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			Biomaterials					
2.2 Course convenor			Prof. dr. eng. Stoicanescu Maria					
2.3 Seminar/ laboratory/ project convenor			Prof. dr. eng. Stoicanescu Maria					
2.4 Study year	II	2.5 Semester	1	2.6 Evaluation type	V	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	**3**	out of which: 3.2 lecture	**1**	3.3 seminar/ laboratory/ project	**0/2/0**
3.4 Total number of hours in the curriculum	42	out of which: 3.5 lecture	14	3.6 seminar/ laboratory/ project	0/28/0

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	18
Tutorial	
Examinations	
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	• not applicable
4.2 competences-related	• not applicable

5. Conditions (if applicable)

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

6. Specific competences and learning outcomes

Professional competences	**Cp1. 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. 2.2. 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.

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	• Forming a global vision about biomaterials viewed as a complex of modern disciplines aimed at obtaining useful products
7.2 Specific objectives	• Familiarizing students with the fundamental theoretical and practical principles • Knowledge of the applications of biotechnological processes in everyday life. • Knowledge of the physiological, biochemical and molecular mechanisms through which industrial microorganisms produce products of great importance for health and economy.

8. Content

8.1 Course	Teaching methods	Number of hours	Remarks
Introductory course in biomaterials and biotechnology	Lecture, interactive course	2	
Chemical-mechanical characteristics of biomaterials used in the manufacture of implants		2	
Surface effects in implant function - Interaction at the biomaterial-tissue interface		2	

Biomaterials for bone prostheses. Methods of obtaining, processing and testing		2	
Composite and ceramic biomaterials for implants. Methods of obtaining, processing and testing		2	
Smart and functional materials – bio. Methods of obtaining, processing and testing		2	
Biomaterials for soft and semi-rigid tissue implants. Methods of obtaining, processing and testing		2	
Bibliography 1. M.F.Shackeleford- Introduction to Materials Science for Engineers 2. Ratner, Buddy D., Hoffman, Allan S., Schoen, Frederick J. Biomaterials Science: An Introduction to Materials in Medicine. 3rd ed., Elsevier, 2012 3. P. Vadgana- Surfaces and Interfaces for Biomaterials- Baca Raton CRC press, 2005 4. J. Breme, R. Thhull, J.C. Kirkpatrick – Metallic Biomaterials Interfaces, Weinheim, WILEY-VCH Verlag, 2008 5. I. Ghiuță, I. , D. Cristea., C. Croitoru., J. Kost., R. Wenkert., I. Vyrides, A. Anayiotos, D. Munteanu, Characterization and antimicrobial activity of silver nanoparticles, biosynthesized using Bacillus species, Applied Surface Science 438 (2018) 66- 73			
8.2 Seminar/ laboratory/ project	Teaching-learning methods	Number of hours	Remarks
Presentation of laboratory work.	General presentation	2	
Physico-chemical characterization of metallic biomaterials	Practical work	2	
Surface modification and evaluation of biological material interaction		2	
Characterization of ceramic and bioceramic materials		2	
Biodegradable polymers and hydrogels for biomedical applications		2	
In vitro biocompatibility tests – cells and material-cell interactions		2	
Mechanical testing of porous structures or tissue scaffolds		2	
Degradation and controlled release of biomaterials		2	
Evaluation of corrosion and interaction of metallic implants with body fluids		2	
Surface characterization: spectroscopy, microscopy and roughness		2	
Study of biofilms and infections associated with biomaterials		2	
Implantation simulation and finite element analysis (FEA) for biomaterials		2	
Designing a bioactive composite (metal-ceramic or polymer-ceramic)		2	
Recovery and end of the laboratory situation	Practical work	2	
Bibliography 1. M.F.Shackeleford- Introduction to Materials Science for Engineers 2. Ratner, Buddy D., Hoffman, Allan S., Schoen, Frederick J. Biomaterials Science: An Introduction to Materials in			

Medicine. 3rd ed., Elsevier, 2012
3. P. Vadgana- Surfaces and Interfaces for Biomaterials- Baca Raton CRC press, 2005
4. J. Breme, R. Thhull, J.C. Kirkpatrick – Metallic Biomaterials Interfaces, Weinheim, WILEY-VCH Verlag, 2008
5. I. Ghiuță, I. , D. Cristea., C. Croitoru., J. Kost., R. Wenkert., I. Vyrides, A. Anayiotos, D. Munteanu, Characterization and antimicrobial activity of silver nanoparticles, biosynthesized using Bacillus species, Applied Surface Science 438 (2018) 66- 73

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 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	- degree of knowledge of basic concepts	verification Checks along the way (oral)	60%
	- way of approaching problems		
10.5 Seminar/ laboratory/ project	acquiring theoretical and practical knowledge specific to the laboratory	Periodic evaluation. Oral. Laboratory colloquium	40%
	Systematic preparation of the tasks provided for individual study		
10.6 Minimal performance standard			
• The minimum exam grade is 5 • Knowledge of concepts related to biomaterials, biotechnology, biocompatibility			

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			Functional materials					
2.2 Course convenor			Assoc. Prof. dr. eng. Vasile-Adrian Surdu					
2.3 Seminar/ laboratory/ project convenor			Assoc. Prof. dr. eng. Vasile-Adrian Surdu Lect. dr. eng. Simona Radu					
2.4 Study year	2	2.5 Semester	1	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 materials, devices and equipment specific to functional materials processing 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 the main approaches, models, and theories used in the design of functional materials intended for the electronics, photonics, sensors and actuators applications.
7.2 Specific objectives	The course covers the following advanced topics, concepts, and principles, all aimed at providing students with a comprehensive understanding of the methodological and procedural framework in the field: • Understand the fundamental principles governing functional materials. • Analyze the relationship between composition, structure, and functional properties. • Acquire hands-on experience with synthesis and characterization techniques. • Evaluate applications of functional materials in modern technologies. • Design a small research project related to functional materials.

8. Content

8.1 Course	Teaching methods	Number of hours	Remarks
1. Introduction to Functional Materials: definitions, classes, and applications	Lecture Explanation Conversation Problematization Case studies	2	
2. Structure–property relationships in solids		2	
3. Electronic and ionic conductivity in materials		4	
4. Semiconductors and optoelectronic materials		4	
5. Ferroelectric and piezoelectric materials		4	
6. Superconducting materials		2	
7. Optical materials		2	
8. Catalytic and photocatalytic materials		2	
9. Characterization techniques for functional materials		4	
10. Industrial and emerging applications		2	

Bibliography

1. Z. Zhang, M. Zhao, Y. Qin, Functional Materials for Electrocatalytic Energy Conversion, Wiley, 2025.
2. S. Banarjee, A.K. Tyagi, Functional Materials: Prepraration, Processing, and Applications, Elsevier, 2012.
3. Nanoelectronics and Information Technology: Advanced Electronic Materials and Novel Devices, Ed. Rainer Waser,

Wiley-VCH Verlag GmbH, Weinheim, Germany, 2012.
4. R. K. Pandey, Fundamentals of electroceramics : materials, devices, and applications, John Wiley & Sons, Inc., Hoboken, NJ, USA, 2019.
5. Advances and Applications in Electroceramics II, Eds. K. M. Nair, Shashank Priya, John Wiley & Sons, Inc., Hoboken, New Jersey, 2012.

8.2 Laboratory	Teaching-learning methods	Number of hours	Remarks
1. Sol-gel synthesis of photocatalytic material	Selection of material with predefined properties, sol-gel synthesis	2	
2. Thin-film deposition (spin coating or dip coating)	The sol-gel precursor is deposited through spin coating or dip coating	4	
3. Phase composition and structure analysis using X-ray diffraction	A study is carried out using X-ray diffraction with the Bruker D8 Advanced – ICDT-L8-DS.	4	
4. Surface and morphology analysis using SEM/AFM	Morpho-structural and compositional characteristics are determined using a scanning electron microscope (SEM) coupled with an energy-dispersive X-ray spectrometer (EDS) or atomic force microscope – ICDT-L8-DS.	4	
5. Optical properties measurement	A study is carried out by UV-Vis spectrometer	2	
6. Photocatalytic behavior	A study is carried out for a die degradation using UV-vis spectrometer	4	
7. Data interpretation	Phase composition analysis, morphology analysis and photocatalytic degradation profile determination and interpretation	4	
Missed assignments make-up Assessment of completing the laboratory requirements	Discussion, evaluation	4	
8.3 Project			
A paper is prepared on a pre-established topic related to the course content.	• Completion of the individual assignment • Periodic presentation (during project	14	

	sessions) of the progress in completing the assignment		

Bibliography

1. S. Banarjee, A.K. Tyagi, Functional Materials: Prepraration, Processing, and Applications, Elsevier, 2012.
2. Dumitru R, Ianculescu A, Păcurariu C, Lupa L, Pop A, Vasile B, Surdu A, Manea F. $BiFeO_3$-synthesis, characterization and its photocatalytic activity towards doxorubicin degradation from water. Ceramics international;45(2):2789-80,2, 2019.
3. Surdu VA, Trușcă RD, Vasile BȘ, Oprea OC, Tanasă E, Diamandescu L, Andronescu E, Ianculescu AC. $Bi_{1-x}Eu_xFeO_3$ powders: Synthesis, characterization, magnetic and photoluminescence properties. Nanomaterials. 2019 Oct 16;9(10):1465.

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**	**Conf. dr. eng. Camelia GABOR** **……** **Head of Department**
Assoc. prof. dr. eng. Vasile-Adrian Surdu **……** **Course holder**	Assoc. Prof. dr. eng. Vasile-Adrian Surdu **……** Lect. dr. eng. Simona Radu **……**

	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			Additive manufacturing					
2.2 Course convenor			CS II dr. eng. Mihai Alin Pop					
2.3 Seminar/ **laboratory/ project** convenor			CS II dr. eng. Mihai Alin Pop / CS II dr. eng. Mihai Alin Pop					
2.4 Study year	II	2.5 Semester	3	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	10
Preparation of seminars/ laboratories/ projects, homework, papers, portfolios, and essays	15
Tutorial	5
Examinations	9
Other activities.....	

3.7 Total number of hours of student activity	64
3.8 Total number per semester	120
3.9 Number of credits[5)]	4

4. Prerequisites (if applicable)

4.1 curriculum-related	• Computer-aided design
4.2 competences-related	• Basic computer and software skills

5. Conditions (if applicable)

5.1 for course development	• Classroom with blackboard and video projector
5.2 for seminar/ laboratory/ project development	• Laboratory equipped with a blackboard • Computer network with Microsoft Windows operating system and CAD software packages Rapid prototyping equipment

6. Specific competences and learning outcomes

Professional competences	**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.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.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 contributes to the training of specialists capable of approaching product design and manufacturing while considering both the functional and aesthetic roles of the products. It prepares professionals to improve manufacturing efficiency by reducing the time required to launch new products and by using virtual and physical models.
7.2 Specific objectives	• To enable students to understand and apply fundamental design principles, • To equip students with proficiency in 2D and 3D design software environments, • To train students in creating accurate 3D virtual models, • To guide students in developing physical prototypes through appropriate techniques.

8. Content

8.1 Course	Teaching methods	Number of hours	Remarks
Introduction to Rapid Prototyping - Mold making methods / Rapid manufacturing processes. - The role of rapid prototyping in new product development.	Presentation, interactive course, lecture, conversation	4	
Additive manufacturing software. From 3D CAD models to sliced models.	Presentation, interactive course, lecture, conversation	2	
Rapid prototyping design - Requirements for the virtual model used / Geometric modelling / Standard STL file, - Transfer of the virtual model to RP machines	Presentation, interactive course, lecture, conversation	4	
Fused Deposition Modelling - FDM Principle / Equipment used. - Rapid Prototyping technology for plastics / composites / metals.	Presentation, interactive course, lecture, conversation	2	
Selective Laser Sintering (SLS) - Working principle of SLS, materials used / SLS manufacturing technology of metal parts / Types of metal powders used and the principle of their sintering - Manufacturing technology of ceramic moulds and cores.	Presentation, interactive course, lecture, conversation	4	
Other RP technologies - Selective Laser Melting / 3D Printing / Interference Beam Solidification / Laminated Object Manufacturing (LOM) / Stereolithography (SLA) / Liquid Deposition Modelling (LDM). - Comparison of Rapid Prototyping technologies.	Presentation, interactive course, lecture, conversation	6	

Materials used in Rapid Prototyping technologies	Presentation, interactive course, lecture, conversation	4	
Applications of Rapid Prototyping in the production of moulds and various specific parts. Case studies.	Presentation, interactive course, lecture, conversation	2	

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1. Cazan C., Pop M.A.: Advances in Sustainable Polymeric Materials II , ISBN:978-3-7258-1326-1 (2024)
2. Shi, Y., Yan, C., Zhou, Y., Wu, J., Wang, Y., Yu, S., & Ying, C. (2021). *Materials for additive manufacturing*. Academic Press.
3. Sadasivuni, K. K., Deshmukh, K., & AlMaadeed, M. A. (Eds.). (2020). 3D and 4D printing of polymer nanocomposite materials: processes, applications, and challenges.
4. Pop M.A., Geaman V., Radomir I: Advanced composites used for thin-walled models fabrication, Lambert Academic Publishing, ISBN:978-3-8454-7241-6 (2018)
5. Zhang, Y., Zheng, W., Wang, Y., Ma, K., Feng, X., Ji, Q., ... & Lu, B. (2025). A review of 3D printing continuous carbon fiber reinforced thermoplastic polymers: Materials, processes, performance enhancement, and failure analysis. *Polymer Composites*.
6. Ma, T., Zhang, Y., Ruan, K., Guo, H., He, M., Shi, X., ... & Gu, J. (2024). Advances in 3D printing for polymer composites: a review. *InfoMat*, *6*(6), e12568.
7. Alarifi, I. M. (2024). Revolutionising fabrication advances and applications of 3D printing with composite materials: a review. *Virtual and Physical Prototyping*, *19*(1), e2390504.
8. Jandyal, A., Chaturvedi, I., Wazir, I., Raina, A., & Haq, M. I. U. (2022). 3D printing–A review of processes, materials and applications in industry 4.0. *Sustainable Operations and Computers*, *3*, 33-42.

8.2 Seminar/ **laboratory**/ project	Teaching-learning methods	Number of hours	Remarks
Labor protection. Presentation of laboratory papers	Individual practical work	2	
Dates transfer format. STL files. Choosing the appropriate RP technology.	Individual practical work	2	
Choosing working parameters and optimizing support structures. Obtaining parts using RP technologies (FFF, LDM, SLS), Practical applications using the **MiniFactory Ultra digital 3D printing system**, and **Peopoly XXL V2 – Stereolithography**.	Individual practical work	4	
Layered manufacturing. Model definition and solid model creation. Part scanning using **3D Scanner, Einscan HX, portable with a hybrid blue laser & LED light source.**	Individual practical work	2	
Defect analysis and remedial measures using **high-resolution digital microscope (Hirox HRX-01)**	Individual practical work	2	
Recovery of overdue laboratory work, colloquium	Evaluation	2	

Bibliography

1. Shi, Y., Yan, C., Zhou, Y., Wu, J., Wang, Y., Yu, S., & Ying, C. (2021). *Materials for additive manufacturing*. Academic Press.
2. Sadasivuni, K. K., Deshmukh, K., & AlMaadeed, M. A. (Eds.). (2020). 3D and 4D printing of polymer nanocomposite materials: processes, applications, and challenges.

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4. Chicos, L. A., Rodríguez, J., Cañadas, I., Galindo, J., Cempura, G., Kruk, A., ... & Lancea, C. (2025). Application of concentrated solar energy in postprocessing of selective laser melted Ti6Al4V alloy through simultaneously gas nitriding and heat treatment. *Scientific Reports*, *15*(1), 28193.
5. Pop, M. A., Coșniță, M., Zaharia, S. M., Chicoș, L. A., Croitoru, C., Roată, I. C., & Cătană, D. (2025). Influence of the Fill Value Parameters on Acoustic and Physical–Mechanical Performance of 3D-Printed Panels. *Polymers*, *17*(13), 1806.
6. Pop, M. A., Croitoru, C., Matei, S., Zaharia, S. M., Coșniță, M., & Spîrchez, C. (2024). Thermal and Sound Insulation Properties of Organic Biocomposite Mixtures. *Polymers*, *16*(5), 672.

8.2 Seminar/ laboratory/ **project**	Teaching-learning methods	Number of hours	Remarks
Project topics specific to the topic taught	Work practical individual	14	

Bibliography

1. Shi, Y., Yan, C., Zhou, Y., Wu, J., Wang, Y., Yu, S., & Ying, C. (2021). *Materials for additive manufacturing*. Academic Press.
2. Sadasivuni, K. K., Deshmukh, K., & AlMaadeed, M. A. (Eds.). (2020). 3D and 4D printing of polymer nanocomposite materials: processes, applications, and challenges.
3. Zhang, Y., Zheng, W., Wang, Y., Ma, K., Feng, X., Ji, Q., ... & Lu, B. (2025). A review of 3D printing continuous carbon fiber reinforced thermoplastic polymers: Materials, processes, performance enhancement, and failure analysis. *Polymer Composites*.
4. Ma, T., Zhang, Y., Ruan, K., Guo, H., He, M., Shi, X., ... & Gu, J. (2024). Advances in 3D printing for polymer composites: a review. *InfoMat*, *6*(6), e12568.
5. Alarifi, I. M. (2024). Revolutionising fabrication advances and applications of 3D printing with composite materials: a review. *Virtual and Physical Prototyping*, *19*(1), e2390504.
6. Jandyal, A., Chaturvedi, I., Wazir, I., Raina, A., & Haq, M. I. U. (2022). 3D printing–A review of processes, materials and applications in industry 4.0. *Sustainable Operations and Computers*, *3*, 33-42.

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

- Discussions with employer representatives to find out the minimum level of knowledge required for this discipline, as well as the most common practical issues that can be addressed in applications.
- Study of practice evaluation questionnaires by host companies.

10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of the final grade
10.4 Course	Accumulated knowledge	Oral examination, computer application	60%
10.5 Seminar/ laboratory/ project	Level of acquisition of theoretical and practical knowledge	Laboratory Colloquium	10%

	Level of acquisition of theoretical and practical knowledge	Project Colloquium / individual presentation	30%
10.6 Minimal performance standard			
• Participation in the exam is conditional on passing the laboratory colloquium, presenting and completing the project, and passing the colloquium. • 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 …./…../……..

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** …… **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			Surface engineering					
2.2 Course convenor			Assoc. prof. Ph.D. Eng. Camelia GABOR					
2.3 Laboratory/Project convenor			Assoc. prof. Ph.D. Eng. Camelia GABOR					
2.4 Study year	II	2.5 Semester	III	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 laboratory/ project	**2/1**
3.4 Total number of hours in the curriculum	70	out of which: 3.5 lecture	28	3.6 laboratory/ project	28/14

Time allocation	hours
Study of textbooks, course support, bibliography and notes	35
Additional documentation in libraries, specialized electronic platforms, and field research	30
Preparation of seminars/ laboratories/ projects, homework, papers, portfolios, and essays	35
Tutorial	4
Examinations	6
Other activities	-

3.7 Total number of hours of student activity	110
3.8 Total number per semester	180
3.9 Number of credits[5)]	6

4. Prerequisites (if applicable)

4.1 curriculum-related	Basic concepts of material properties and selection, solid mechanics, machines parts
4.2 competences-related	Foundational knowledge in engineering, ability to use Microsoft Office, basic scientific literature search skills.

5. Conditions (if applicable)

5.1 for course development	Classroom with projector or large display screen,
5.2 for seminar/ laboratory/ project development	A laboratory room equipped with specialized equipment for thin-film deposition and mechanical/tribological testing, as well as test samples

6. Specific competences and learning outcomes

Professional competences	**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. **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** (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. 3.3. 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. 3.6. 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.2.** Planning, monitoring and assuming the professional tasks of a subordinate professional group(s) (ESCO - has teamwork capacity; demonstrates organizational skills) **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. **Responsibility and autonomy** 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	The general objective of this course is to provide students with a comprehensive understanding of surface engineering by integrating fundamental principles of tribology with modern thin-film coating technologies, enabling them to analyze, design, and select surface treatments that enhance the performance, durability, and reliability of engineering components.
7.2 Specific objectives	- To understand the various surface treatment techniques and their role in enhancing surface properties (hardness, wear resistance, corrosion resistance, etc). - To acquire knowledge of the main thin-film deposition methods (such as PVD,

	CVD) and to understand the physical and chemical phenomena governing the formation, structure, and behavior of thin films. - To analyze the key factors influencing the quality, stability, and performance of thin-film coatings and to become familiar with the principal characterization methods used to evaluate their properties. - To apply theoretical concepts to practical case studies or projects related to surface engineering, enabling students to evaluate, design, and optimize coating solutions and tribological systems. - To develop the ability to operate specialized laboratory equipment for thin-film deposition, surface characterization, and the mechanical/tribological testing of coated components.

8. Content

8.1 Course	Teaching methods	Number of hours	Remarks
Introduction to surface engineering, surface topography, and solid surface contact.	Lecture, discussion.	2	
Mechanics and surface contact. Tribology, wear, lubricants.	Lecture, discussion.	4	
Methods for improving the surface properties of materials (diffusion surface treatments – general concepts; thin-films).	Lecture, discussion.	2	
Surface preparation for thin-film deposition. Prerequisites for deposition.	Lecture, discussion.	2	
Formation and structure of thin films. Nucleation and growth of thin films.	Lecture, discussion.	2	
Amorphous/ crystalline structure and its influence on thin films properties.	Lecture, discussion.	2	
PVD methods for obtaining thin films.	Lecture, discussion, exercises.	4	
CVD methods for obtaining thin films.	Lecture, discussion.	2	
Chemical, structural, and morphological characterization of thin films.	Lecture, discussion.	2	
Mechanical and electrical characterisation of thin films.	Lecture, discussion.	2	
Functional thin films used in optical, optoelectronic, electronic, and decorative applications.	Lecture, discussion.	2	
Different types of thin films, their synthesis methods and applications (nitride, oxynitride, carbide, oxycarbide thin films, multilayer and functionally graded, self-lubricating, DLC, etc.)	Lecture, discussion.	2	

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1. Camelia Gabor – annually updated course material - available on e-learning platform, based on: Camelia Gabor, Daniel Munteanu, Straturi subțiri cu rol decorativ obținute prin depunere fizică din vapori, Editura Universității Transilvania din Brașov, ISBN:978-973-598-742-8, 2010; Daniel Munteanu, Camelia Gabor, ș.a., Straturi subtiri de tip Ti-Si-C și Ti-O-C obținute prin pulverizare reactivă în sistem magnetron, Editura Universității Transilvania din Brașov, 2007; Daniel Cristea et al., Straturi subțiri de tip oxinitrură, Editura Universității Transilvania din Brașov, 2014.

2. Mohd Shkir, Kamlesh V Chandekar, Nanostructured Thin Films, Elsevier, 2025
3. Ohring, M., Materials Science of thin films – Deposition & Structure, 2nd edition, Academic Press, San Diego, 2012.
4. Manish Roy - Surface Engineering for Enhanced Performance against Wear - Springer, 2013
5. Gwidon Stachowiak, Andrew W Batchelor - Engineering Tribology, 5th Edition, Elsevier, 2025

8.2 Laboratory	Teaching-learning methods	Number of hours	Remarks
Introductory laboratory session: orientation, familiarization with the laboratory equipment. Occupational health and safety briefing.	Discussions, short training session	2	Health and safety acknowledgment signing
Surfaces topography evaluation at micro and nano levels (mechanic profilometer method and optical methods).	Collective application, Group work, Laboratory analyses	2	
Substrates samples preparation for future deposition of thin films.		2	
Thin films deposition by PVD method (magnetron sputtering).		6	
Determining thin films thickness and adhesion; Ball-cratering technique and scratch test.		2	
The indentation method; establishing the elastic modulus and indentation hardness of coatings and thin films.		2	
Tribology; establishing the dynamic friction coefficient for coatings and thin films using the ball-on-disk tribometer.		2	
Tribology; establishing the wear rate of coatings and thin films using Ball-on-disk tribometer and using the profilometer method.		2	
Determining structural and morphological properties of thin films (SEM, XRD).		4	
Missed assignments make-up Assessment for completing the laboratory requirements.	Discussion, evaluation	4	Pass/fail assessment
8.2 Project	Teaching-learning methods	Number of hours	Remarks
Research-based project. Getting started. Forming teams of 2 students. Choosing a topic/ thin film type.	Discussion, brainstorming, project elaboration	2	
Collecting research articles that match your research question and provide background for your research.	Discussion, data-base documentation	2	
Writing an analytical review based on selected sources.	Discussion, group-work.	2	First project evaluation.
Practical applications related to the selected topic, involving the use of laboratory equipment to carry out hands-on activities aligned with the chosen project theme (determining at least one property of the selected thin film/material: hardness, Youngs modulus, wear, friction coefficient, wettability, corrosion, structure, etc.)	Group-work, project elaboration, practical applications	6	Second project evaluation.
Each student will prepare a presentation that describes: (i) the nature and background of the research problem; (ii) a rationale for the methods chosen by the student to approach	Discussions, individual work	2	

the problem; (iii) how did the students carry out tehir research and what resources they used.			

Bibliography

1. Camelia Gabor – annually updated course material - available on e-learning platform, based on: Camelia Gabor, Daniel Munteanu, Straturi subțiri cu rol decorativ obținute prin depunere fizică din vapori, Editura Universității Transilvania din Brașov, ISBN:978-973-598-742-8, 2010; Daniel Munteanu, Camelia Gabor, ș.a., Straturi subtiri de tip Ti-Si-C și Ti-O-C obținute prin pulverizare reactivă în sistem magnetron, Editura Universității Transilvania din Brașov, 2007; Daniel Cristea et al., Straturi subțiri de tip oxinitrură, Editura Universității Transilvania din Brașov, 2014.
2. Mohd Shkir, Kamlesh V Chandekar, Nanostructured Thin Films, Elsevier, 2025
3. Ohring, M., Materials Science of thin films – Deposition & Structure, 2nd edition, Academic Press, San Diego, 2012.
4. Manish Roy - Surface Engineering for Enhanced Performance against Wear - Springer, 2013
Gwidon Stachowiak, Andrew W Batchelor - Engineering Tribology, 5th Edition, Elsevier, 2025
5. Elsevier – Thin Solid Films, https://www.sciencedirect.com/journal/thin-solid-films
6. Elsevier – Applied Surface Science, https://www.sciencedirect.com/journal/applied-surface-science

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

In corroboration with Industrial Companies interests (Schaeffler Romania, Duratek, Dacia-Renault, Montblanc Industri, etc).

10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of the final grade
10.4 Course	Understanding of key concepts in surface engineering.	Oral assessment, subjective items	30%
	Clarity and accuracy in answers.		
	Engagement during course.		10%
10.5 Laboratory	Understanding the basis of the practical activities conducted in the laboratory. Ability to describe deposition and/or characterisation methods, equipment's basic work principles.	Oral evaluation with subjective items.	Compulsory pass/fail evaluation. (not included in the final grade)
	Presenting a complete portfolio, including laboratory work and collected data.		
10.5 Project	First project evaluation on the analytical literature review: - relevance of sources (up-to-date, appropriate academic literature) - analytical depth, clarity and structure.	Ongoing assessment, progress check evaluated with pass/fail.	compulsory requirement for passing the course (not included in the final grade)

	Second project evaluation: - Consistency - Practical activity with data collection, data accuracy	Ongoing assessment, progress check evaluated with pass/fail.	compulsory requirement for passing the course (not included in the final grade)
	Final project evaluation: - Quality of the project presentation (clarity, structure, professional delivery) - Ability to answer questions (coherent, accurate, reflective responses) - Argumentation and critical thinking - Overall completeness and coherence of the project	oral assessment with subjective items.	60%

10.6 Minimal performance standard

- Passes the two ongoing pass/fail assessments for project development. Both are mandatory requirements and do not contribute numerically to the final grade.
- Passes the fail/pass assessment for the laboratory. Mandatory requirements and do not contribute numerically to the final grade.
- Submits a complete final project aligned with the chosen topic.
- Participates in the final oral evaluation, showing minimum acceptable understanding of course concepts and the ability to explain and justify project decisions (the ability to distinguish between PVD and CVD deposition methods, as well as between surface-modification techniques and those that add material to the surface; the ability to define and distinguish the fundamental concepts related to friction, wear, adhesion, hardness, structure, morphology)

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

Prof. Ph.D. Eng Alexandru PASCU **Dean**	**Assoc. prof. Ph.D. Eng Camelia GABOR** **Head of Department**
Assoc. prof. Ph.D. Eng Camelia GABOR **Course holder**	**Assoc. prof. Ph.D. Eng Camelia GABOR** **Holder of 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 III					
2.2 Course convenor								
2.3 Seminar/ laboratory/ project convenor			Prof. dr. eng. Daniel CRISTEA					
2.4 Study year	2	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
Bibliographic research in the field of the dissertation topic • Research planning • Defining the research stages and expected objectives • Establishing and detailing the activities	Analysis Problematization Coordination Applications	28	
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	56	

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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 project management					
2.2 Course convenor			Assoc. prof. Ph.D. Eng. Camelia GABOR					
2.3 Project convenor			Assoc. prof. Ph.D. Eng. Camelia GABOR					
2.4 Study year	II	2.5 Semester	IV	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	**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	20
Additional documentation in libraries, specialized electronic platforms, and field research	10
Preparation of seminars/ laboratories/ projects, homework, papers, portfolios, and essays	26
Tutorial	4
Examinations	4
Other activities	-

3.7 Total number of hours of student activity	64
3.8 Total number per semester	120
3.9 Number of credits[5)]	4

4. Prerequisites (if applicable)

4.1 curriculum-related	• Not applicable
4.2 competences-related	• Foundational knowledge in engineering, ability to use Microsoft Office, basic scientific literature search skills.

5. Conditions (if applicable)

5.1 for course development	• Classroom with projector or large display screen,
5.2 for seminar/ laboratory/ project development	• Access to specialised software (MS Project), Internet connection for accessing databases, computers/laptops.

6. Specific competences and learning outcomes

Professional competences	**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. **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. Students will know: – essential principles of research project management; – core research project management stages; – key skills a research project/programme manager need. Students will be able to: – design and evaluate research questions; – critically assess information from a variety of sources; – effectively communicate professional information in oral and written formats and through – presentations; – critically assess the potential research designs in a selected area; – assess the impact of potential risks on the research; – identify what skills and resources a project needs to achieve its objectives; – break a project into manageable tasks and estimate long it should take to complete a given project; – identify the activities needed to complete the research as planned. Students will possess: - the necessary skills to manage a research project from its initial design stages to the analysis of findings.

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.) **Ct.2.** Planning, monitoring and assuming the professional tasks of a subordinate professional group(s) (ESCO - has teamwork capacity; demonstrates organizational skills) **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. **Responsibility and autonomy** 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	• To develop students' theoretical and practical understanding of research project management, with emphasis on European and national funding opportunities and project planning tools relevant to research-focused initiatives, particularly within the HORIZON EUROPE framework.
7.2 Specific objectives	• To provide basic knowledge of project management principles, including planning and scheduling techniques. • To familiarize students with major European funding programs and the categories of entities eligible for support. • To introduce European research programs, with a focus on HORIZON EUROPE and its relevance to scientific and technological fields. • To develop introductory skills in using project management software (Microsoft Project Planner mandatory; Primavera and OpenProj optional). • To explore the role of materials and materials technologies within European-funded research projects.

8. Content

8.1 Course	Teaching methods	Number of hours	Remarks
Introduction in project management. Core terms and definitions. Arguments for using project management. International and national founding resources, European context. Specific of research projects.	Lecture, discussion.	2	
Scientific knowledge and research methodology. Research methodology. Organization of research.	Lecture, discussion.	2	Developing a research question for each student's project.
Research Project Lifecycle. Project stages. General issues and management strategies for each stage, including a research project manager role and impact.	Lecture, discussion.	2	
Project design. Stakeholders. Roles and responsibilities. Applying for funding and research design.	Lecture, discussion.	2	
Cost estimation and allocation	Lecture,	2	

Acquiring the knowledge required for estimating and allocating project costs. Developing the competencies needed for managing project costs. The cost management plan.	discussion.		
Project planning. Work breakdown structure. Network analysis, Gantt charts, Critical Path Method, Perth Method.	Lecture, discussion, exercises.	4	
Resource and risk management. Sources of risk. Symptoms of risk. Risk effects. Risk management planning.	Lecture, discussion.	2	
Project Team Leadership and teamwork. Communication. Managing Problems.	Lecture, discussion.	2	
Project Implementation Monitoring tools. Managing the project budget. Time management.	Lecture, discussion.	2	
Project completion. Discussion of research project results. How to reflect on a project. Project development in the long run.	Lecture, discussion.	2	
Project planning in accordance with European policies Objectives of European policy for the 2021–2027 programming period. Allocation of structural and investment funds in Romania. Accessing EU structural funds by private companies in Romania.	Lecture, discussion.	2	
Microsoft Project Planner – main commands	Lecture, Software-based exercises	4	
Bibliography 1. Project Management – A Handbook for Engineering Students – Camelia Gabor, Ioana Popescu, Transilvania University Press, Brașov, 2020 (English translated content available for students in e-learning platform). 2. Project Management, Planning and Control. Managing Engineering, Construction and Manufacturing Projects to PMI, APM and BSI Standards – Albert Lester, Seventh Edition, 2017 (available on e-learning and science-direct). 3. Project management : a multi-perspective leadership framework - Hans Mikkelsen, Jens O. Riis., ISBN, 2017, 9781787148291 (e-book on Transilvania University library)			
8.2 Project	Teaching-learning methods	Number of hours	Remarks
Research-based project. Getting started.	Discussion, project elaboration	2	
Developing a research question. Collecting research articles that match your research question and provide background for your research.	Brainstorming, discussion, data-base documentation	2	
Writing an analytical review based on selected sources.	Discussion, group-work.	2	First project evaluation.
Defining objectives and activities.	Discussion, group-work.	2	
Work-breakdown structure. Gantt Chart.	Discussion, group-work.	2	Second project evaluation.

Resources, project team, project budget. Identifying project calls that match the chosen topic.	Discussion, group-work.	4	
Risks evaluation and mitigation methods.	Discussion, group-work.	2	
Gantt chart in MS Project software. Setting milestones, activities precedencies.	Discussion, group-work.	4	
Finalising the projects and preparing a 10-minute presentation.	Discussion, group-work.	4	
Projects evaluation. Each participant will prepare a presentation that describes: (i) the nature and background of the research problem; (ii) a rationale for the methods chosen by the student to approach the problem; (iii) how you intend to carry out your research and what resources you will need; Gantt chart, WBS, risks.	Evaluation, discussions	4	

Bibliography

1. Project Management – A Handbook for Engineering Students – Camelia Gabor, Ioana Popescu, Transilvania University Press, Brașov, 2020 (English translated content available for students in e-learning platform).
2. Project Management, Planning and Control. Managing Engineering, Construction and Manufacturing Projects to PMI, APM and BSI Standards – Albert Lester, Seventh Edition, 2017 (available on e-learning and science-direct).
3. Project management: a multi-perspective leadership framework - Hans Mikkelsen, Jens O. Riis., ISBN, 2017, 9781787148291 (e-book on Transilvania University library).
4. Kennett, B. (2014). Planning and managing scientific research. ANU Press., free access https://www.jstor.org/stable/j.ctt6wp816

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

Inviting specialists from the business, banking, governmental, and research sectors to identify relevant issues for analysis and teaching. Discussing the course content with representatives of the local project management community. Collaboration with the Consultancy Center of the Brașov Chamber of Commerce and Industry, whose main activity is the preparation and implementation of projects funded through non-reimbursable grants.

10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of the final grade
10.4 Course	Understanding of key concepts in research project management	Ongoing assessment based on 3 short quizzes or conceptual checks with objective items.	30%
	Clarity and accuracy in answers (engagement during lectures).	Ongoing assessment based on engagement.	10%
10.5 Project	First project evaluation on the analytical literature review: - relevance of sources (up-to-date, appropriate academic literature) - analytical depth, clarity and structure.	Ongoing assessment, progress check evaluated with pass/fail.	compulsory requirement for passing the course (not included in the final grade)

	Second project evaluation on objectives, activities, WBS: - Clarity and relevance of project objectives (SMART, consistent with the topic) - Coherence of activities (activities logically derived from objectives, properly sequenced) - Correct development of the Work Breakdown Structure (WBS) (hierarchical structure, appropriate level of detail) - Feasibility (realistic scope, time frame, and structure) - Consistency (alignment among objectives, activities, and WBS)	Ongoing assessment, progress check evaluated with pass/fail.	compulsory requirement for passing the course (not included in the final grade)
	Final project evaluation: - Quality of the project presentation (clarity, structure, professional delivery) - Understanding of project management concepts (ability to explain choices and justify decisions) - Ability to answer questions (coherent, accurate, reflective responses) - Argumentation and critical thinking (capacity to analyze risks, alternatives, and project feasibility) - Overall completeness and coherence of the project	oral assessment with subjective items.	60%
10.6 Minimal performance standard			
• Passes both ongoing pass/fail assessments, specifically: the analytical literature review check; the objectives–activities–WBS check. Both are mandatory requirements and do not contribute numerically to the final grade. • Submits a complete final project aligned with the chosen topic, demonstrating: correct application of project			

management concepts; coherence between objectives, activities, and planning tools; proper structure and clarity. • Participates in the final oral evaluation, showing minimum acceptable understanding of course concepts and the ability to explain and justify project decisions.

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

Prof. Ph.D. Eng Alexandru PASCU **Dean**	**Assoc. prof. Ph.D. Eng Camelia GABOR** **Head of Department**
Assoc. prof. Ph.D. Eng Camelia GABOR **Course holder**	**Assoc. prof. Ph.D. Eng Camelia GABOR** **Holder of 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			Total Quality Management					
2.2 Course convenor			Prof. dr. eng, Miloșan Ioan					
2.3 Seminar/ laboratory/ project convenor			Lecturer dr. eng. Gheorghiță Iuliana					
2.4 Study year	2	2.5 Semester	4	2.6 Evaluation type	E	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	**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	28/0/0

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	• Students should have a basic background in management, operations, statistics, and quality management concepts
4.2 competences-related	• The student/graduate should be able to analyze basic management and operations processes, apply statistics, and understand fundamental quality management concepts and tools. • 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/	• Students should actively participate, have access to relevant case studies and

project development	discussion materials, and engage in group exercises and practical problem-solving activities.

6. Specific competences and learning outcomes

Professional competences	**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 develop students' ability to analyze, design, and improve organizational processes using quality management principles and tools to enhance efficiency, performance, and customer satisfaction.
7.2 Specific objectives	• The course enables students to apply total quality management tools and techniques to real-world organizational processes, evaluate performance using quantitative and qualitative methods, identify opportunities for continuous improvement, and contribute to strategic decision-making that enhances overall efficiency and customer satisfaction.

8. Content

8.1 Course	Teaching methods	Number of hours	Remarks
1. Introduction to Total Quality Management	Lecture Explanation Conversation Problematization Case studies	2	
2. Quality Standards and ISO Systems		2	
3. Statistical Process Control and Data Analysis		2	
4. Quality Tools and Techniques (e.g., Six Sigma, Kaizen, 7 QC Tools)		2	
5. Operations and Process Management		2	
6. Strategic Quality Planning		2	

7. Supplier Quality and Procurement Management		2	
8. Lean Management and Continuous Improvement		2	
9. Customer Satisfaction and Service Quality		2	
10. Risk Management and Quality Auditing		2	
11. Project Management for Quality Improvement		2	
12. Information Systems and Quality Data Management		2	
13. Performance Measurement and Key Quality Indicators (KQIs)		2	
14. Sustainable and Green Quality Management Practices		2	
Bibliography 1. Evans, J. R., & Lindsay, W. M. (2019). Managing for Quality and Performance Excellence. 11th Edition. Cengage Learning. 2. Oakland, J. S. (2014). Total Quality Management and Operational Excellence: Text with Cases. 4th Edition. Routledge. 3. Montgomery, D. C. (2019). Introduction to Statistical Quality Control. 8th Edition. Wiley. 4. Goetsch, D. L., & Davis, S. B. (2016). Quality Management for Organizational Excellence: Introduction to Total Quality. 8th Edition. Pearson.			
8.2 Seminar	Teaching-learning methods	Number of hours	Remarks
1. The Role of Total Quality Management in Organizations	Interactive discussions, case studies, and practical exercises to develop analytical and problem-solving skills in logistics and materials management	2	
2. Quality Standards and ISO Certification		4	
3. Statistical Process Control and Data-Driven Improvement		4	
4. Lean Management and Continuous Improvement		4	
5. Six Sigma and Problem-Solving Methodologies		2	
6. Supplier Quality and Procurement Management		2	
7. Customer Satisfaction and Service Quality		2	
8. Risk Management and Quality Auditing		4	
9. Performance Measurement and Key Quality Indicators		2	
10. Sustainable and Green Quality Practices		2	
Bibliography 1. Evans, J. R., & Lindsay, W. M. (2019). Managing for Quality and Performance Excellence. 11th Edition. Cengage Learning. 2. Oakland, J. S. (2014). Total Quality Management and Operational Excellence: Text with Cases. 4th Edition. Routledge.			

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 equips students with skills sought by quality management professionals, preparing them to implement quality systems, drive continuous improvement, and support strategic decision-making in organizations.

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	60%
10.5 Seminar	Active participation, case discussions, and group exercises.	Understanding and application of TQM concepts, quality of analysis, feasibility of solutions, and clarity of reports and presentations.	40%
10.6 Minimal performance standard			
Achieving at least 50% of the points allocated for the course and practical 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**	**Conf. dr. eng. Camelia GABOR** **.....** **Head of Department**
Prof. dr. eng. Ioan MILOȘAN **.....** **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 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 IV					
2.2 Course convenor								
2.3 Seminar/ laboratory/ project convenor			Prof. dr. eng. Daniel CRISTEA					
2.4 Study year	2	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
Experimental research for the dissertation topic • Organizing the experiments • Applying specific experimental methods • Collecting and processing data	Coordination Applications	42	
Verification of solutions and consolidation of obtained results • Validation of solutions through simulation • Verification of models and macromodels • Analysis and interpretation of results	Coordination Applications	42	

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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			Practice for dissertation preparation					
2.2 Course convenor								
2.3 Seminar/ laboratory/ project convenor			Prof. dr. eng. Daniel CRISTEA					
2.4 Study year	2	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	60
Preparation of seminars/ laboratories/ projects, homework, papers, portfolios, and essays	33
Tutorial	
Examinations	3
Other activities.....	

3.7 Total number of hours of student activity	96
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	•
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.
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
Organization of the dissertation content • Structuring the paper • Meeting formal requirements • Aesthetic aspects • Corrections	Coordination Applications	42	
Presentation of the dissertation • Organizing the presentation in PowerPoint	Coordination Applications	42	

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
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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			Drafting the dissertation					
2.2 Course convenor								
2.3 Seminar/ laboratory/ project convenor			Prof. dr. eng. Daniel CRISTEA					
2.4 Study year	2	2.5 Semester	II	2.6 Evaluation type	V	2.7 Course status	Content[3)]	PLD
							Attendance type[4)]	CPC

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

3.1 Number of hours per week	**10**	out of which: 3.2 lecture	**0**	3.3 seminar/ laboratory/ project	**10**
3.4 Total number of hours in the curriculum	140	out of which: 3.5 lecture	0	3.6 seminar/ laboratory/ project	140

Time allocation	hours
Study of textbooks, course support, bibliography and notes	40
Additional documentation in libraries, specialized electronic platforms, and field research	60
Preparation of seminars/ laboratories/ projects, homework, papers, portfolios, and essays	90
Tutorial	23
Examinations	3
Other activities.....	

3.7 Total number of hours of student activity	216
3.8 Total number per semester	300
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	•
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.
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
Organization of the dissertation content • Structuring the paper • Meeting formal requirements • Aesthetic aspects • Corrections	Coordination Applications	70	
Presentation of the dissertation • Organizing the presentation in PowerPoint	Coordination Applications	14	
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			Materials for energy					
2.2 Course convenor			Assoc. Prof. dr. eng. Vasile-Adrian Surdu					
2.3 Seminar/ laboratory/ project convenor			Assoc. Prof. dr. eng. Vasile-Adrian Surdu Lect. dr. eng. Simona Radu					
2.4 Study year	2	2.5 Semester	1	2.6 Evaluation type	E	2.7 Course status	Content[3)]	SC
							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	**0/2/1**
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	40
Additional documentation in libraries, specialized electronic platforms, and field research	20
Preparation of seminars/ laboratories/ projects, homework, papers, portfolios, and essays	35
Tutorial	10
Examinations	5
Other activities.....	

3.7 Total number of hours of student activity	110
3.8 Total number per semester	180
3.9 Number of credits[5)]	6

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 materials, devices and equipment specific to energy materials processing 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 the main approaches, models, and theories used in the design of materials intended for the production and storage of electrical energy.
7.2 Specific objectives	The course covers the following advanced topics, concepts, and principles, all aimed at providing students with a comprehensive understanding of the methodological and procedural framework in the field: • Design and development of materials for the production and storage of electrical energy using alternative and unconventional methods. • Compositional, structural, microstructural, and functional characterization of materials employed in energy production and storage, using modern analytical techniques. • Ability to establish complex composition–structure–property–processing relationships in materials used for energy production and storage.

8. Content

8.1 Course	Teaching methods	Number of hours	Remarks
1. Fundamentals –Materials for Electrical Energy Production and Storage**:** basic concepts, general properties, applications	Lecture Explanation Conversation Problematization Case studies	2	
2. Conventional Capacitors**:** classification, composition, properties, applications		2	
3. Supercapacitors (Electrochemical Capacitors): operating principle, classification, composition, properties, applications; - Electric double-layer capacitors: types and corresponding materials; - Pseudocapacitors: types and corresponding materials; - Hybrid supercapacitors: types and corresponding materials		4	
4. Lithium-Ion Batteries and sodium-ion batteries: operating principle, classification,		3	

components, composition, properties			
5. Solar Cells: classification, operating principle, components, composition, properties		3	
6. Fuel Cells: constructive types of cells; fuel cell performance: characteristic curve, overall efficiency; advantages of using fuel cells		2	
7. Fuel Cell Components (cathode, anode, solid electrolyte, interconnector): characteristics, materials used for their fabrication, component manufacturing techniques		8	
8. Hydrogen – the Ideal Fuel for the Future: properties, production methods, storage, transport, distribution, applications		4	

Bibliography

1. Olivier Guillon, *Advanced Ceramics for Energy Conversion and Storage*, Elsevier, 2020.
2. Yoon-Bong Hahn, Tahmineh Mahmoudi, Youseng Wang, *Next-Generation Solar Cells*, Jenny Stanford Publishing, 2024.
3. Max Lu, Francois Beguin, Elzbieta Frackowiak, *Supercapacitors: Materials, Systems, and Applications*, Wiley, 2013.
4. B. E. Conway, *Electrochemical Supercapacitors: Scientific Fundamentals and Technological Applications*, Springer, 1999.
5. Christian Julien, Alain Mauger, Ashok Vijh, Karim Zaghib, *Lithium Batteries: Science and Technology*, Springer, 2015.
6. Masaki Yoshio, Ralph J. Brodd, Akiya Kozawa, *Lithium-Ion Batteries*, Springer, 2009.
7. Xiaodong Wang, Zhiming M. Wang, *High-Efficiency Solar Cells: Physics, Materials, and Devices*, Springer, 2014.

8.2 Laboratory	Teaching-learning methods	Number of hours	Remarks
1. Design of a material for energy conversion or storage	Selection of material with predefined properties	2	
2. Synthesis of a material for energy conversion or storage	Powders are processed using the FRITSCH Premium Line Pulverisette 7 planetary mill – ICDT-L4-DS	4	
3. Consolidation of material by conventional sintering	Consolidation of material by alternative strategies uniaxial pressing and sintering or cold sintering	4	
4. Characterization of the phase composition of the synthesized material	A study is carried out using X-ray diffraction with the Bruker D8 Advanced – ICDT-L8-DS.	4	
5. Characterization of the specific ceramic properties	A study is carried out by Archimedes' method	4	
6. Study of morphological, compositional, and structural characteristics using scanning electron microscopy (SEM)	Morpho-structural and compositional characteristics are determined using a scanning electron	4	

	microscope (SEM) coupled with an energy-dispersive X-ray spectrometer (EDS) – ICDT-L8-DS.		
7. Analysis of the electrical properties	A study is carried out by impedance spectroscopy	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.	• Completion of the individual assignment • Periodic presentation (during project sessions) of the progress in completing the assignment	14	
Bibliography 1. N. Q. Minh, T. Takahashi, *Science and Technology of Ceramic Fuel Cells,* Elsevier, 1995.			

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%
8.5. 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**	**Conf. dr. eng. Camelia GABOR** **.....** **Head of Department**
Assoc. prof. dr. eng. Vasile-Adrian Surdu **.....** **Course holder**	Assoc. Prof. dr. eng. Vasile-Adrian Surdu **.....** Lect. dr. eng. Simona Radu **.....** **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			Materials Processing					
2.2 Course convenor			Lecturer dr. eng. Gheorghiță Iuliana					
2.3 Seminar/ laboratory/ project convenor			Lecturer dr. eng. Gheorghiță Iuliana					
2.4 Study year	2	2.5 Semester	4	2.6 Evaluation type	E	2.7 Course status	Content[3)]	SC
							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	**0/2/1**
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	40
Additional documentation in libraries, specialized electronic platforms, and field research	30
Preparation of seminars/ laboratories/ projects, homework, papers, portfolios, and essays	35
Tutorial	2
Examinations	3
Other activities.....	

3.7 Total number of hours of student activity	110
3.8 Total number per semester	180
3.9 Number of credits[5)]	6

4. Prerequisites (if applicable)

4.1 curriculum-related	• Students should have a basic background in material science, chemistry, applied physics, physical metallurgy
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	• The course provides an integrated overview of the fundamental principles of material manufacturing, covering both conventional processing methods and emergent non-conventional technologies. The course builds the knowledge required to understand modern trends in materials engineering and their industrial applications.
5.2 for ~~seminar~~/ laboratory/ project development	• Operation of basic laboratory equipment: microscope, hardness tester, electric oven • Processing and interpretation of experimental data

	• Ability to write a technical report

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.

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 advanced knowledge of modern material processing, with a focus on: - understanding the relationship between process, microstructure, and properties - evaluating and optimizing technologies used in the manufacture of advanced materials: metals, polymers, ceramics, and composites - developing skills in the analysis, investigation, and coordination of complex technological flows.
7.2 Specific objectives	• Integrated analysis of manufacturing processes and their correlation with the properties of advanced materials. • Design and optimization of technological flows using phase diagrams. • Selection of appropriate processing methods depending on the application, material, and functional requirements. • Assessment of technological risks, defects, and proposal of quality control methods.

8. Content

8.1 Course	Teaching methods	Number of hours	Remarks
1. Introduction to Material Manufacturing: From Traditional Methods to Advanced and Non-Conventional Technologies	Lecture Explanation Conversation Problematization Case studies	2	
2. Thermodynamics and kinetics applied to materials processing		2	
3. Melting processing and solidification control		2	

4. Processing of advanced metallic materials by plastic deformation		2	
5. Advanced processing of polymeric materials		2	
6. Advanced processing of ceramic materials		2	
7. Additive manufacturing		2	
8. Advanced heat treatments and surface treatments		2	
9. High-performance machining		2	
10. Welding and laser processing		2	
11. Processing of advanced materials for micro- and nanotechnologies		2	
12. Advanced quality control and process monitoring		2	
13. Energy efficiency, sustainability, and recycling in advanced materials processing		2	
14. AI in process optimization, case studies Short review and exam hints		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. Groover M.P., *Fundamentals of Modern Manufacturing 6th edition*, Wiley, 2016, ISBN 9781119128809
3. Kalpakjian S., Schmid S, *Manufacturing Processes for Engineering Materials 6th edition*, Pearson, 2022, ISBN 9781292254418
4. Campbell J., *Complete casting handbook: metal casting processes, metallurgy, techniques and design 2nd edition*, Butterworth-Heinemann, 2015, ISBN 9780444635099
5. Hosford, W.F., *Materials for engineers*, Cambridge University press, 2012, ISBN 9780511810732
6. Gibson I., Rosen D., Stucker B., Khorasani M., Additive Manufacturing Technologies 3th edition, Springer Nature, 2021, ISBN 9783030561277

8.2.1 Laboratory	Teaching-learning methods	Number of hours	Remarks
1. Laboratory work presentation, equipment, and procedures	Interactive discussions, case studies, and practical exercises to develop analytical and problem-solving skills	2	
2. Phase diagram analysis with software (e.g. Thermo-Calc)		2	
3. Melt-spinning processing of Al alloys (cooling rate impact on microstructure and properties)		2	
4. Sever plastic deformation of Al alloys		2	
5. Case hardening of steel (carburizing or nitriding)		2	
6. Steel, Al alloy, Cu alloy machining with roughness measurement		2	
7. Obtained of an advanced composite and fractographic analysis		2	
8. Isostatic pressing of powders		2	
9. Analysis of different AM parts		2	
10. Identification and measurement of the heat-affected zone (HAZ) at laser processing		2	

11. NDT methods for samples inspection		2	
12. Modern recycling methods for Al alloys		2	
13. Industry 4.0 and materials processing		2	
14. Laboratory report and evaluation		2	
8.2.2 Project			
1. Individual subject selection, indicated the material and applications	Project-base	2	
2. Phase diagram/structure/functional requirements analysis		2	
3. Proposed technological flow (min.2)		2	
4. Software for process simulation (solidification, deformation, AM or sintering)		2	
5. Possible defects and quality control proposals		2	
6. Energy and environmental impact		2	
7. Final presentation		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. Groover M.P., *Fundamentals of Modern Manufacturing 6th edition*, Wiley, 2016, ISBN 9781119128809
3. Kalpakjian S., Schmid S, *Manufacturing Processes for Engineering Materials 6th edition*, Pearson, 2022, ISBN 9781292254418
4. Campbell J., *Complete casting handbook: metal casting processes, metallurgy, techniques and design 2nd edition*, Butterworth-Heinemann, 2015, ISBN 9780444635099
5. Hosford, W.F., *Materials for Engineers*, Cambridge University press, 2012, ISBN 9780511810732
6. Gibson I., Rosen D., Stucker B., Khorasani M., *Additive Manufacturing Technologies 3rd edition*, Springer Nature, 2021, ISBN 9783030561277

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 Laboratory	Active participation, case discussions, and group exercises	Written evaluation (objective items)	20%
10.5.2 Project	Individual assignments	Oral presentation and questions session	30%
10.6 Minimal performance standard			
Achieving at least 50% of the points allocated for the course and practical 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**	**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).