content

8.1 Course	Teaching methods	Number of hours	Remarks
Introductory notions of metrology: history, standardization, strategies for quantitative and qualitative analysis, statistical processing.	Lecture, debate	3	
The structure of a material and types of structures. Techniques for structural investigation. Methods and instruments that reveal the crystalline lattice image. X-ray diffraction, interpretation of a diffraction pattern.		6	
Methods and instruments that reveal the topography and morphology of a surface, the chemical composition, and the distribution of chemical elements (SEM, TEM, AFM, EDAX). X-ray spectrometry.		6	
Determination of thermal properties: thermal conductivity, specific heat, expansion, thermomechanical analyses.		3	
Determination of electrical properties: electrical conductivity of metallic materials; determination of dielectric characteristics; semiconductors.		3	
Measurement of magnetic and optical properties.		3	
Determination of functional properties: corrosion resistance, wear resistance.		2	
Determination of functional properties: biological response; biocompatibility; environmental impact.		2	

Bibliography

1. Khalid Sultan – Practical Guide to Materials Characterization. Techniques and Applications – Wiley, 2023
2. Horst Czichos, Tetsuya Saito, Leslie Smith (Editori) - Springer Handbook of Materials Measurement Methods – Springer, 2006
3. Terry L. Alford et al. - Fundamentals of Nanoscale Film Analysis - Springer, 2007
4. Hans Kuzmany - Solid-State Spectroscopy – Springer, 2009
5. Anthony C. Fischer-Cripps – Nanoindentation – Springer, 2011

8.2 Laboratory	Teaching-learning methods	Number of hours	Remarks
Processing the results and interpreting the graphs obtained from structural and chemical composition characterization.	Experiment Explanation Conversation	4	X-ray diffractometer Scanning Electron Microscope (SEM) SERS–RAMAN investigation system Atomic force microscope
Analysis of data obtained from the mechanical		4	Equipments used:

characterization of coarse materials. Statistical processing of results obtained from the mechanical and functional characterization of nanometric materials.			Microhardness tester Universal mechanical testing machine Atomic force microscope Scanning Electron Microscope (SEM) High-resolution digital microscope Nanoindenter
Determination of thermal properties and/or phase transformations. Thermogravimetric analysis, differential thermal analysis, differential scanning calorimetry.		6	Equipments used: Dilatometer Differential thermal analyzer
Determination of functional properties: biological response; biocompatibility.		4	Equipments used: High-resolution digital microscope UV-VIS spectrophotometer
Electrochemical methods for analyzing corrosion behavior		4	Equipments used: High-resolution digital microscope Potentiostat Power sources
Determination of electrical properties: electrical conductivity of materials		4	4-point probe multimeter
Final laboratory assessment		2	

Bibliography

1. Khalid Sultan – Practical Guide to Materials Characterization. Techniques and Applications – Wiley, 2023
2. Horst Czichos, Tetsuya Saito, Leslie Smith (Editori) - Springer Handbook of Materials Measurement Methods – Springer, 2006
3. Terry L. Alford et al. - Fundamentals of Nanoscale Film Analysis - Springer, 2007
4. Hans Kuzmany - Solid-State Spectroscopy – Springer, 2009
5. Anthony C. Fischer-Cripps – Nanoindentation – Springer, 2011

9. Correlation of course content with the demands of the labour market (epistemic communities, professional associations, potential employers in the field of study)

The curriculum aligns with the needs of representative employers in the field of advanced materials engineering and management. The course content follows current academic trends and ensures a high relevance of the skills imparted to students. It reflects methods and theories accepted by the scientific community and is consistent with state-of-the-art approaches, enabling students to build a solid and up-to-date scientific foundation.

10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of the final grade

10.4 Course	Knowledge of investigation techniques, analytical principles, equipment, and interpretation of results.	Ongoing assessment Summative assessment	70 %
10.5 Laboratory	Correct acquisition and interpretation of data regarding material characteristics and the correlation between properties, influencing factors, and structure.	Final laboratory assessment	30 %
10.6 Minimal performance standard			
• Achieving at least 50% of the points allocated for the course and practical activities. Attendance at practical activities is mandatory and a prerequisite for taking the exam. Passing the exam requires knowledge of at least three methods for analyzing and characterizing materials.			

This course outline was certified in the Department Board meeting on …./…../…….. and approved in the Faculty Board meeting on …./…../……..

Prof. dr. eng. Alexandru PASCU **………………………………………………………………………** **Dean**	**Assoc. Prof. dr. eng. Camelia GABOR** **…………………………………………………………………………………………………** **Head of Department**
Prof. dr. eng. Daniel CRISTEA **……………………………………………………………………** **Course holder**	**Lect. dr. eng. Andreea Crisbășan** **…………………………………………………………………………………………………** **Holder of seminar/ laboratory/ project**

Note:

1) Field of study – select one of the following options: Bachelor / Master / Doctorat (to be filled in according to the forceful classification list for study programmes);

2) Study level – choose from among: Bachelor / Master / Doctorat;

3) Course status (content) – for the Bachelor level, select one of the following options: **FC** (fundamental course) / **DC** (course in the study domain)/ **SC** (speciality course)/ **CC** (complementary course); for the Master level, select one of the following options: **PC** (proficiency course)/ SC (synthesis course)/ **AC** (advanced course);

4) Course status (attendance type) – select one of the following options: **CPC** (compulsory course)/ **EC** (elective course)/ **NCPC** (non-compulsory course);

5) One credit is the equivalent of 30 study hours (teaching activities and individual study).

COURSE OUTLINE

1. Data about the study programme

1.1 Higher education institution	Transilvania University of Brașov
1.2 Faculty	Materials Science and Engineering
1.3 Department	Materials Science
1.4 Field of study[1)]	Materials Engineering
1.5 Study level[2)]	Master
1.6 Study programme/ Qualification	Materials Science, Engineering, and Management

2. Data about the course

2.1 Name of course			Nanomaterials					
2.2 Course convenor			Assoc. Prof. dr. eng. Ioana Popescu Assoc. Prof. dr. eng. Vasile-Adrian Surdu					
2.3 Seminar/ laboratory/ project convenor			Assoc. Prof. dr. eng. Ioana Popescu Assoc. Prof. dr. eng. Vasile-Adrian Surdu					
2.4 Study year	1	2.5 Semester	2	2.6 Evaluation type	E	2.7 Course status	Content[3)]	SC
							Attendance type[4)]	CPC

3. Total estimated time (hours of teaching activities per semester)

3.1 Number of hours per week	**5**	out of which: 3.2 lecture	**2**	3.3 seminar/ laboratory/ project	**0/2/1**
3.4 Total number of hours in the curriculum	70	out of which: 3.5 lecture	28	3.6 seminar/ laboratory/ project	0/28/14
Time allocation					hours
Study of textbooks, course support, bibliography and notes					35
Additional documentation in libraries, specialized electronic platforms, and field research					15
Preparation of seminars/ laboratories/ projects, homework, papers, portfolios, and essays					20
Tutorial					5
Examinations					5
Other activities....................................					

3.7 Total number of hours of student activity	80
3.8 Total number per semester	150
3.9 Number of credits[5)]	5

4. Prerequisites (if applicable)

4.1 curriculum-related	• Attendance of the courses: Introduction to materials science
4.2 competences-related	• The student/graduate analyzes and explains theoretical and experimental results related to the production/obtaining, processing, characterization, and testing of materials. • The student/graduate selects and applies basic concepts, principles, and methods from the field for calculations related to the design, production, processing, and management of engineering materials. • The student/graduate selects and uses bibliographic sources specific to the field.

5. Conditions (if applicable)

5.1 for course development	• Participation in the course; prior review of the indicated bibliographic references to

	engage in dialogue with the professor on specific topics. Absence of disruptive factors.
5.2 for seminar/ laboratory/ project development	• Participation in the project and laboratory activities; review of the indicated bibliographic references. • Laboratory with devices and equipment specific to nanomaterials synthesis and characterization. • The deadline for submitting and presenting the laboratory work is set by the course instructor, in agreement with the students.

6. Specific competences and learning outcomes

Professional competences	**Cp.1. Use of modern concepts and theories in the field of advanced materials** (ESCO - evaluates the suitability of metal types for specific applications; manipulates metals; works in metal production teams) ***Knowledge*** L.O. 1.1. The graduate defines modern concepts and theories in the field of advanced materials. L.O. 1.2. The graduate describes how materials engineering products and processes have a positive impact on global and social issues, using modern concepts and theories in the field of advanced materials. ***Skills*** L.O. 1.3. The graduate analyses data obtained from the use of the structure-property relationship for the characteristics of different types of materials and especially metallic, polymer, ceramic and composite materials. L.O. 1.4. The graduate can identify opportunities and design strategies in solving needs in the field of materials engineering. ***Responsibility and autonomy*** L.O. 1.5. The graduate has autonomy in learning. L.O. 1.6. The graduate autonomously integrates concepts and theories in materials engineering into new contexts in the workplace. **Cp.2. Identifying and defining a research topic in the field of advanced materials and developing a plan to achieve the proposed objectives** (ESCO - approaches problems critically; develops materials testing procedures; presents reports on test results) ***Knowledge*** L.O. 2.1. The graduate can identify and define a topic of actuality or of maximum necessity in the field of advanced materials through the criterial materials selection. L.O. 2.2. The graduate can identify, define and develop a specific plan for processing advanced materials according to technological parameters in achieving the proposed objectives. ***Skills*** L.O. 2.3. The graduate can develop a plan for selecting appropriate tools for advanced materials processing, using them safely to achieve the proposed objectives. L.O. 2.4. The graduate can use modern tools and techniques to modify, characterize and measure

	the properties of materials and to design processes according to accepted standards. *Responsibility and autonomy* L.O. 2.5. The student/graduate selects and uses bibliographic sources specific to the field. L.O. 2.6. The student/graduate demonstrates autonomy in learning on issues specific to the field. **Cp.3. Applying the principles of scientific research specific to the field and carrying out an oral/written communication, through which the results are presented, in a clear and convincing manner.** (ESCO - conducts scientific research; tests materials; develops advanced materials). *Knowledge* L.O. 5.1. The graduate knows how to apply the principles of scientific research specific to the field and to communicate clearly and concisely, both in writing and orally, regarding the results obtained by applying the principles of scientific research specific to the field of advanced materials and related fields. *Skills* L.O. 5.2. The graduate can apply the principles of scientific research specific to the field by acquiring the ability to perceive, understand and promote quality and creativity in research and communication of the results obtained. L.O. 5.3. The graduate can develop skills as a researcher and good communicator in the field of materials engineering by applying the principles of scientific research by extracting relevant conclusions from the research carried out. L.O. 5.4. The graduate knows how to correctly communicate the results of analyses and calculations carried out in scientific research, thus explaining the correctness of the proposed solutions. *Responsibility and autonomy* L.O. 5.5. The graduate assumes the intellectual paternity of his/her own research and respects the deontological norms. L.O. 5.6. The graduate demonstrates autonomy in the dissemination of knowledge by initiating and managing the publication process.
Transversal competences	**Ct.1. Performing complex professional tasks, respecting the norms of professional ethics and moral conduct, following a personal work plan established based on individual study** (ESCO - applies scientific, technological and engineering knowledge; develops strategies for solving problems.) L.O. 1.1. The graduate can perform complex professional tasks while observing the rules of professional ethics and moral conduct, following a self-established work plan based on individual study. L.O. 1.2. The graduate can identify continuous training opportunities and using them effectively for personal development in carrying out complex professional tasks, following a self-established work plan based on individual study. L.O. 1.3. The graduate is capable of recognizing, understanding, and promoting quality and creativity in performing complex professional tasks. L.O. 1.4. The graduate knows the occupational health and safety regulations, thus ensuring safe

	working conditions for themselves and for the team they are part of. **Ct.3. Permanent information and documentation in his/her field of activity and related fields, in correlation with the needs of the labor market** (ESCO - demonstrates a desire to learn; manages personal development.) L.O. 3.1. The graduate can identify continuous training opportunities and use them effectively for personal development in their field or related activities and domains, in correlation with labor market needs. L.O. 3.2. The graduate can develop original models to accurately describe real processes specific to materials engineering, based on thorough individual study. L.O. 3.3. The graduate is capable of objectively and effectively self-assessing their professional activity, thereby gaining an overall understanding of their own knowledge, with a strong emphasis on continuous information gathering and documentation in their field of activity.

7. Course objectives (resulting from the specific competences to be acquired)

7.1 General course objective	• Assimilation of information and knowledge related to nanotechnologies used in the synthesis, characterization, and processing of widely used nanoproducts.
7.2 Specific objectives	• The aim of the course is to provide concrete information regarding the synthesis methods of nanomaterials, their characterization in the context of currently produced materials, from the perspective of usage efficiency and future development prospects.

8. Content

8.1 Course	Teaching methods	Number of hours	Remarks
1. Introductory course – nanomaterials and nanotechnologies	Lecture Explanation Conversation Problematization Case studies	2	
2. Properties of materials at the nanometre scale		2	
3. Liquid-phase synthesis of nanomaterials		4	
4. Vapor-phase synthesis of nanomaterials		6	
5. Solid-phase synthesis of nanomaterials		2	
6. Processing techniques of nanostructured materials		2	
7. Characterization of nanomaterials by transmission electron microscopy (TEM)		2	
8. Characterization of nanomaterials by scanning electron microscopy (SEM)		2	
9. Characterization of nanomaterials by atomic force microscopy (AFM)		2	
10. Nanomaterials applications. Case studies		4	

Bibliography

1. S. Peng, P. Li – Nanomaterials and Nanotechnology: Basic, Preparation and Applications, Springer Nature, 2024
2. Ghiuță I., Cristea D. – Silver nanoparticles for delivery purposes - Nanoengineered Biomaterials for Advanced Drug Delivery 1st Edition, Elsevier, 2020.
3. R. Tantra – Nanomaterial Characterization: An Introduction, Wiley, 2016
4. Y. Gogotsi – Nanomaterials Handbook Second Edition, CRC Press, 2017
5. D. Vollath – Nanomaterials: An Introduction to Synthesis, Properties, and Applications Second Edition, Wiley, 2013

8.2 Laboratory	Teaching-learning methods	Number of hours	Remarks
1. Nanopowders synthesis by ball milling	Powders are processed using the FRITSCH Premium Line Pulverisette 7 planetary mill – ICDT-L4-DS	2	
2. Nanopowders synthesis by wet chemical methods	Nanoparticles are produced in the laboratory using the precipitation method	4	
3. Thin films depositions by spin-coating method	Thin films are deposited using the spin coating method	4	
4. Thin films depositions by dip-coating method	Thin films are deposited using the dip coating method	4	
5. Analysis of the thermal stability of synthesized powders using simultaneous thermal analysis	A study is carried out using simultaneous thermal analysis with the NETZSCH STA 449 F3 JUPITER – ICDT-L4-DS.	4	
6. Study of phase composition and transformations using X-ray diffractometry	A study is carried out using X-ray diffraction with the Bruker D8 Advanced – ICDT-L8-DS.	4	
7. Study of morphological, compositional, and structural characteristics using scanning electron microscopy (SEM)	Morpho-structural and compositional characteristics are determined using a scanning electron microscope (SEM) coupled with an energy-dispersive X-ray spectrometer (EDS) – ICDT-L8-DS.	4	
8. Analysis of the obtained data. Preparation of the final laboratory report. Review and closure of the records.	The obtained data are analyzed and interpreted.	2	
8.3 Project			
A paper is prepared on a pre-established topic related to the course content (or from the field of nanotechnology as an extension of this topic).	• Completion of the individual assignment • Periodic presentation (during project sessions) of the progress in completing the assignment	14	

Bibliography
1. Suresh C. Ameta, Rakshit Ameta - The Science of Nanomaterials: Basics and Applications, Routledge, 2023
2. Gérrard Eddy Jai Poinern – A Laboratory Course in Nanoscience and Nanotechnology, CRC Press, 2015

9. Correlation of course content with the demands of the labour market (epistemic communities, professional associations, potential employers in the field of study)

The curriculum aligns with the needs of representative employers in the field of materials engineering and is consistent with similar study programs offered by major universities both nationally and internationally.

10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of the final grade
10.4 Course	Acquired knowledge: understanding theoretical concepts and correct use of specific terminology	Ongoing assessment (during interactive courses) and final oral examination	55%
10.5 Laboratory	Laboratory reports	Evaluation of the accuracy of laboratory reports and the final thematic paper	25%
10.5. Project	Thematic project	Verification and final defense	20%
10.6 Minimal performance standard			
Achieving at least 50% of the points allocated for the course and practical activities. Attendance at practical activities is mandatory and a prerequisite for taking the exam.			

This course outline was certified in the Department Board meeting on …./…../…….. and approved in the Faculty Board meeting on …./…../……..

Prof. dr. eng. Alexandru PASCU **……………………………………………………………** **Dean**	**Assoc. Prof. dr. eng. Camelia GABOR** **……………………………………………………………………………** **Head of Department**
Assoc. Prof. dr. eng. Ioana Popescu …………………………………………………………… Assoc. Prof. dr. eng. Vasile-Adrian Surdu …………………………………………………………… **Course holder**	Assoc. Prof. dr. eng. Ioana Popescu …………………………………………………………… Assoc. Prof. dr. eng. Vasile-Adrian Surdu …………………………………………………………… **Holder of seminar/ laboratory/ project**

Note:

1) Field of study – select one of the following options: Bachelor / Master / Doctorat (to be filled in according to the forceful classification list for study programmes);

2) Study level – choose from among: Bachelor / Master / Doctorat;

[3] Course status (content) – for the Bachelor level, select one of the following options: **FC** (fundamental course) / **DC** (course in the study domain)/ **SC** (speciality course)/ **CC** (complementary course); for the Master level, select one of the following options: **PC** (proficiency course)/ SC (synthesis course)/ **AC** (advanced course);

[4] Course status (attendance type) – select one of the following options: **CPC** (compulsory course)/ **EC** (elective course)/ **NCPC** (non-compulsory course);

[5] One credit is the equivalent of 30 study hours (teaching activities and individual study).

COURSE OUTLINE

1. Data about the study programme

1.1 Higher education institution	Transilvania University of Brașov
1.2 Faculty	Faculty of Materials Science and Engineering
1.3 Department	Materials Science
1.4 Field of study[1)]	Materials Engineering
1.5 Study level[2)]	Master
1.6 Study programme/ Qualification	Materials Science, Engineering, and Management

2. Data about the course

2.1 Name of course	Expert software: CAD, CAM, CAE							
2.2 Course convenor	CS II dr. eng. Mihai Alin Pop							
2.3 Seminar/ laboratory/ project convenor	CS II dr. eng. Mihai Alin Pop /Lecturer dr. eng Crisbășan Andreea							
2.4 Study year	I	2.5 Semester	2	2.6 Evaluation type	E	2.7 Course status	Content[3)]	SC
							Attendance type[4)]	CPC

3. Total estimated time (hours of teaching activities per semester)

3.1 Number of hours per week	**4**	out of which: 3.2 lecture	**2**	3.3 seminar/ laboratory/ project	**0/1/1**
3.4 Total number of hours in the curriculum	56	out of which: 3.5 lecture	28	3.6 seminar/ laboratory/ project	0/14/14

Time allocation	hours
Study of textbooks, course support, bibliography and notes	25
Additional documentation in libraries, specialized electronic platforms, and field research	30
Preparation of seminars/ laboratories/ projects, homework, papers, portfolios, and essays	19
Tutorial	10
Examinations	5
Other activities....................................	5

3.7 Total number of hours of student activity	94
3.8 Total number per semester	150
3.9 Number of credits[5)]	5

4. Prerequisites (if applicable)

4.1 curriculum-related	•
4.2 competences-related	• Basic computer skills

5. Conditions (if applicable)

5.1 for course development	• Classroom equipped with a blackboard and video projector
5.2 for seminar/ laboratory/ project development	• Classroom equipped with a blackboard and video projector • Computer network, Microsoft Windows operating system, CAD CAM, CAE software packages

6. Specific competences and learning outcomes

Professional competences	**Cp.1. Use of modern concepts and theories in the field of advanced materials** (ESCO - evaluates the suitability of metal types for specific applications; manipulates metals; works in metal production teams) ***Knowledge*** L.O. 1.1. The graduate defines modern concepts and theories in the field of advanced materials. L.O. 1.2. The graduate describes how materials engineering products and processes have a positive impact on global and social issues, using modern concepts and theories in the field of advanced materials. ***Skills*** L.O. 1.3. The graduate analyses data obtained from the use of the structure-property relationship for the characteristics of different types of materials and especially metallic, polymer, ceramic and composite materials. L.O. 1.4. The graduate can identify opportunities and design strategies in solving needs in the field of materials engineering. ***Responsibility and autonomy*** L.O. 1.5. The graduate has autonomy in learning. L.O. 1.6. The graduate autonomously integrates concepts and theories in materials engineering into new contexts in the workplace.
Transversal competences	**Ct.1. Performing complex professional tasks, respecting the norms of professional ethics and moral conduct, following a personal work plan established based on individual study** (ESCO - applies scientific, technological and engineering knowledge; develops strategies for solving problems.) L.O. 1.1. The graduate can perform complex professional tasks while observing the rules of professional ethics and moral conduct, following a self-established work plan based on individual study. L.O. 1.2. The graduate can identify continuous training opportunities and using them effectively for personal development in carrying out complex professional tasks, following a self-established work plan based on individual study. L.O. 1.3. The graduate is capable of recognizing, understanding, and promoting quality and creativity in performing complex professional tasks. L.O. 1.4. The graduate knows the occupational health and safety regulations, thus ensuring safe working conditions for themselves and for the team they are part of.

7. Course objectives (resulting from the specific competences to be acquired)

7.1 General course objective	• The course aims to deepen students' understanding of computer-aided design using specialized software in the fields of CAD, CAM, and CAE. The applications include examples demonstrating the use of software packages for three-dimensional modeling and simulation analysis of the operation of parts and assemblies.
7.2 Specific objectives	• To acquire knowledge and practical skills in using software specific to the field of advanced materials. • To develop the ability to interact with computers and advanced computer-controlled processing equipment.

	• To apply modeling and simulation techniques to technological processes.

8. Content

8.1 Course	Teaching methods	Number of hours	Remarks
3D modeling, assembly creation, automatic detailing, technology design, and technological process management	Explanation, Interactive course Lecture, Conversation, Problematization, Case studies	4	
Sketcher Module		6	
Part Design Module		6	
Assembly Design Module		4	
Analysis and simulation (CAE)		6	
Applications in materials engineering		2	

Bibliography

1. Silviu Luis Butnariu, Gheorghe Leonte Mogan: Finite Element Analysis in mechanical engineering: practical applications in ANSYS, ISBN: 9786061917549, (2024)
2. Sommerville I. Software engineering. America: Pearson Education Inc. 2011. (https://engineering.futureuniversity.com/BOOKS%20FOR%20IT/Software-Engineering-9th-Edition-by-Ian-Sommerville.pdf)
3. Stroud, Ian, and Hildegarde Nagy. *Solid modelling and CAD systems: how to survive a CAD system*. Springer Science & Business Media, 2011. (https://dokumen.pub/qdownload/solid-modelling-and-cad-systems-how-to-survive-a-cad-system-9780857292582-9780857292599-0857292587-0857292595.html)
4. Lee, K.,. *Principles of cad/cam/cae systems*. Reading, MA: Addison-Wesley, 1999. (https://dokumen.pub/principles-of-cad-cam-cae-systems-0201380366.html)

8.2 Seminar/ laboratory/ project	Teaching-learning methods	Number of hours	Remarks
Presentation of laboratory assignments		2	
Modeling parts and assemblies	Individual practical work	2	
Static analysis simulations	Individual practical work	2	
Fatigue analysis simulations	Individual practical work	2	
Static analysis of flat and cylindrical steel samples	Individual practical work	2	
Static analysis of assembled mechanical support structures	Individual practical work	2	
Completion and review of laboratory work	Individual practical work	2	

Bibliography

5. Silviu Luis Butnariu, Gheorghe Leonte Mogan: Finite Element Analysis in mechanical engineering: practical applications in ANSYS, ISBN: 9786061917549, (2024)
6. Sommerville I. Software engineering. America: Pearson Education Inc. 2011. (https://engineering.futureuniversity.com/BOOKS%20FOR%20IT/Software-Engineering-9th-Edition-by-Ian-Sommerville.pdf)
7. Stroud, Ian, and Hildegarde Nagy. *Solid modelling and CAD systems: how to survive a CAD system*. Springer Science & Business Media, 2011. (https://dokumen.pub/qdownload/solid-modelling-and-cad-systems-how-to-survive-a-cad-system-9780857292582-9780857292599-0857292587-0857292595.html)

Lee, K.,. *Principles of cad/cam/cae systems*. Reading, MA: Addison-Wesley, 1999. (https://dokumen.pub/principles-of-cad-cam-cae-systems-0201380366.html)

9. Correlation of course content with the demands of the labour market (epistemic communities, professional associations, potential employers in the field of study)

The curriculum is in line with the needs of representative employers in the fields of engineering and management, and is consistent with similar study programs offered by major university centers in the country and abroad.

10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of the final grade
10.4 Course	Knowledge gained	Oral exam, computer application	55%
10.5 Seminar/ laboratory/ project	1. Level of acquisition of theoretical and practical knowledge	Project colloquium	30%
	2. Laboratory reports	Periodic check	15%
10.6 Minimal performance standard			
• Achieving at least 50% of the points allocated for the course and practical activities. Attendance at practical activities is mandatory and a prerequisite for taking the exam.			

This course outline was certified in the Department Board meeting on …./…../…….. and approved in the Faculty Board meeting on …./…../……..

Prof. dr. eng. Alexandru PASCU **…………………………………………………………………** **Dean**	**Assoc. Prof. dr. eng. Camelia GABOR** **………………………………………………………………………………………** **Head of Department**
CS **II** dr. eng. Mihai Alin Pop …………………………………………………………………… **Course holder**	CS **II**. dr. eng. Mihai Alin Pop …………………………………………………………………… Lecturer dr. eng. Andreea Crisbășan …………………………………………………………………… **Holder of seminar/ laboratory/ project**

Note:

1) Field of study – select one of the following options: Bachelor / Master / Doctorat (to be filled in according to the forceful classification list for study programmes);

2) Study level – choose from among: Bachelor / Master / Doctorat;

3) Course status (content) – for the Bachelor level, select one of the following options: **FC** (fundamental course) / **DC** (course in the study domain)/ **SC** (speciality course)/ **CC** (complementary course); for the Master level, select one of the following options: **PC** (proficiency course)/ SC (synthesis course)/ **AC** (advanced course);

4) Course status (attendance type) – select one of the following options: **CPC** (compulsory course)/ **EC** (elective course)/ **NCPC** (non-compulsory course);

5) One credit is the equivalent of 30 study hours (teaching activities and individual study).

COURSE OUTLINE

1. Data about the study programme

1.1 Higher education institution	Transilvania University of Brașov
1.2 Faculty	Materials Science and Engineering
1.3 Department	Materials Science
1.4 Field of study[1)]	Materials Engineering
1.5 Study level[2)]	Master
1.6 Study programme/ Qualification	Materials Science, Engineering, and Management

2. Data about the course

2.1 Name of course	Research practice I							
2.2 Course convenor								
2.3 Seminar/ laboratory/ project convenor	Prof. dr. eng. Daniel CRISTEA							
2.4 Study year	1	2.5 Semester	I	2.6 Evaluation type	V	2.7 Course status	Content[3)]	RP
							Attendance type[4)]	CPC

3. Total estimated time (hours of teaching activities per semester)

3.1 Number of hours per week	**6**	out of which: 3.2 lecture	**0**	3.3 seminar/ laboratory/ project	**6**
3.4 Total number of hours in the curriculum	84	out of which: 3.5 lecture	0	3.6 seminar/ laboratory/ project	84

Time allocation	hours
Study of textbooks, course support, bibliography and notes	
Additional documentation in libraries, specialized electronic platforms, and field research	42
Preparation of seminars/ laboratories/ projects, homework, papers, portfolios, and essays	21
Tutorial	
Examinations	3
Other activities....................................	

3.7 Total number of hours of student activity	66
3.8 Total number per semester	150
3.9 Number of credits[5)]	5

4. Prerequisites (if applicable)

4.1 curriculum-related	•
4.2 competences-related	•

5. Conditions (if applicable)

5.1 for course development	•
5.2 for seminar/ laboratory/ project development	• Laboratory room equipped with specific equipment for testing and test samples.

6. Specific competences and learning outcomes

Professional competences	**Cp.1. Use of modern concepts and theories in the field of advanced materials** (ESCO - evaluates the suitability of metal types for specific applications; manipulates metals; works in metal production teams) ***Knowledge*** L.O. 1.1. The graduate defines modern concepts and theories in the field of advanced materials. L.O. 1.2. The graduate describes how materials engineering products and processes have a positive impact on global and social issues, using modern concepts and theories in the field of advanced materials. ***Skills*** L.O. 1.3. The graduate analyses data obtained from the use of the structure-property relationship for the characteristics of different types of materials and especially metallic, polymer, ceramic and composite materials. L.O. 1.4. The graduate can identify opportunities and design strategies in solving needs in the field of materials engineering. ***Responsibility and autonomy*** L.O. 1.5. The graduate has autonomy in learning. L.O. 1.6. The graduate autonomously integrates concepts and theories in materials engineering into new contexts in the workplace. **Cp.2. Identifying and defining a research topic in the field of advanced materials and developing a plan to achieve the proposed objectives** (ESCO - approaches problems critically; develops materials testing procedures; presents reports on test results) ***Knowledge*** L.O. 2.1. The graduate can identify and define a topic of actuality or of maximum necessity in the field of advanced materials through the criterial materials selection. L.O. 2.2. The graduate can identify, define and develop a specific plan for processing advanced materials according to technological parameters in achieving the proposed objectives. ***Skills*** L.O. 2.3. The graduate can develop a plan for selecting appropriate tools for advanced materials processing, using them safely to achieve the proposed objectives. L.O. 2.4. The graduate can use modern tools and techniques to modify, characterize and measure the properties of materials and to design processes according to accepted standards. ***Responsibility and autonomy*** L.O. 2.5. The student/graduate selects and uses bibliographic sources specific to the field. L.O. 2.6. The student/graduate demonstrates autonomy in learning on issues specific to the field. **Cp.3. Application of modern analytical techniques adapted to the field of advanced materials and related fields** (ESCO - performs laboratory tests; prepares samples for analysis; performs sample analysis; uses chemical analysis equipment; applies laboratory safety procedures; performs

	metallurgical structural analysis) *Knowledge* L.O. 3.1. The graduate has a deep understanding of various modern analytical techniques, adapted to the field of advanced materials and related fields. L.O. 3.2. The graduate uses various modelling, simulation and optimization software techniques and applications, adapted to the field of advanced materials and related fields. L.O. 3.3. The graduate can collect, interpret and analyze data that is specific to the application of modern analytical techniques to extract relevant conclusions in the field of advanced materials and related fields. *Skills* L.O. 3.4. The graduate can design and analyze experiments appropriate to modern analytical techniques in the field of advanced materials and related fields, incorporating statistical procedures. L.O. 3.5. The graduate can use modelling, simulation and optimization software programs to develop and evaluate new materials. *Responsibility and autonomy* L.O. 3.6. The graduate ensures the rigor of the analysis through judicious selection of data and methods. L.O. 3.7. The graduate assumes responsibility for the validity of the conclusions resulting from the data analysis. **Cp.5. Applying the principles of scientific research specific to the field and carrying out an oral/written communication, through which the results are presented, in a clear and convincing manner.** (ESCO - conducts scientific research; tests materials; develops advanced materials). *Knowledge* L.O. 5.1. The graduate knows how to apply the principles of scientific research specific to the field and to communicate clearly and concisely, both in writing and orally, regarding the results obtained by applying the principles of scientific research specific to the field of advanced materials and related fields. *Skills* L.O. 5.2. The graduate can apply the principles of scientific research specific to the field by acquiring the ability to perceive, understand and promote quality and creativity in research and communication of the results obtained. L.O. 5.3. The graduate can develop skills as a researcher and good communicator in the field of materials engineering by applying the principles of scientific research by extracting relevant conclusions from the research carried out. L.O. 5.4. The graduate knows how to correctly communicate the results of analyses and calculations carried out in scientific research, thus explaining the correctness of the proposed solutions.

Transversal competences	**Ct.1. Performing complex professional tasks, respecting the norms of professional ethics and moral conduct, following a personal work plan established based on individual study** (ESCO - applies scientific, technological and engineering knowledge; develops strategies for solving problems.) L.O. 1.1. The graduate can perform complex professional tasks while observing the rules of professional ethics and moral conduct, following a self-established work plan based on individual study. L.O. 1.2. The graduate can identify continuous training opportunities and using them effectively for personal development in carrying out complex professional tasks, following a self-established work plan based on individual study. L.O. 1.3. The graduate is capable of recognizing, understanding, and promoting quality and creativity in performing complex professional tasks. L.O. 1.4. The graduate knows the occupational health and safety regulations, thus ensuring safe working conditions for themselves and for the team they are part of. **Ct.2. Planning, monitoring and assuming the professional tasks of a subordinate professional group(s)** (ESCO - has teamwork capacity; demonstrates organizational skills) L.O. 2.1. The graduate can plan and monitor the execution of complex professional tasks carried out by a group or subordinate professional teams. L.O. 2.2. The graduate can take responsibility for the consequences of decisions made while coordinating complex professional activities carried out by a group or subordinate professional teams. **Ct.3. Permanent information and documentation in his/her field of activity and related fields, in correlation with the needs of the labor market** (ESCO - demonstrates a desire to learn; manages personal development.) L.O. 3.1. The graduate can identify continuous training opportunities and use them effectively for personal development in their field or related activities and domains, in correlation with labor market needs. L.O. 3.2. The graduate can develop original models to accurately describe real processes specific to materials engineering, based on thorough individual study. L.O. 3.3. The graduate is capable of objectively and effectively self-assessing their professional activity, thereby gaining an overall understanding of their own knowledge, with a strong emphasis on continuous information gathering and documentation in their field of activity.

7. Course objectives (resulting from the specific competences to be acquired)

7.1 General course objective	• Initiating the process of preparing a scientific research project, starting from the formulation of the topic and research objectives, and developing the work plan.
7.2 Specific objectives	• Cognitive: Understanding the methodology for planning the stages of research. • Procedural: Using bibliographic sources, conducting experimental research, verifying solutions based on theoretical models. • Attitudinal: Developing a critical, analytical, and argumentative mindset.

8. Content

8.2 Project	Teaching-learning methods	Number of hours	Remarks
Formulation of the research problem according to a given topic: • Resource analysis • Setting objectives	Analysis Problematization Coordination Applications	28	
Research planning: • Defining the research stages and expected objectives • Establishing and detailing the activities	Analysis Problematization Coordination Applications	14	
Use of technical-scientific documentation: • Studying the bibliography • Analyzing and assessing the relevance of bibliographic sources • Researching online • Processing the information • Preparing the practice report	Documentation based on the indicated bibliographic materials Coordination of applied activities	28	

Bibliography

1. C. George Thomas, Research Methodology and Scientific Writing 2nd Edition, ANE Books India, Springer Nature, 2021.
2. Robert Goldbort Writing for Science, Yale University Press, New Haven & London, 2006
3. Loraine Blaxter, Christina Hughes, Malcom Tight How to Research, Third Ed., Open University Press, McGraw-Hill Education, Berkshire, England, 2006
4. K.Srinagesh The Principles of Experimental Research, Butterworth-Heinemann, 2005
5. David Wilkinson, editor, The Researcher's Toolkit - The Complete Guide to Practitioner Research, Routledge Falmer Taylor and Francis Group, London and New York, 2001
6. Nicholas Walliman, Your Research Project — A Step by step guide for the first time researcher, Sage Publ., London, 2001
7. Mark Balnaves, Peter Caputi, Introduction to Quantitative Research Methods — An Investigative Approach, Sage Publications, London, 2001
8. John Kirkman Good Style — Writing for science and technology, Second ed., Routledge Taylor and Francis Group, London and New York, 2005

9. Correlation of course content with the demands of the labour market (epistemic communities, professional associations, potential employers in the field of study)

The course content is practical and reflects the research and development methodology specific to industry-related companies.

10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of the final grade
10.4 Course			
10.5 Project	Final assessment	Summative assessment	20 %
	Work consistency	Ongoing assessments	30 %

	Knowledge verification	Preparation of a research report	50 %
10.6 Minimal performance standard			
• Preparation of the research report and passing the summative assessment			

This course outline was certified in the Department Board meeting on …./…../…….. and approved in the Faculty Board meeting on …./…../……..

Prof. dr. eng. Alexandru PASCU **……………………………………………………………………** **Dean**	**Assoc. Prof. dr. eng. Camelia GABOR** **……………………………………………………………………………………………** **Head of Department**
Course holder	**Prof. dr. eng. Daniel CRISTEA** **……………………………………………………………………………………………** **Holder of seminar/ laboratory/ project**

Note:

1) Field of study – select one of the following options: Bachelor / Master / Doctorat (to be filled in according to the forceful classification list for study programmes);

2) Study level – choose from among: Bachelor / Master / Doctorat;

3) Course status (content) – for the Bachelor level, select one of the following options: **FC** (fundamental course) / **DC** (course in the study domain)/ **SC** (speciality course)/ **CC** (complementary course); for the Master level, select one of the following options: **PC** (proficiency course)/ SC (synthesis course)/ **AC** (advanced course);

4) Course status (attendance type) – select one of the following options: **CPC** (compulsory course)/ **EC** (elective course)/ **NCPC** (non-compulsory course);

5) One credit is the equivalent of 30 study hours (teaching activities and individual study).

COURSE OUTLINE

1. Data about the study programme

1.1 Higher education institution	Transilvania University of Brașov
1.2 Faculty	Materials Science and Engineering
1.3 Department	Materials Science
1.4 Field of study[1)]	Materials Engineering
1.5 Study level[2)]	Master
1.6 Study programme/ Qualification	Materials Science, Engineering, and Management

2. Data about the course

2.1 Name of course	Research practice II							
2.2 Course convenor								
2.3 Seminar/ laboratory/ project convenor	Prof. dr. eng. Daniel CRISTEA							
2.4 Study year	1	2.5 Semester	II	2.6 Evaluation type	V	2.7 Course status	Content[3)]	RP
							Attendance type[4)]	CPC

3. Total estimated time (hours of teaching activities per semester)

3.1 Number of hours per week	**6**	out of which: 3.2 lecture	**0**	3.3 seminar/ laboratory/ project	**6**
3.4 Total number of hours in the curriculum	84	out of which: 3.5 lecture	0	3.6 seminar/ laboratory/ project	84

Time allocation	hours
Study of textbooks, course support, bibliography and notes	
Additional documentation in libraries, specialized electronic platforms, and field research	42
Preparation of seminars/ laboratories/ projects, homework, papers, portfolios, and essays	21
Tutorial	
Examinations	3
Other activities……………………………	

3.7 Total number of hours of student activity	66
3.8 Total number per semester	150
3.9 Number of credits[5)]	5

4. Prerequisites (if applicable)

4.1 curriculum-related	•
4.2 competences-related	•

5. Conditions (if applicable)

5.1 for course development	•
5.2 for seminar/ laboratory/ project development	• Laboratory room equipped with specific equipment for testing and test samples.

6. Specific competences and learning outcomes

Professional competences	**Cp.1. Use of modern concepts and theories in the field of advanced materials** (ESCO - evaluates the suitability of metal types for specific applications; manipulates metals; works in metal production teams) ***Knowledge*** L.O. 1.1. The graduate defines modern concepts and theories in the field of advanced materials. L.O. 1.2. The graduate describes how materials engineering products and processes have a positive impact on global and social issues, using modern concepts and theories in the field of advanced materials. ***Skills*** L.O. 1.3. The graduate analyses data obtained from the use of the structure-property relationship for the characteristics of different types of materials and especially metallic, polymer, ceramic and composite materials. L.O. 1.4. The graduate can identify opportunities and design strategies in solving needs in the field of materials engineering. ***Responsibility and autonomy*** L.O. 1.5. The graduate has autonomy in learning. L.O. 1.6. The graduate autonomously integrates concepts and theories in materials engineering into new contexts in the workplace. **Cp.2. Identifying and defining a research topic in the field of advanced materials and developing a plan to achieve the proposed objectives** (ESCO - approaches problems critically; develops materials testing procedures; presents reports on test results) ***Knowledge*** L.O. 2.1. The graduate can identify and define a topic of actuality or of maximum necessity in the field of advanced materials through the criterial materials selection. L.O. 2.2. The graduate can identify, define and develop a specific plan for processing advanced materials according to technological parameters in achieving the proposed objectives. ***Skills*** L.O. 2.3. The graduate can develop a plan for selecting appropriate tools for advanced materials processing, using them safely to achieve the proposed objectives. L.O. 2.4. The graduate can use modern tools and techniques to modify, characterize and measure the properties of materials and to design processes according to accepted standards. ***Responsibility and autonomy*** L.O. 2.5. The student/graduate selects and uses bibliographic sources specific to the field. L.O. 2.6. The student/graduate demonstrates autonomy in learning on issues specific to the field. **Cp.3. Application of modern analytical techniques adapted to the field of advanced materials and related fields** (ESCO - performs laboratory tests; prepares samples for analysis; performs sample analysis; uses chemical analysis equipment; applies laboratory safety procedures; performs

	metallurgical structural analysis) ***Knowledge*** L.O. 3.1. The graduate has a deep understanding of various modern analytical techniques, adapted to the field of advanced materials and related fields. L.O. 3.2. The graduate uses various modelling, simulation and optimization software techniques and applications, adapted to the field of advanced materials and related fields. L.O. 3.3. The graduate can collect, interpret and analyze data that is specific to the application of modern analytical techniques to extract relevant conclusions in the field of advanced materials and related fields. ***Skills*** L.O. 3.4. The graduate can design and analyze experiments appropriate to modern analytical techniques in the field of advanced materials and related fields, incorporating statistical procedures. L.O. 3.5. The graduate can use modelling, simulation and optimization software programs to develop and evaluate new materials. ***Responsibility and autonomy*** L.O. 3.6. The graduate ensures the rigor of the analysis through judicious selection of data and methods. L.O. 3.7. The graduate assumes responsibility for the validity of the conclusions resulting from the data analysis. **Cp.5. Applying the principles of scientific research specific to the field and carrying out an oral/written communication, through which the results are presented, in a clear and convincing manner.** (ESCO - conducts scientific research; tests materials; develops advanced materials). ***Knowledge*** L.O. 5.1. The graduate knows how to apply the principles of scientific research specific to the field and to communicate clearly and concisely, both in writing and orally, regarding the results obtained by applying the principles of scientific research specific to the field of advanced materials and related fields. ***Skills*** L.O. 5.2. The graduate can apply the principles of scientific research specific to the field by acquiring the ability to perceive, understand and promote quality and creativity in research and communication of the results obtained. L.O. 5.3. The graduate can develop skills as a researcher and good communicator in the field of materials engineering by applying the principles of scientific research by extracting relevant conclusions from the research carried out. L.O. 5.4. The graduate knows how to correctly communicate the results of analyses and calculations carried out in scientific research, thus explaining the correctness of the proposed solutions.

Transversal competences	**Ct.1. Performing complex professional tasks, respecting the norms of professional ethics and moral conduct, following a personal work plan established based on individual study** (ESCO - applies scientific, technological and engineering knowledge; develops strategies for solving problems.) L.O. 1.1. The graduate can perform complex professional tasks while observing the rules of professional ethics and moral conduct, following a self-established work plan based on individual study. L.O. 1.2. The graduate can identify continuous training opportunities and using them effectively for personal development in carrying out complex professional tasks, following a self-established work plan based on individual study. L.O. 1.3. The graduate is capable of recognizing, understanding, and promoting quality and creativity in performing complex professional tasks. L.O. 1.4. The graduate knows the occupational health and safety regulations, thus ensuring safe working conditions for themselves and for the team they are part of. **Ct.2. Planning, monitoring and assuming the professional tasks of a subordinate professional group(s)** (ESCO - has teamwork capacity; demonstrates organizational skills) L.O. 2.1. The graduate can plan and monitor the execution of complex professional tasks carried out by a group or subordinate professional teams. L.O. 2.2. The graduate can take responsibility for the consequences of decisions made while coordinating complex professional activities carried out by a group or subordinate professional teams. **Ct.3. Permanent information and documentation in his/her field of activity and related fields, in correlation with the needs of the labor market** (ESCO - demonstrates a desire to learn; manages personal development.) L.O. 3.1. The graduate can identify continuous training opportunities and use them effectively for personal development in their field or related activities and domains, in correlation with labor market needs. L.O. 3.2. The graduate can develop original models to accurately describe real processes specific to materials engineering, based on thorough individual study. L.O. 3.3. The graduate is capable of objectively and effectively self-assessing their professional activity, thereby gaining an overall understanding of their own knowledge, with a strong emphasis on continuous information gathering and documentation in their field of activity.

7. Course objectives (resulting from the specific competences to be acquired)

7.1 General course objective	• Initiating the process of preparing a scientific research project, starting from the formulation of the topic and research objectives, and developing the work plan.
7.2 Specific objectives	• Cognitive: Understanding the methodology for planning the stages of research. • Procedural: Using bibliographic sources, conducting experimental research, verifying solutions based on theoretical models. • Attitudinal: Developing a critical, analytical, and argumentative mindset.

8. Content

8.2 Project	Teaching-learning methods	Number of hours	Remarks
Formulation of the research problem according to a given topic: • Resource analysis • Setting objectives	Analysis Problematization Coordination Applications	28	
Research planning: • Defining the research stages and expected objectives • Establishing and detailing the activities	Analysis Problematization Coordination Applications	14	
Use of technical-scientific documentation: • Studying the bibliography • Analyzing and assessing the relevance of bibliographic sources • Researching online • Processing the information • Preparing the practice report	Documentation based on the indicated bibliographic materials Coordination of applied activities	28	

Bibliography

1. C. George Thomas, Research Methodology and Scientific Writing 2nd Edition, ANE Books India, Springer Nature, 2021.
2. Robert Goldbort Writing for Science, Yale University Press, New Haven & London, 2006
3. Loraine Blaxter, Christina Hughes, Malcom Tight How to Research, Third Ed., Open University Press, McGraw-Hill Education, Berkshire, England, 2006
4. K.Srinagesh The Principles of Experimental Research, Butterworth-Heinemann, 2005
5. David Wilkinson, editor, The Researcher's Toolkit - The Complete Guide to Practitioner Research, Routledge Falmer Taylor and Francis Group, London and New York, 2001
6. Nicholas Walliman, Your Research Project — A Step by step guide for the first time researcher, Sage Publ., London, 2001
7. Mark Balnaves, Peter Caputi, Introduction to Quantitative Research Methods — An Investigative Approach, Sage Publications, London, 2001
8. John Kirkman Good Style — Writing for science and technology, Second ed., Routledge Taylor and Francis Group, London and New York, 2005

9. Correlation of course content with the demands of the labour market (epistemic communities, professional associations, potential employers in the field of study)

The course content is practical and reflects the research and development methodology specific to industry-related companies.

10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of the final grade
10.4 Course			
10.5 Project	Final assessment	Summative assessment	20 %
	Work consistency	Ongoing assessments	30 %

	Knowledge verification	Preparation of a research report	50 %
10.6 Minimal performance standard			
• Preparation of the research report and passing the summative assessment			

This course outline was certified in the Department Board meeting on …./…../…….. and approved in the Faculty Board meeting on …./…../……..

Prof. dr. eng. Alexandru PASCU **……………………………………………………………………** **Dean**	**Assoc. Prof. dr. eng. Camelia GABOR** **……………………………………………………………………………………** **Head of Department**
Course holder	**Prof. dr. eng. Daniel CRISTEA** **……………………………………………………………………………………** **Holder of seminar/ laboratory/ project**

Note:

1) Field of study – select one of the following options: Bachelor / Master / Doctorat (to be filled in according to the forceful classification list for study programmes);

2) Study level – choose from among: Bachelor / Master / Doctorat;

3) Course status (content) – for the Bachelor level, select one of the following options: **FC** (fundamental course) / **DC** (course in the study domain)/ **SC** (speciality course)/ **CC** (complementary course); for the Master level, select one of the following options: **PC** (proficiency course)/ SC (synthesis course)/ **AC** (advanced course);

4) Course status (attendance type) – select one of the following options: **CPC** (compulsory course)/ **EC** (elective course)/ **NCPC** (non-compulsory course);

5) One credit is the equivalent of 30 study hours (teaching activities and individual study).

COURSE OUTLINE

1. Data about the study programme

1.1 Higher education institution	Transilvania University of Brasov
1.2 Faculty	Materials Science and Engineering
1.3 Department	Materials Science
1.4 Field of study[1]	Materials Engineering
1.5 Study level[2]	Master
1.6 Study programme/ Qualification	Materials Science, Engineering and Management

2. Data about the course

2.1 Name of course			Sustainable Materials					
2.2 Course convenor			Lecturer dr. eng. Gheorghiță Iuliana					
2.3 Seminar/ laboratory/ project convenor			Lecturer dr. eng. Gheorghiță Iuliana					
2.4 Study year	1	2.5 Semester	1	2.6 Evaluation type	E	2.7 Course status	Content[3]	CC
							Attendance type[4]	EC

3. Total estimated time (hours of teaching activities per semester)

3.1 Number of hours per week	**5**	out of which: 3.2 lecture	**2**	3.3 ~~seminar~~/ laboratory/ project	**0/1/2**
3.4 Total number of hours in the curriculum	70	out of which: 3.5 lecture	28	3.6 ~~seminar~~/ laboratory/ project	0/14/28

Time allocation	hours
Study of textbooks, course support, bibliography and notes	30
Additional documentation in libraries, specialized electronic platforms, and field research	20
Preparation of seminars/ laboratories/ projects, homework, papers, portfolios, and essays	25
Tutorial	2
Examinations	3
Other activities……………………………..	

3.7 Total number of hours of student activity	80
3.8 Total number per semester	150
3.9 Number of credits[5]	5

4. Prerequisites (if applicable)

4.1 curriculum-related	• Students should have a basic background in material science, chemistry, physics
4.2 competences-related	• The student/graduate selects and uses bibliographic sources specific to the field.

5. Conditions (if applicable)

5.1 for course development	• Standard lecture room equipped with a video projector, white or blackboard, and audio system suitable for interactive teaching, and internet access.
5.2 for ~~seminar~~/ laboratory/ project development	•

6. Specific competences and learning outcomes

Professional competences	**Cp.6. Advanced materials management and correlation of their acquisition with alternative resources available in the context of sustainable development.** (ESCO - develops problem-solving strategies; assesses environmental impact) ***Knowledge*** L.O. 6.1. The graduate can explain the diversity and continuous evolution of materials engineering in finding new materials as alternative resources available in the context of sustainable development. L.O. 6.2. The graduate can identify alternative solutions to materials engineering by analyzing the possibilities offered by unconventional technologies in processing new materials in the context of sustainable development. ***Skills*** L.O. 6.3. The graduate can choose correct solutions in processing materials using alternative resources available in the context of sustainable development. ***Responsibility and autonomy*** L.O. 6.4. The graduate correctly assesses potential risk factors and how to manage them while respecting restrictions on environmental impact.
Transversal competences	**Ct.1. Performing complex professional tasks, respecting the norms of professional ethics and moral conduct, following a personal work plan established based on individual study** (ESCO - applies scientific, technological and engineering knowledge; develops strategies for solving problems.) L.O. 1.1. The graduate can perform complex professional tasks while observing the rules of professional ethics and moral conduct, following a self-established work plan based on individual study. L.O. 1.2. The graduate can identify continuous training opportunities and use them effectively for personal development in carrying out complex professional tasks, following a self-established work plan based on individual study. L.O. 1.3. The graduate can recognize, understand and promote quality and creativity in performing complex professional tasks. **Ct.3. Permanent information and documentation in his/her field of activity and related fields, in correlation with the needs of the labor market** (ESCO - demonstrates a desire to learn; manages personal development.) L.O. 3.1. The graduate can identify continuous training opportunities and use them effectively for personal development in their field or related activities and domains, in correlation with labor market needs. L.O. 3.2. The graduate can develop original models to accurately describe real processes specific to materials engineering, based on thorough individual study. L.O. 3.3. The graduate is capable of objectively and effectively self-assessing their professional activity, thereby gaining an overall understanding of their own knowledge, with a strong emphasis on continuous information gathering and documentation in their field of activity.

7. Course objectives (resulting from the specific competences to be acquired)

7.1 General course objective	• The course aims to develop an interdisciplinary understanding of sustainable materials by focusing on: - principles of sustainability, circular economy, and environmental impact assessment applied to engineering materials - correlations between material composition, processing, microstructure, lifecycle, and greenhouse gas footprint - evaluating and designing sustainable alternatives for metals, polymers, ceramics, composites, and emerging green materials

7.2 Specific objectives	• Understanding life-cycle assessment (LCA) and eco-design principles. • Developing the ability to evaluate sustainability indicators for different categories of materials. • Acquiring knowledge of recycling technologies, resource efficiency, and low-carbon manufacturing. • Enhancing skills in assessing environmental risks, regulations, and material compliance.

8. Content

8.1 Course	Teaching methods	Number of hours	Remarks
1. Introduction to Sustainable Materials: Concepts, Regulations, and Circular Economy	Lecture Explanation Conversation Problematization Case studies	2	
2. Environmental impact of engineering materials: LCA, carbon footprint, and eco-indicators		2	
3. Sustainable metallic materials: low-carbon alloys, recycling routes, scrap-based metallurgy		2	
4. Sustainable polymers: biodegradable, bio-based and recyclable systems		2	
5. Sustainable ceramic and glass materials: energy efficiency and waste-derived ceramics		2	
6. Composites with reduced environmental impact and recycling		2	
7. Sustainable processing: low-energy manufacturing, green processing technologies		2	
8. Additive manufacturing for sustainability: resource efficiency		2	
9. Energy efficiency in materials production and use: emissions, resource optimization		2	
10. Recycling and re-manufacturing technologies for metals, polymers, ceramics, and composites		2	
11. Critical raw materials and substitution strategies		2	
12. Environmental risk assessment, standards, and material compliance (REACH, RoHS, ESG)		4	
13. Sustainable materials for emerging technologies (batteries, hydrogen, microelectronics)		2	

Bibliography:

1. ASM Handbook Series, Vol. 1–22, ASM International, 1990 ÷ 2024/ see collections at link https://dl.asminternational.org/handbooks/pages/collections
2. Ashby F.M., *Materials and Sustainable Development 2nd edition*, Butterworth-Heinemann, 2022, ISBN 9780323985468
3. Ashby F.M., *Materials and the Environment 3rd edition*, Butterworth-Heinemann, 2021, ISBN 9780128215265
4. Graedel T.E., Allenby B.R., *Industrial Ecology and Sustainable Engineering*, Prentice Hall, 2010, ISBN 9780136008064

5. Reza Rahimpour M., et all., *Greenhouse Gases Emissions and Climate Change*, Elsevier, 2024, ISBN 9780443192319			
8.2.1 Project	Teaching-learning methods	Number of hours	Remarks
1. General title of project: Design and assessment of a sustainable material solution for an industrial application, including material selection, functional analysis, life-cycle assessment, sustainable processing routes, energy and environmental impact analysis, risk assessment, and end-of-life strategies. Selection of material and industrial application; problem definition	Project-base Interactive discussions, case studies, and practical exercises to develop analytical and problem-solving skills	2	
2. Functional requirements and sustainability constraints		2	
3. Analysis of composition, microstructure, and baseline performance		2	
4. Preliminary environmental impact assessment (introductory LCA)		2	
5. Comparison with alternative sustainable materials (scoring matrix)		2	
6. Identification of two sustainable technological processing routes		2	
7. Energy and resource consumption assessment for selected routes		2	
8. Digital simulations (solidification, AM, deformation, energy, or LCA modules)		2	
9. Defect analysis and sustainable quality control strategies		2	
10. Environmental risk and compliance evaluation (REACH, RoHS, ESG)		2	
11. Life-cycle performance update (intermediate LCA)		2	
12. Circular planning: reuse, repair, recycling strategies		2	
13. Report writing and individual consultation		2	
14. Final presentation and evaluation		2	
8.2.2 Laboratory			
1. Engineer, Supplier, Auditor – sustainable material selection for a product (role play)	Role-play Interactive discussions, case studies, and practical exercises to develop analytical and problem-solving skills	2	
2. Material sustainability screening – multicriteria evaluation of materials		2	
3. Mini-LCA of a common engineering material (Al, PET, steel, composite)		2	
4. Case study: Additive Manufacturing vs. Conventional Processing – energy, emissions, resource efficiency		2	

5. Industry 4.0 for sustainability – simulation of a digitalized material flow and environmental tracking		2	
6. Recycling audit – classification and recyclability assessment of multiple material samples		2	
7. Eco-design workshop – redesign of a product to reduce environmental impact		2	

Bibliography:

1. ASM Handbook Series, Vol. 1–22, ASM International, 1990 ÷ 2024/ see collections at link https://dl.asminternational.org/handbooks/pages/collections
2. Ashby F.M., *Materials and Sustainable Development 2nd edition*, Butterworth-Heinemann, 2022, ISBN 9780323985468
3. Ashby F.M., *Materials and the Environment 3rd edition*, Butterworth-Heinemann, 2021, ISBN 9780128215265
4. Graedel T.E., Allenby B.R., *Industrial Ecology and Sustainable Engineering*, Prentice Hall, 2010, ISBN 9780136008064
5. Reza Rahimpour M., et all., *Greenhouse Gases Emissions and Climate Change*, Elsevier, 2024, ISBN 9780443192319

9. Correlation of course content with the demands of the labour market (epistemic communities, professional associations, potential employers in the field of study)

The curriculum aligns with the needs of representative employers in the field of materials engineering and is consistent with similar study programs offered by major universities both nationally and internationally.

10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of the final grade
10.4 Course	Individual assignments Assessing theoretical knowledge	Ongoing assessment (during courses) and final written examination	50%
10.5.1 Project	Quality of project, depth of analysis, clarity of presentation, ability to answer questions	Project presentation	30%
10.5.2 Laboratory	Active participation, case discussions, problem-solving activities	Questions session	20%
10.6 Minimal performance standard			
Achieving at least 50% of the points allocated for the course and practical activities including: ◘ Demonstrating basic understanding of sustainability concepts applied to materials engineering, ◘ Ability to identify at least one sustainable alternative for a given material or technological process, ◘ Completing laboratory work and presenting a coherent project.			

This course outline was certified in the Department Board meeting on …./…../…….. and approved in the Faculty Board meeting on …./…../……..

Prof. dr. eng. Alexandru PASCU **Dean**	**Conf. dr. eng. Camelia GABOR** **Head of Department**
Lecturer. dr. eng. Iuliana GHEORGHIȚĂ **Course holder**	Lecturer dr. eng, Iuliana GHEORGHIȚĂ **Holder of ~~seminar~~/ laboratory/ project**

Note:

1) Field of study – select one of the following options: Bachelor / Master / Doctorat (to be filled in according to the forceful classification list for study programmes);

2) Study level – choose from among: Bachelor / Master / Doctorat;

3) Course status (content) – for the Bachelor level, select one of the following options: **FC** (fundamental course) / **DC** (course in the study domain)/ **SC** (speciality course)/ **CC** (complementary course); for the Master level, select one of the following options: **PC** (proficiency course)/ SC (synthesis course)/ **AC** (advanced course);

4) Course status (attendance type) – select one of the following options: **CPC** (compulsory course)/ **EC** (elective course)/ **NCPC** (non-compulsory course);

5) One credit is the equivalent of 25 study hours (teaching activities and individual study).

COURSE OUTLINE

1. Data about the study programme

1.1 Higher education institution	Transilvania University of Brașov
1.2 Faculty	Materials Science and Engineering
1.3 Department	Materials Science
1.4 Field of study[1)]	Materials Engineering
1.5 Study level[2)]	Master
1.6 Study programme/ Qualification	Materials Science, Engineering, and Management

2. Data about the course

2.1 Name of course	Materials recycling and environmental management							
2.2 Course convenor	Prof. dr. eng. Stoicanescu Maria							
2.3 Seminar/ laboratory/ project convenor	Prof. dr. eng. Stoicanescu Maria							
2.4 Study year	I	2.5 Semester	1	2.6 Evaluation type	E	2.7 Course status	Content[3)]	CC
							Attendance type[4)]	EC

3. Total estimated time (hours of teaching activities per semester)

3.1 Number of hours per week	**5**	out of which: 3.2 lecture	**2**	3.3 seminar/ laboratory/ project	**0/1/2**
3.4 Total number of hours in the curriculum	70	out of which: 3.5 lecture	28	3.6 seminar/ laboratory/ project	0/14/28
Time allocation					hours
Study of textbooks, course support, bibliography and notes					32
Additional documentation in libraries, specialized electronic platforms, and field research					30
Preparation of seminars/ laboratories/ projects, homework, papers, portfolios, and essays					18
Tutorial					
Examinations					
Other activities...................................					

3.7 Total number of hours of student activity	80
3.8 Total number per semester	150
3.9 Number of credits[5)]	5

4. Prerequisites (if applicable)

4.1 curriculum-related	• not applicable
4.2 competences-related	• not applicable

5. Conditions (if applicable)

5.1 for course development	• Classroom, blackboard, chalk, computer, video projector
5.2 for seminar/ laboratory/ project development	• Classroom, blackboard, chalk, computer, video projector

6. Specific competences and learning outcomes

Professional competences	**Cp.1. Use of modern concepts and theories in the field of advanced materials** (ESCO - evaluates the suitability of metal types for specific applications; manipulates metals; works in metal production teams) ***Knowledge*** L.O. 1.1. The graduate defines modern concepts and theories in the field of advanced materials. L.O. 1.2. The graduate describes how materials engineering products and processes have a positive impact on global and social issues, using modern concepts and theories in the field of advanced materials. ***Skills*** L.O. 1.3. The graduate analyses data obtained from the use of the structure-property relationship for the characteristics of different types of materials and especially metallic, polymer, ceramic and composite materials. L.O. 1.4. The graduate can identify opportunities and design strategies in solving needs in the field of materials engineering. ***Responsibility and autonomy*** L.O. 1.5. The graduate has autonomy in learning. L.O. 1.6. The graduate autonomously integrates concepts and theories in materials engineering into new contexts in the workplace. **Cp.6. Advanced materials management and correlation of their acquisition with alternative resources available in the context of sustainable development.** (ESCO - develops problem-solving strategies; assesses environmental impact) ***Knowledge*** L.O. 6.1. The graduate can explain the diversity and continuous evolution of materials engineering in finding new materials as alternative resources available in the context of sustainable development. L.O. 6.2. The graduate can identify alternative solutions to materials engineering by analyzing the possibilities offered by unconventional technologies in processing new materials in the context of sustainable development. ***Skills*** L.O. 6.3. The graduate can choose correct solutions in processing materials using alternative resources available in the context of sustainable development. ***Responsibility and autonomy*** L.O. 6.4. The graduate correctly assesses potential risk factors and how to manage them while respecting restrictions on environmental impact.

Transversal competences	**Ct.1. Performing complex professional tasks, respecting the norms of professional ethics and moral conduct, following a personal work plan established based on individual study** (ESCO - applies scientific, technological and engineering knowledge; develops strategies for solving problems.) L.O. 1.1. The graduate can perform complex professional tasks while observing the rules of professional ethics and moral conduct, following a self-established work plan based on individual study. L.O. 1.2. The graduate can identify continuous training opportunities and using them effectively for personal development in carrying out complex professional tasks, following a self-established work plan based on individual study. L.O. 1.3. The graduate is capable of recognizing, understanding, and promoting quality and creativity in performing complex professional tasks. L.O. 1.4. The graduate knows the occupational health and safety regulations, thus ensuring safe working conditions for themselves and for the team they are part of. **Ct.2. Planning, monitoring and assuming the professional tasks of a subordinate professional group(s)** (ESCO - has teamwork capacity; demonstrates organizational skills) L.O. 2.1. The graduate can plan and monitor the execution of complex professional tasks carried out by a group or subordinate professional teams. L.O. 2.2. The graduate can take responsibility for the consequences of decisions made while coordinating complex professional activities carried out by a group or subordinate professional teams. **Ct.3. Permanent information and documentation in his/her field of activity and related fields, in correlation with the needs of the labor market** (ESCO - demonstrates a desire to learn; manages personal development.) L.O. 3.1. The graduate can identify continuous training opportunities and use them effectively for personal development in their field or related activities and domains, in correlation with labor market needs. L.O. 3.2. The graduate can develop original models to accurately describe real processes specific to materials engineering, based on thorough individual study. L.O. 3.3. The graduate is capable of objectively and effectively self-assessing their professional activity, thereby gaining an overall understanding of their own knowledge, with a strong emphasis on continuous information gathering and documentation in their field of activity.

7. Course objectives (resulting from the specific competences to be acquired)

7.1 General course objective	• The general objective of the discipline is for master'students to acquire theoretical knowledge about specific issues of materials recycling and materials management
7.2 Specific objectives	• Familiarizing master students with specific notions of materials recycling and environmental management: - General characteristics regarding the production, collection, reuse and recycling of materials; - European and national legislation regarding waste management; - Integrated waste management; • Recycling of ferrous, non-ferrous waste, glass, plastics, paper, cardboard,etc.

8. Content

8.1 Course	Teaching methods	Number of hours	Remarks
General characteristics regarding the production, collection, reuse and recycling of materials	Lecture, interactive course, video projector Checks along the way	2	
Material waste: definition, classification.		2	
The effect of waste on environmental polluting factors		2	
National and European legislation on waste. Government Decision 856/2002 on waste management records		2	
Waste management. Stages of waste management		2	
Waste management strategies. Minimization and prevention of waste; Recycling; Incineration; Landfill.		4	
Hazardous waste management.		2	
Biological recycling with compost. Thermal treatment of waste. Waste incineration		2	
Environmental management. General notions.		2	
Specific environmental management standards. Basic characteristics of the ISO 14001 standard.		2	
Vocabulary and terminology of environmental management.		2	
Specific environmental management documents.		2	
Specific environmental management audit.		2	
Bibliography Mohammad Hossein Abdolhamidi, Mohammad Ali Niroomand, et al., Industrial Waste Management and Hazardous Materials Recycling: Innovative Solutions for Environmental Sustainability, 2025 Emilie O'Leary, Mega Watts To Mega Recycling: Recovering end-of-life and landfill-bound materials generated by large-scale renewable energy projects.2025 Muammer Kaya, Electronic Waste and Printed Circuit Board Recycling Technologies (The Minerals, Metals & Materials Series) 1st ed. 2019 Edition, Kindle Edition F. Pacheco-Torgal et al, Advances in Construction and Demolition Waste Recycling: Management, Processing and Environmental Assessment (Woodhead Publishing Series in Civil and Structural Engineering) 1st Edition Stoicănescu Maria, Course note, 2025			
8.2 Seminar/ **laboratory**/ project	Teaching-learning methods	Number of hours	Remarks
Presentation of papers. Presentation of specific OSH concepts. Analysis of industrial waste streams	Presentation, group work, case studies and practical work. Working visits Checks along the way	2	
Assessing the recycling potential of metal waste		2	
Plastic recycling – methods and challenges		2	
Recycling of composite materials and hybrid composites		2	
Heat treatments and reuse of metal waste		2	
Hazardous waste management and environmental regulations		2	
Recoveries and lab completion		2	
8.2 Seminar/ laboratory/ **project**	Teaching-learning	Number of hours	Remarks

	methods		
• General project theme: To study the possibility of recycling waste coming from the manufacturing or use of metallic / ceramic / composite / plastic materials and to establish the stages of their recovery management in accordance with the Environmental Management System. • Project topics specific to the topic taught. A project is prepared on a pre-established topic related to the course topic. It takes into account the technical, economic and marketing aspects regarding the recycling and recovery of: Metallic materials (ferrous and non-ferrous); Plastic materials; Glass; Paper and cardboard	Project Implementation Case Studies – Design Checks along the way	28	The completion of the assignment is done individually. The processed information must come from other bibliographic sources and from specialized articles published in internationally recognized journals (from online databases).

Bibliography

Mohammad Hossein Abdolhamidi, Mohammad Ali Niroomand, et al., Industrial Waste Management and Hazardous Materials Recycling: Innovative Solutions for Environmental Sustainability, 2025

Emilie O'Leary, Mega Watts To Mega Recycling: Recovering end-of-life and landfill-bound materials generated by large-scale renewable energy projects.2025

Muammer Kaya, Electronic Waste and Printed Circuit Board Recycling Technologies (The Minerals, Metals & Materials Series) 1st ed. 2019 Edition, Kindle Edition

F. Pacheco-Torgal et al, Advances in Construction and Demolition Waste Recycling: Management, Processing and Environmental Assessment (Woodhead Publishing Series in Civil and Structural Engineering) 1st Edition

Stoicănescu Maria, Course note, 2025

9. Correlation of course content with the demands of the labour market (epistemic communities, professional associations, potential employers in the field of study)

The concepts taught, along with the implementation of materials recycling technologies established in the project theme, are corroborated with the expectations of representatives of epistemic communities, professional associations and representative employers in the field related to the program.

10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of the final grade
10.4 Course	General characteristics regarding the production, collection, reuse and recycling of materials.	Oral exam Procedure checks (oral)	10 %

	Waste management: prevention/minimization; recovery; treatment and storage.		20 %
	Technologies for minimizing losses through recycling.		20 %
	Specific documents of environmental management. Environmental policy.		10%
10.5 Seminar/ laboratory/ project	the precision of solving the problems specific	Laboratory work evaluation Procedure checks (oral)	10%
	the way of presenting the project	Project support Procedure checks (oral)	30%
10.6 Minimal performance standard			
• project implementation and delivery • knowledge of technologies for minimizing losses through recycling			

This course outline was certified in the Department Board meeting on …./…../…….. and approved in the Faculty Board meeting on …./…../……..

Prof. dr. eng. Alexandru PASCU **Dean**	**Assoc. Prof. dr. eng. Camelia Gabor** **Head of Department**
Prof. dr. eng. Maria Stoicanescu **Course holder**	**Prof. dr. eng. Maria Stoicanescu** **Holder of seminar/ laboratory/ project**

Note:

1) Field of study – select one of the following options: Bachelor / Master / Doctorat (to be filled in according to the forceful classification list for study programmes);

2) Study level – choose from among: Bachelor / Master / Doctorat;

3) Course status (content) – for the Bachelor level, select one of the following options: **FC** (fundamental course) / **DC** (course in the study domain)/ **SC** (speciality course)/ **CC** (complementary course); for the Master level, select one of the following options: **PC** (proficiency course)/ SC (synthesis course)/ **AC** (advanced course);

4) Course status (attendance type) – select one of the following options: **CPC** (compulsory course)/ **EC** (elective course)/ **NCPC** (non-compulsory course);

5) One credit is the equivalent of 30 study hours (teaching activities and individual study).

COURSE OUTLINE

1. Data about the study programme

1.1 Higher education institution	Transilvania University of Brașov
1.2 Faculty	Materials Science and Engineering
1.3 Department	Materials Science
1.4 Field of study[1)]	Materials Engineering
1.5 Study level[2)]	Master
1.6 Study programme/ Qualification	Materials Science, Engineering, and Management

2. Data about the course

2.1 Name of course	Logistics and material management							
2.2 Course convenor	Assoc. prof. dr. eng. Ioana POPESCU							
2.3 Seminar/ laboratory/ project convenor	Assoc. prof. dr. eng. Ioana POPESCU							
2.4 Study year	1	2.5 Semester	2	2.6 Evaluation type	E	2.7 Course status	Content[3)]	CC
							Attendance type[4)]	EC

3. Total estimated time (hours of teaching activities per semester)

3.1 Number of hours per week	**4**	out of which: 3.2 lecture	**2**	3.3 seminar/ laboratory/ project	**1/0/1**
3.4 Total number of hours in the curriculum	56	out of which: 3.5 lecture	28	3.6 seminar/ laboratory/ project	14/0/14

Time allocation	hours
Study of textbooks, course support, bibliography and notes	30
Additional documentation in libraries, specialized electronic platforms, and field research	25
Preparation of seminars/ laboratories/ projects, homework, papers, portfolios, and essays	30
Tutorial	5
Examinations	4
Other activities....................................	

3.7 Total number of hours of student activity	94
3.8 Total number per semester	150
3.9 Number of credits[5)]	5

4. Prerequisites (if applicable)

4.1 curriculum-related	• Not applicable
4.2 competences-related	• The student/graduate selects and applies basic concepts, principles, and methods from the field for calculations related to the design, production, processing, and management of engineering materials. • The student/graduate selects and uses bibliographic sources specific to the field.

5. Conditions (if applicable)

5.1 for course development	• Students should have a basic understanding of management, operations, and quantitative methods, and access to case studies, logistics tools, and supply chain software. Successful course participation also requires active engagement in lectures, discussions, group exercises, and practical simulations.
5.2 for seminar/ laboratory/	• Students should actively participate, have access to relevant case studies,

project development	discussion materials, and engage in group exercises and practical problem-solving activities. Students should be able to analyze logistics problems, collect and interpret data, apply theoretical concepts, and prepare reports and presentations using appropriate tools and software.

6. Specific competences and learning outcomes

Professional competences	**Cp.1. Use of modern concepts and theories in the field of advanced materials** (ESCO - evaluates the suitability of metal types for specific applications; manipulates metals; works in metal production teams) ***Knowledge***. L.O. 1.2. The graduate describes how materials engineering products and processes have a positive impact on global and social issues, using modern concepts and theories in the field of advanced materials. ***Skills*** L.O. 1.4. The graduate can identify opportunities and design strategies in solving needs in the field of materials engineering. ***Responsibility and autonomy*** L.O. 1.5. The graduate has autonomy in learning. L.O. 1.6. The graduate autonomously integrates concepts and theories in materials engineering into new contexts in the workplace. **Cp.2. Identifying and defining a research topic in the field of advanced materials and developing a plan to achieve the proposed objectives** (ESCO - approaches problems critically; develops materials testing procedures; presents reports on test results) ***Knowledge*** L.O. 2.1. The graduate can identify and define a topic of actuality or of maximum necessity in the field of advanced materials through the criterial materials selection. ***Skills*** L.O. 2.3. The graduate can develop a plan for selecting appropriate tools for advanced materials processing, using them safely to achieve the proposed objectives.

	Responsibility and autonomy L.O. 2.5. The student/graduate selects and uses bibliographic sources specific to the field. L.O. 2.6. The student/graduate demonstrates autonomy in learning on issues specific to the field. **Cp.4. Use of basic concepts in the field of research management in materials engineering** (ESCO - manages engineering projects; finds solutions to problems; applies numerical calculation skills; provides project management; identifies process improvements; prepares scientific reports; makes independent operational decisions) *Knowledge* L.O. 4.1. The graduate knows and understands the basic concepts in the field of research management in materials engineering, being able to approach complex and interdisciplinary projects involving materials. *Skills* L.O. 4.2. The graduate applies the basic concepts of research management in materials engineering based on logical and thorough reasoning, with the purpose of interpreting various types of situations, processes, and projects specific to engineering and management. The graduate designs and carries out research activities using validated scientific methods. L.O. 4.3. The graduate can perform calculations, demonstrations, and applications to solve tasks specific to materials engineering, based on knowledge of fundamental sciences. L.O. 4.4. The graduate can prepare and interpret technical and managerial documentation specific to research in the field of materials engineering. *Responsibility and autonomy* L.O. 4.5. Manages individual or group research activities. L.O. 4.6. The graduate applies the values of ethics and professional conduct as a materials engineer. L.O. 4.7. The graduate correctly evaluates the workload, manages available resources, and respects the deadlines for completing professional tasks.

Transversal competences	**Ct.1. Performing complex professional tasks, respecting the norms of professional ethics and moral conduct, following a personal work plan established based on individual study** (ESCO - applies scientific, technological and engineering knowledge; develops strategies for solving problems.) L.O. 1.1. The graduate can perform complex professional tasks while observing the rules of professional ethics and moral conduct, following a self-established work plan based on individual study. L.O. 1.2. The graduate can identify continuous training opportunities and using them effectively for personal development in carrying out complex professional tasks, following a self-established work plan based on individual study. L.O. 1.3. The graduate is capable of recognizing, understanding, and promoting quality and creativity in performing complex professional tasks. **Ct.2. Planning, monitoring and assuming the professional tasks of a subordinate professional group(s)** (ESCO - has teamwork capacity; demonstrates organizational skills) L.O. 2.1. The graduate can plan and monitor the execution of complex professional tasks carried out by a group or subordinate professional teams. L.O. 2.2. The graduate can take responsibility for the consequences of decisions made while coordinating complex professional activities carried out by a group or subordinate professional teams. **Ct.3. Permanent information and documentation in his/her field of activity and related fields, in correlation with the needs of the labor market** (ESCO - demonstrates a desire to learn; manages personal development.) L.O. 3.1. The graduate can identify continuous training opportunities and use them effectively for personal development in their field or related activities and domains, in correlation with labor market needs.

7. Course objectives (resulting from the specific competences to be acquired)

7.1 General course objective	• The course aims to familiarize students with logistics issues specific to technical systems and materials management.
7.2 Specific objectives	• The course aims to develop students' understanding of the role of logistics within a company and its relationships across the supply chain, enabling them to analyze and solve major logistics-related problems. It also seeks to build knowledge of materials management concepts and the formation of strategic alliances for production and supply to reduce costs and optimize asset utilization. Students will learn effective methods for storing and transporting goods through distribution channels and will be encouraged to use information technology to enhance logistics efficiency and improve customer service.

8. Content

8.1 Course	Teaching methods	Number of hours	Remarks
1. Introduction to Logistics and Supply Chain Management	Lecture Explanation Conversation Problematization	2	
2. Relationships between Logistics and Distribution		2	

3. Logistics Costs and Performance Analysis	Case studies	2	
4. Warehousing and Inventory Management		2	
5. Materials Management and Resource Planning (MRP)		2	
6. Production Systems Planning and Control		2	
7. Procurement and Sourcing Management		2	
8. Transportation and Distribution Systems		2	
9. E-Commerce and Digital Logistics		2	
10. Information Systems in Logistics (ERP and WMS Applications)		2	
11. Supply Chain Strategy and Design		2	
12. Sustainable and Green Logistics		2	
13. Global Logistics and International Trade		2	
14. Risk Management and Resilience in Supply Chains		2	

Bibliography

1. Christopher, M. (2016). Logistics and Supply Chain Management: Strategies for Reducing Cost and Improving Service. 5th Edition. Pearson Education.
2. Ballou, R. H. (2007). Business Logistics/Supply Chain Management: Planning, Organizing, and Controlling the Supply Chain. 5th Edition. Pearson Prentice Hall.
3. Chopra, S., & Meindl, P. (2023). Supply Chain Management: Strategy, Planning, and Operation. 8th Edition. Pearson Education.
4. Arnold, J. R. T., Chapman, S. N., & Clive, L. M. (2012). Introduction to Materials Management. 7th Edition. Pearson.

8.2 Seminar	Teaching-learning methods	Number of hours	Remarks
1. The Strategic Role of Logistics in Modern Organizations	Interactive discussions, case studies, and practical exercises to develop analytical and problem-solving skills in logistics and materials management	2	
2. Transition from Traditional Logistics to Integrated Supply Chain Managemen		2	
3. Cost Analysis and Performance Indicators in Logistics Operations.		2	
4. Warehouse Design and Inventory Optimization Techniques		2	
5. The Impact of E-Commerce on Logistics and Distribution Systems		2	
6. Sustainability and Green Logistics Practices.		2	
7. The Role of Information Technology and ERP Systems in Logistics Management		2	

8.3 Project			
Students will select a logistics or materials management problem, analyze the current situation to identify challenges or inefficiencies, and propose practical, data-supported solutions. The project includes a report with a clear structure (introduction, analysis, recommendations, references) and presentation summarizing the findings. Evaluation is based on the relevance of	Independent research and data collection	2	
	Problem-solving and analytical exercises	2	
	Group discussions and collaboration	4	
	Application of theoretical concepts to real-world	4	

the problem, depth of analysis, feasibility of solutions, quality of the report, and clarity of the presentation.	scenarios		
	Oral presentations and peer feedback	2	

Bibliography

1. Christopher, M. (2016). *Logistics and Supply Chain Management: Strategies for Reducing Cost and Improving Service.* 5th Edition. Pearson Education.
2. Ballou, R. H. (2007). *Business Logistics/Supply Chain Management: Planning, Organizing, and Controlling the Supply Chain.* 5th Edition. Pearson Prentice Hall.

9. Correlation of course content with the demands of the labour market (epistemic communities, professional associations, potential employers in the field of study)

The course develops skills and knowledge sought by logistics and supply chain professionals, preparing graduates to address real-world challenges and support strategic decision-making.

10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of the final grade
10.4 Course	individual assignments assessing theoretical knowledge.	Ongoing assessment (during interactive courses) and final oral examination	50%
10.5 Seminar	Active participation, case discussions, and group exercises.	Evaluation of the engagement, critical thinking, and contribution to discussions	20%
14.5. Project	Analytical report and oral presentation demonstrating problem-solving and practical application	Verification and final defense	30%
10.6 Minimal performance standard			
Achieving at least 50% of the points allocated for the course and practical activities. Attendance at practical activities is mandatory and a prerequisite for taking the exam.			

This course outline was certified in the Department Board meeting on 03/09/2025 and approved in the Faculty Board meeting on 29/09/2025.

Prof. dr. eng. Alexandru PASCU .... **Dean**	**Conf. dr. eng. Camelia GABOR** .... **Head of Department**
Assoc. prof. dr. eng. Ioana Popescu **Course holder**	Assoc. prof. dr. eng. Ioana Popescu **Holder of seminar/ laboratory/ project**

Note:

1) Field of study – select one of the following options: Bachelor / Master / Doctorat (to be filled in according to the forceful classification list for study programmes);

[2] Study level – choose from among: Bachelor / Master / Doctorat;

[3] Course status (content) – for the Bachelor level, select one of the following options: **FC** (fundamental course) / **DC** (course in the study domain)/ **SC** (speciality course)/ **CC** (complementary course); for the Master level, select one of the following options: **PC** (proficiency course)/ SC (synthesis course)/ **AC** (advanced course);

[4] Course status (attendance type) – select one of the following options: **CPC** (compulsory course)/ **EC** (elective course)/ **NCPC** (non-compulsory course);

[5] One credit is the equivalent of 30 study hours (teaching activities and individual study).

COURSE OUTLINE

1. Data about the study programme

1.1 Higher education institution	Transilvania University of Brașov
1.2 Faculty	Materials Science and Engineering
1.3 Department	Materials Science
1.4 Field of study[1)]	Materials Engineering
1.5 Study level[2)]	Master
1.6 Study programme/ Qualification	Materials Science, Engineering, and Management (in English)

2. Data about the course

2.1 Name of course	Integrated waste management							
2.2 Course convenor	Prof. dr. eng. Miloșan Ioan							
2.3 Seminar/ laboratory/ project convenor	Prof. dr. eng. Stoicănescu Maria							
2.4 Study year	I	2.5 Semester	II	2.6 Evaluation type	E	2.7 Course status	Content[3)]	CC
							Attendance type[4)]	EC

3. Total estimated time (hours of teaching activities per semester)

3.1 Number of hours per week	**4**	out of which: 3.2 lecture	**2**	3.3 seminar/ laboratory/ project	**0/1/2**
3.4 Total number of hours in the curriculum	70	out of which: 3.5 lecture	28	3.6 seminar/ laboratory/ project	0/14/14

Time allocation	Hours
Study of textbooks, course support, bibliography and notes	35
Additional documentation in libraries, specialized electronic platforms, and field research	15
Preparation of seminars/ laboratories/ projects, homework, papers, portfolios, and essays	20
Tutorial	5
Examinations	5
Other activities....................................	

3.7 Total number of hours of student activity	80
3.8 Total number per semester	150
3.9 Number of credits[5)]	5

4. Prerequisites (if applicable)

4.1 curriculum-related	•
4.2 competences-related	•

5. Conditions (if applicable)

5.1 for course development	• Students should have a basic understanding of materials recycling and environmental management and access to case studies, national and international legislation in the field. Successful course participation also requires active engagement in lectures, discussions, group exercises, and practical simulations.
5.2 for seminar/ laboratory/ project development	• Seminar room, blackboard, computer, video projector

6. Specific competences and learning outcomes

Professional competences	**Cp.1. Use of modern concepts and theories in the field of advanced materials** (ESCO - evaluates the suitability of metal types for specific applications; manipulates metals; works in metal production teams) ***Knowledge*** L.O. 1.1. The graduate defines modern concepts and theories in the field of advanced materials. L.O. 1.2. The graduate describes how materials engineering products and processes have a positive impact on global and social issues, using modern concepts and theories in the field of advanced materials. ***Skills*** L.O. 1.3. The graduate analyses data obtained from the use of the structure-property relationship for the characteristics of different types of materials and especially metallic, polymer, ceramic and composite materials. L.O. 1.4. The graduate can identify opportunities and design strategies in solving needs in the field of materials engineering. ***Responsibility and autonomy*** L.O. 1.5. The graduate has autonomy in learning. L.O. 1.6. The graduate autonomously integrates concepts and theories in materials engineering into new contexts in the workplace. **Cp.2. Identifying and defining a research topic in the field of advanced materials and developing a plan to achieve the proposed objectives** (ESCO - approaches problems critically; develops materials testing procedures; presents reports on test results) ***Knowledge*** L.O. 2.1. The graduate can identify and define a topic of actuality or of maximum necessity in the field of advanced materials through the criterial materials selection. L.O. 2.2. The graduate can identify, define and develop a specific plan for processing advanced materials according to technological parameters in achieving the proposed objectives. ***Skills*** L.O. 2.3. The graduate can develop a plan for selecting appropriate tools for advanced materials processing, using them safely to achieve the proposed objectives. L.O. 2.4. The graduate can use modern tools and techniques to modify, characterize and measure the properties of materials and to design processes according to accepted standards. ***Responsibility and autonomy*** L.O. 2.5. The student/graduate selects and uses bibliographic sources specific to the field. L.O. 2.6. The student/graduate demonstrates autonomy in learning on issues specific to the field. **Cp.5. Applying the principles of scientific research specific to the field and carrying out an oral/written communication, through which the results are presented, in a clear and convincing manner.** (ESCO - conducts scientific research; tests materials; develops advanced materials). ***Knowledge*** L.O. 5.1. The graduate knows how to apply the principles of scientific research specific to the field and to communicate clearly and concisely, both in writing and orally, regarding the results obtained by applying the principles of scientific research specific to the field of advanced materials and related fields. ***Skills*** L.O. 5.2. The graduate can apply the principles of scientific research specific to the field by acquiring the ability to perceive, understand and promote quality and creativity in research and communication of the results obtained.

	L.O. 5.3. The graduate can develop skills as a researcher and good communicator in the field of materials engineering by applying the principles of scientific research by extracting relevant conclusions from the research carried out. L.O. 5.4. The graduate knows how to correctly communicate the results of analyses and calculations carried out in scientific research, thus explaining the correctness of the proposed solutions. *Responsibility and autonomy* L.O. 5.5. The graduate assumes the intellectual paternity of his/her own research and respects the deontological norms. L.O. 5.6. The graduate demonstrates autonomy in the dissemination of knowledge by initiating and managing the publication process.
Transversal competences	**Ct.1. Performing complex professional tasks, respecting the norms of professional ethics and moral conduct, following a personal work plan established based on individual study** (ESCO - applies scientific, technological and engineering knowledge; develops strategies for solving problems.) L.O. 1.1. The graduate can perform complex professional tasks while observing the rules of professional ethics and moral conduct, following a self-established work plan based on individual study. L.O. 1.2. The graduate can identify continuous training opportunities and using them effectively for personal development in carrying out complex professional tasks, following a self-established work plan based on individual study. L.O. 1.3. The graduate is capable of recognizing, understanding, and promoting quality and creativity in performing complex professional tasks. L.O. 1.4. The graduate knows the occupational health and safety regulations, thus ensuring safe working conditions for themselves and for the team they are part of. **Ct.3. Permanent information and documentation in his/her field of activity and related fields, in correlation with the needs of the labor market** (ESCO - demonstrates a desire to learn; manages personal development.) L.O. 3.1. The graduate can identify continuous training opportunities and use them effectively for personal development in their field or related activities and domains, in correlation with labor market needs. L.O. 3.2. The graduate can develop original models to accurately describe real processes specific to materials engineering, based on thorough individual study. L.O. 3.3. The graduate is capable of objectively and effectively self-assessing their professional activity, thereby gaining an overall understanding of their own knowledge, with a strong emphasis on continuous information gathering and documentation in their field of activity.

7. Course objectives (resulting from the specific competences to be acquired)

7.1 General course objective	• Training skills to understand environmental problems generated by anthropogenic activities as well as specific methods, techniques and means to reduce the impact of activities on environmental quality
7.2 Specific objectives	• The correct approach to managing a certain type of waste from the perspective of avoiding its generation, minimizing and material/energy recovery, respectively final disposal • Understanding and knowing recycling-recovery techniques appropriate to the type of waste, in order to reduce the risk potential of waste and reduce the burden on landfills.

8. Content

8.1 Course	Teaching methods	Number of hours	Remarks
The concept of sustainability. Dimensions of sustainability. Classical representation methods. Advanced models of sustainability representation	Interactive course, case studies, and practical exercises to develop analytical and problem-solving skills criteria for materials selection	2	
Cleaner production. Definition. Strategy for integrated pollution prevention. Methodological steps for implementing cleaner production. Clean technologies		4	
The concept of integrated waste management. Hierarchy of the stages that define the integrated waste management system.		2	
Waste management planning in EU member states. Regulatory framework. Legislation		2	
Characteristics and directions of materials recycling management in EU member states		2	
Mechanical-biological treatment of waste. Types of treatment plants		2	
Solutions for valorizing resources from urban wastewater treatment plants: energy/co-generation, biosolids recycling		2	
Thermal conversion processes of solid waste: incineration, gasification, pyrolysis		2	
Biodegradable waste. Sludge processing processes from urban sewage treatment plants		2	
Composting biodegradable waste		2	
Hybrid processes for treating urban sludge		2	
Recycling packaging waste		2	
Waterproofing systems used in the lining and final closure of landfills		2	

Bibliography

1. Gupta, K.P. (2024). Integrated Waste Management: Trends, Policies, and Perspectives. Taylor & Francis Group Publisher.
2. Yatoo, A.M., Gupta, P.K., Singh, R.P. (2025). Integrated Waste Management. Trends, Policies, and Perspectives. CRC Press.
3. Pope, K. (2020) Global Waste Management. Models for Tackling the International Waste Crisis. Kogan Page Publisher, London, England.
4. Wang, LK, Wang, MHS, Hung, YT. (2021). "Solid Waste Engineering and Management, Volume 1", Springer Nature Switzerland.

8.2 Laboratory	Teaching-learning methods	Number of hours	Remarks
Presentation of laboratory work.	General presentation	2	
Case Study: Hazardous Waste Landfills	Practical work	2	
Environmental impact assessment of municipal waste landfills		4	
Composting household and garden waste		4	
Recoveries and closure of the situation		2	

Bibliography

<table>
<tr><td colspan="4">1. Gupta, K.P. (2024). Integrated Waste Management: Trends, Policies, and Perspectives. Taylor & Francis Group Publisher.
2. Pope, K. (2020) Global Waste Management. Models for Tackling the International Waste Crisis. Kogan Page Publisher, London, England.</td></tr>
<tr><td>8.3 Project</td><td></td><td></td><td></td></tr>
<tr><td>Design theme. Design of an integrated system that includes waste management activities (segregation at source, collection, transport, transfer, sorting and recycling, composting, mechanical-biological treatment, storage in a single system).</td><td rowspan="7">• Independent research and data collection.
• Problem-solving
• Completion of the individual assignment
• Periodic presentation (during project sessions) of the progress in completing the assignment</td><td>2</td><td></td></tr>
<tr><td>Description/Characterization of the location (county, city, village, economic enterprise, institutions)</td><td>2</td><td></td></tr>
<tr><td>Waste hierarchy. Collection and transport: types of waste generated, estimated quantities</td><td>2</td><td></td></tr>
<tr><td>Proposal for a sorting station scheme for separately collected recyclable waste</td><td>2</td><td></td></tr>
<tr><td>Proposal for a schematic/brief description of a mechanical-biological treatment plant for the treatment and inerting of the wet fraction
Storage (location/site)</td><td>2</td><td></td></tr>
<tr><td>Problems identified and proposed measures</td><td>2</td><td></td></tr>
<tr><td>Oral presentations of individual projects and peer feedback.</td><td>2</td><td></td></tr>
<tr><td colspan="4">Bibliography
1. Gupta, K.P. (2024). Integrated Waste Management: Trends, Policies, and Perspectives. Taylor & Francis Group Publisher.
2. Pope, K. (2020) Global Waste Management. Models for Tackling the International Waste Crisis. Kogan Page Publisher, London, England.</td></tr>
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9. Correlation of course content with the demands of the labour market (epistemic communities, professional associations, potential employers in the field of study)

The concepts taught alongside practical laboratory work and specific calculations for the Integrated waste management, are corroborated with the expectations of representatives of epistemic communities, professional associations and representative employers in the field related to the program and the curriculum is consistent with similar study programs offered by major universities in the country and abroad.

10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of the final grade
10.4 Course	Acquired knowledge: understanding theoretical concepts and correct use of specific terminology	Ongoing assessment (during interactive courses) and final oral examination	55%
10.5 Laboratory	Laboratory reports	Evaluation of the accuracy of laboratory reports and the final thematic paper	15%

10.6 Project	Thematic project	Verification and final defense	30%
10.7 Minimal performance standard			
• The minimum exam score is 5. • Knowledge of techniques for Integrated waste management, the design and execution process of an integrated system that includes waste management activities			

This course outline was certified in the Department Board meeting on …./…../…….. and approved in the Faculty Board meeting on …./…../……..

Prof. Dr. Eng. Alexandru PASCU **…………………………………………………………………** **Dean**	**Assoc. Prof. Dr. Eng. Camelia GABOR** **……………………………………………………………………………………** **Head of Department**
Prof. Dr. Eng. Ioan MILOȘAN **Course holder**	**Prof. Dr. Eng. Maria STOICĂNESCU** **Holder of seminar/ laboratory/ project**

Note:

1) Field of study – select one of the following options: Bachelor / Master / Doctorat (to be filled in according to the forceful classification list for study programmes);

2) Study level – choose from among: Bachelor / Master / Doctorat;

3) Course status (content) – for the Bachelor level, select one of the following options: **FC** (fundamental course) / **DC** (course in the study domain)/ **SC** (speciality course)/ **CC** (complementary course); for the Master level, select one of the following options: **PC** (proficiency course)/ SC (synthesis course)/ **AC** (advanced course);

4) Course status (attendance type) – select one of the following options: **CPC** (compulsory course)/ **EC** (elective course)/ **NCPC** (non-compulsory course);

5) One credit is the equivalent of 30 study hours (teaching activities and individual study).