Syllabi

The syllabi are structured following the semesters, numbered from 1 (first course offered) to 26 (last course offered) and the course numbers in the syllabi are numbered/university.

List of Courses

Nr.	Courses
1	Sustainability and Resilience in Project Management
2	Introduction to Data Mining, Artificial Intelligence and Digitalization
3	Pavement Analysis, Design and Evaluation
4	Material Testing and Evaluation
5	Elective Courses
6	Transportation Geotechnics
7	Sustainable and Multifunctional Pavement Materials
8	Airports and Railways
9	Enhanced and Smart Pavement Surface Functions
10	Digitalisation of Pavement Monitoring
11	Highway Environment Management Systems
12	Sustainable Transport Infrastructure
13	Sustainable Pavement and Embankment/Subgrade Materials (COIL)
14	Circular Life-Based Pavement Management
15	Sustainable Geometric Design Practices
16	Smart Solutions for Transport Infrastructure
17	Advanced Sustainable Pavement Materials and Technologies
18	Soil Stabilization Techniques for Resilient Roads
19	Spatial Technologies for Smart Roads
20	Economics of Eco-Friendly Road Infrastructure

Nr.	Courses
21	Computer-Aided Road Design
22	Industrial Training Project on Pavements
23	Research and Communication Skills (online)
24	Sustainable Mobilities Policies (Online)
25	Theory and Design of Bridges (online)
26	Dissertation

COURSE 1: SUSTAINABILITY AND RESILIENCE IN PROJECT MANAGEMENT

Degree			Academic year
			2026/2027
JOINT MASTER'S DEGREE IN SUSTAINABLE AND RESILIENT PAVEMENT ENGINEERING			Semester
			1
Course			Group/Language
Course 1	Sustainability and Resilience in Project Management		English
Type	Language	ECTS Credits	
Compulsory	English	6	
Lecturer			
HERNANDO, DAVID			

DESCRIPTION

This course aims to introduce the student to sustainability and resilience thinking. The course describes the multiple dimensions of sustainability and their application to road infrastructure and delves into the environmental component in procurement and product declarations. An introduction to material flow analysis and the principles of material circularity is also provided. Finally, the course covers road infrastructure resilience, assessment, and adaptation and mitigation strategies.
In this course, we discuss the fundamentals of good project management for pavement projects. The course is composed of two parts, which will give a combined vision of the future method for project management in sustainable pavement engineering. The focus of the first part is on providing and applying various management methods applied to the complex construction methods, especially throughout the life cycle of infrastructure projects. This involves the entire process of design, implementation and maintenance, risk analysis and budgets. The most common and advanced tools will be discussed. Guest speakers will demonstrate practical examples, even those under development. Next, management methods, including systems engineering, will be connected to the most innovative technology with the highest impact in the construction world: Building Information Modelling (BIM). This operational and holistic information system will be broadly discussed, for example, the use of AI and IoT assistive technology to optimize construction processes economically, logistically and environmentally will be demonstrated.

PREREQUISITES

none

LEARNING OUTCOMES IN TERMS OF GENERIC AND SPECIFIC COMPETENCES

- Understand the broader implications of engineering on ecosystems, communities, and public health, and learn methodologies for assessing and minimizing adverse impacts
- Cultivate the ability to conduct independent studies, innovate, and contribute to advancements in sustainable and resilient technologies
- Describe the different dimensions of sustainability
- Define the challenges that climate change poses and how societies must adapt and innovate

- Assess network resilience and propose solutions
- Apply management process steps for sustainable projects, including economic and environmental tools, lean management construction principles, budget and agile project management.
- Apply risk management strategies and systems engineering approach.
- Apply the Envision Framework to evaluate and promote sustainability and resilience

CONTENTS

Part 1: Sustainability
Humanity and the Environment. Understanding natural systems and resources. Global climate change. Sharing the practices from the leaders. Circular economy. Environmental and social justice. Policy and governance.
Part 2: Resilience
Definition and Importance. Fundamentals of resilience. Risk, vulnerability, and robustness. Designing for resilience.
Part 3: Project Management
Quality control. Project Management Methods: Agile Project Management, Risk Management Strategies, Lean Construction Principles, Integration and Interdisciplinary Collaboration. Systems Engineering. Innovative Technologies for Construction Process Management.
Part 4. Envision framework
Introduction. Categories and credits. Case studies.

DEMONSTRATION OF THE CONSISTENCY OF THE SYLLABUS WITH THE LEARNING OBJECTIVES OF THE COURSE

Through the contents described in the syllabus, the student will learn a series of concepts, models, and management tools that will enable achieving the learning objectives. The program covers the theoretical component of these concepts, models, and tools and their practical component through a series of course assignments to be solved by the students.

TEACHING METHODS AND PLANNED LEARNING ACTIVITIES

The teaching methods for this course include class-contact teaching through lectures and practice sessions, personal work, and project-based learning.

Classroom activities

- Lectures
- Discussion
- Practical sessions
- Quizzes

Outside-class activities

- Preparation for lectures and self-study
- Assignments

Distribution of hours by activity type

DISTRIBUTION OF HOURS BY ACTIVITY TYPE			
ACTIVITY	WORK IN THE CLASSROOM	OUTSIDE CLASSROOM WORK	TOTAL
Lectures	39	79	118
Practical sessions	4	16	20
Assignments	2	28	30
TOTAL	45	123	168

ASSESSMENT METHODS AND CRITERIA

- Continuous evaluation (20-40%): attendance, participation in class
- Assignments to be submitted during the semester (20-50%)
- Quizzes with open questions and multiple choice (20-40%)
- Written/oral exam (0-40%)

DEMONSTRATION OF THE CONSISTENCY OF THE TEACHING METHODOLOGIES WITH THE LEARNING OBJECTIVES OF THE CURRICULAR UNIT

The teaching methods envisioned for this class combine slides, class printouts, discussions, and hands-on problem-solving assignments to meet the needs of different learner types. The continuous evaluation of attendance and participation in class provides information on the level of engagement of the student, which is a necessary component for effective learning. Furthermore, the assignments provide a scan of the level of understanding of the concepts covered in the syllabus, so the necessary corrective measures can be taken. Finally, surveys distributed among the students during the semester will provide additional first-hand feedback on the effectiveness of the teaching methods.

COURSE MATERIALS

Course notes will be provided to the students along with additional references to delve into specific topics.

ADVICE AND TIPS TO PROCESS LEARNING CONTENT – BIBLIOGRAPHY TO CONSULT

It is advised that the students review the content provided in advance in preparation for the lectures. Likewise, students should go through the contents covered in class afterward and list all questions they may have so the instructor can answer them during the next lecture.

- Von Rising, M. (2024). The Sustainability Handbook, Vol 1. Elsevier, ISBN: 9780323901109.
- Brinkmann, R. (2021). Introduction to Sustainability, 2nd Ed. Wiley, ISBN: 9781119675464.
- Zommers, Z., Alverson, K. (2018). Resilience: The Science of Adaptation to Climate Change. Elsevier, ISBN: 9780128118917.
- Lester, A. (2021). Project Management, Planning and Control, 8th Ed. BH, ISBN: 9780128243398.
- FHWA (2017). Vulnerability Assessment and Adaptation Framework, FHWA-HEP-18-020. https://www.fhwa.dot.gov/environment/sustainability/resilience/adaptation_framework/.

COURSE 2: INTRODUCTION TO DATA MINING, ARTIFICIAL INTELLIGENCE, AND DIGITALIZATION

Degree			Academic year
JOINT MASTER'S DEGREE IN SUSTAINABLE AND RESILIENT PAVEMENT ENGINEERING			**2026/2027**
Course			Semester
Course 2	**Introduction to Data Mining, Artificial Intelligence, and Digitalization**		**1**
Type	Language	ECTS Credits	Group/Language
Compulsory	**English**	**6**	**English**
Lecturer			
VUYE, CEDRIC **RANYAL, ESHTA** **HASHEMINEJAD, NAVID**			

DESCRIPTION

Explore the intersection of Pavement Engineering, Digitalization, and Artificial Intelligence in this immersive course. As the world of infrastructure embraces cutting-edge technologies, the ability to leverage data for informed decision-making becomes paramount. This course offers a comprehensive introduction to data mining and machine learning techniques tailored specifically for the field of pavement engineering.

The course structure balances theoretical foundations with practical application. Limited theoretical lectures provide essential foundational knowledge, complemented by extensive computer labs that offer a distinctive hands-on learning experience. Engage in practical assignments and real-world projects utilizing MATLAB/Python and pavement-related datasets, allowing you to apply your theoretical understanding to solve tangible challenges.

PREREQUISITES

Sufficient English knowledge to comprehend/speak/read/write.

Prior knowledge (bachelor level) in civil engineering, material science, or other relevant fields. Familiarity with basic statistical concepts is recommended but not mandatory. Familiarity with MATLAB/Python or a similar programming language is required.

LEARNING OUTCOMES IN TERMS OF GENERIC AND SPECIFIC COMPETENCES

- Explore the core concepts and principles of data mining, Artificial Intelligence (AI) and Building Information Models and Management (BIM).
- Demonstrate techniques for data collection.
- Implement data preprocessing methods including data cleaning and preparation.
- Utilize data visualization techniques, supervised and unsupervised learning techniques, classification and regression methods.
- Evaluate case studies demonstrating automated inspection and distress detection.
- Apply AI-driven decision-making strategies for repair and maintenance.
- Consider technologies such as AI, VR and IoT to optimize engineering management.
- Apply BIM elements and digital models.

CONTENTS

- Core concepts, principles of data mining and applications of AI in various industries
- Data collection techniques in engineering
- Data preprocessing and visualization
- Supervised and unsupervised learning techniques
- Classification and Regression methods
- Deep Learning Neural Networks
- Automated inspection and detection of distresses
- AI-driven decision-making for repair and maintenance strategies
- Augmented Reality, Virtual Reality, Internet of Things
- BIM tools, object types library, standards, clash detection

DEMONSTRATION OF THE CONSISTENCY OF THE SYLLABUS WITH THE LEARNING OBJECTIVES OF THE COURSE

The content is developed in a way to teach the students the concepts of data mining, Artificial Intelligence (AI) applications, BIM, and their specific relevance to engineering. Each syllabus corresponds directly to one or more learning objectives. For instance, the section on 'Data collection techniques in engineering' directly supports the objective of demonstrating practical data collection methods. Similarly, the module focusing on 'Case studies and practical applications in engineering' directly corresponds to the objective of evaluation of case studies demonstrating automated inspection and detection of distresses and applying AI-driven decision-making strategies for repair and maintenance, aligning theory with practical application in the field of engineering.

TEACHING METHODS AND PLANNED LEARNING ACTIVITIES

The teaching methods include both classroom activities and outside-class activities. Classroom sessions involve comprehensive lectures and immersive computer labs. These aim to teach students the fundamentals first and then facilitate practical application through hands-on exercises and projects. Outside class, students engage in preparatory study for lectures and theoretical understanding, alongside exercises and individual assignments focusing on practical implementation of the theories.

Classroom activities

- Lectures (2h per lecture)
- Computer labs (4h per lab)

Outside-class activities

- Preparing for lectures and studying theory
- Computer lab preparation and finalization of exercises using MATLAB/Python toolboxes
- Individual assignments in MATLAB/Python

Distribution of hours by activity type

DISTRIBUTION OF HOURS BY ACTIVITY TYPE

ACTIVITY	WORK IN THE CLASSROOM	OUTSIDE CLASSROOM WORK	TOTAL
Lectures	12	12	24
Computer labs	24	24	48
Individual assignments	0	12	12
TOTAL	45	48	84

ASSESSMENT METHODS AND CRITERIA

Written exam (30-50%)
- Mix of open questions and multiple-choice

Individual assignments and permanent evaluation (50-70%)
- Permanent evaluation (20-40%): presence and activity during the computer labs; exercises from the computer labs to be finalized and submitted before a specific deadline
- Additional individual assignments to be submitted during the semester (20-40%)

DEMONSTRATION OF THE CONSISTENCY OF THE TEACHING METHODOLOGIES WITH THE LEARNING OBJECTIVES OF THE CURRICULAR UNIT

The teaching methods directly link to the objectives. The lectures deliver foundational knowledge aligning with core understanding objectives. The computer labs provide hands-on experience, fulfilling practical application goals, utilizing MATLAB/Python and other software for datasets. By mixing classroom lectures and computer labs, the students will be able to use the theoretical concepts they learn to conduct and develop practical skills, aiding in real-world problem-solving. The outside-class activities including the individual assignments further solidify practical application, ensuring alignment with objectives. This cohesive approach ensures a balanced and comprehensive learning experience, directly serving the curricular unit's defined objectives.

COURSE MATERIALS

- Dong, Q., Chen, X., Huang, B. (2023). Data Analysis in Pavement Engineering: Methodologies and Applications, 1st Edition. Elsevier, ISBN: 978-0-4431-5928-2.
- Paluszek, M. Thomas, S. (2017). MATLAB Machine Learning, 2nd Edition. springer Link, ISBN: 978-1-4842-2250-8.
- Kensek, K., Noble, D. (2014). Building Information Modeling: BIM in Current and Future Practice. Wiley, ISBN: 978-111876630.

ADVICE AND TIPS TO PROCESS LEARNING CONTENT – BIBLIOGRAPHY TO CONSULT

Advice and tips

Effective learning is an ongoing process that involves active participation, organization, and a commitment to understanding and applying the knowledge gained in the course.

Don't hesitate to reach out to instructors or peers if you have questions or need clarification on specific topics.

Bibliography

- Han, J., Kamber, M., Pei, J. (2012). Data Mining: Concepts and Techniques, 3rd Edition. Morgan Kaufmann, ISBN 978-0-12-381479-1
- Kim, P. (2017). MATLAB Deep Learning: With Machine Learning, Neural Networks and Artificial Intelligence. Apress Berkeley, ISBN 978-1-4842-2844-9.

A list of relevant scientific publications will be made available through the learning management system.

COURSE 3: PAVEMENT ANALYSIS, DESIGN AND MANAGEMENT

Degree			Academic year
JOINT MASTER'S DEGREE IN SUSTAINABLE AND RESILIENT PAVEMENT ENGINEERING			**2026/2027**
			Semester
Course			**1**
Course 3	**Pavement Analysis, Design and Management**		Group/Language
Type	Language	ECTS Credits	**English**
Compulsory	**English**	**6**	
Lecturer			
Roberto, Antonio			

DESCRIPTION

This course aims at developing specific knowledge, skills, and practical experiences for students who would like to delve into several pavement design methods and materials. Particularly, the course focuses on road and airport pavement design, from traffic and stress analyses to practical design of the structure, either layered or not. Therefore, students will develop specific knowledge to operate and deal with public authorities and management companies in the field of design and maintenance of road and airport infrastructure.

PREREQUISITES

Sufficient English knowledge to comprehend/speak/read/write.
To be enrolled in Advanced testing and material characterisation and the other relevant courses organised within the joint master.
Prior knowledge (bachelor level) in one of civil engineering, material science, or other relevant fields.

LEARNING OUTCOMES IN TERMS OF GENERIC AND SPECIFIC COMPETENCES

Generic Competences:
- Learn different pavement design methodologies.
- Acquire the necessary competencies for managing infrastructure assets.

Specific Competences:
- Acquire knowledge to independently design flexible and rigid pavements for road and airport infrastructure.
- Link material requirements to the specific function of the layer.
- Relate material properties to on-field performance and distresses to allow the infrastructure to be functional throughout the design life.
- Familiarize with pavement management systems
- Apply innovative construction methods and technologies for pavement maintenance and rehabilitation

CONTENTS

- Traffic analysis (Equivalent Single-Wheel Load and Equivalent Axel Load concepts)
- Material characteristics (geotechnical properties of soils, on-field requirements for concrete, asphalt mixtures, and partially bounded materials)
- Stress analyses for rigid and flexible pavements (MnPave method and Westergard's equations)
- Mechanistic-empirical pavement design
- Introduction to pavement management systems (PMS)
- Prediction models for pavement deterioration

DEMONSTRATION OF THE CONSISTENCY OF THE SYLLABUS WITH THE LEARNING OBJECTIVES OF THE COURSE

The course covers a range of concepts, models, and tools that will help students achieve their learning goals. Students will learn about the theory behind these concepts, models, and tools, and will have the opportunity to put them into practice through a series of course assignments.

TEACHING METHODS AND PLANNED LEARNING ACTIVITIES

Classroom activities

- The classes will be organised mainly on campus, even if a few lectures will be attended online if guest lecturers are invited from abroad (outside Belgium).
- The course will be characterised by frontal theoretical lectures, practical exercises (the use of software, and numerical calculation) carried out by the lecturer and guest lectures. Practical exercises will be assigned to students to be held independently outside the course hours.

Assignment

- Depending on the number of enrolments, students will be divided into subgroups to design flexible and rigid pavements for airport and road infrastructure. Specifically, a case study will be assigned and presented via a report and a presentation.

Distribution of hours by activity type

DISTRIBUTION OF HOURS BY ACTIVITY TYPE			
ACTIVITY	WORK IN THE CLASSROOM	OUTSIDE CLASSROOM WORK	T
Lectures	40	40	
Work in groups and pairs (Mini-projects)	8	70	
TOTAL	48	110	

ASSESSMENT METHODS AND CRITERIA

- Assignments (60-80%)
- Individual oral exam (20-40%)

Students should deliver a design report which will have 3 folds including the written report, technical draws, and oral presentation. This is a group assignment so the evaluation will be based on teamwork and their report (not individually). Each group must achieve 50% on each component (written report, technical draws, and oral presentation) to pass this course. All components may be retaken during the second session. Important remark: **If a group does not achieve 10/20 on one or more components, the final score is equal to the lowest score.**

DEMONSTRATION OF THE CONSISTENCY OF THE TEACHING METHODOLOGIES WITH THE LEARNING OBJECTIVES OF THE CURRICULAR UNIT

The classes incorporate a dynamic teaching methodology that facilitates the students in comprehending the fundamental issues related to the course programme. Apart from presenting the concepts, methods, and models, practical examples are also discussed and presented, which provides an opportunity for students to actively participate in the learning process. Throughout the project, students are engaged in a series of activities that help

them solidify their knowledge and acquire new information about pavement design and management. These activities include the application of knowledge acquired regarding material selection, on-field performance, critical analyses of designed layers, maintenance and rehabilitation.

COURSE MATERIALS

Presentations, exercises, and Excel sheets used during the lectures are made available to students.

ADVICE AND TIPS TO PROCESS LEARNING CONTENT – BIBLIOGRAPHY TO CONSULT

Bibliography:

- Yang H. Huang, "Pavement Analysis and Design", Prentice Hall.
- M.Y. Shahin, "Pavement Management for airports, roads and parking lots" KAP.
- Rajib B. Mallick and Taher El-Korchi, “Pavement Engineering: Principles and Practice”, CRC Press.
- Haas, R., Hudson, W.R., Cowe Falls, L. (2015). Pavement Asset Management. Wiley. ISBN: 978-11-19038-70-2.
- American Association of State Highway and Transportation Officials (AASHTO) (2012). Pavement Management Guide, 2nd Edition. AASHTO. ISBN: 978-1-56051-545-6.

COURSE 4: MATERIAL TESTING AND EVALUATION

Degree			Academic year
JOINT MASTER'S DEGREE IN SUSTAINABLE AND RESILIENT PAVEMENT ENGINEERING			**2026/2027**
Course			Semester
Course 4	**Material Testing and Evaluation**		**1**
Type	Language	ECTS Credits	Group/Language
Compulsory	**English**	**6**	**English**
Lecturer			
Omranian, Seyed Reza **Blom, Johan**			

DESCRIPTION

The objectives of this course are built upon preparing students with in-depth knowledge of materials performance, skills, and practical experience in the field of pavement engineering. During this course, students will become familiar with bituminous materials in different scales from nano to macro scales, and understand such materials' characterization using several conventional/advanced testing methods. The students will also develop their proficiency in the laboratory by initially becoming acquainted with existing standards and equipment to perform tests and later interpret/analyze data in an accurate and critical way. The final goal is to design/produce bituminous/concrete mixtures with respect to their optimized/durable performance in the context of sustainability.

PREREQUISITES

Sufficient English knowledge (i.e. B2) to comprehend/speak/read/write
Enrolment in the other relevant courses organized within the joint master Prior knowledge (bachelor level) in one of civil engineering, material science, architecture, or other relevant fields

LEARNING OUTCOMES IN TERMS OF GENERIC AND SPECIFIC COMPETENCES

- Understanding the conventional, rheological, mechanical, and chemical concepts in the field of bituminous materials characterization
- Transferring the theoretical knowledge to practical and experimental concepts
- Developing a hypothesis related to characterization and performance of bituminous materials
- Designing experimental matrix to test and validate the hypothesis and analyzing data
- Gaining proficiency to differentiate the characteristic properties of different bituminous materials
- Performing practical conventional and advanced tests to critically evaluate the bituminous materials
- Interpreting the data critically and writing scientific reports
- Demonstrating teamwork capability through effective collaboration and communication

CONTENTS

- Introduction to bitumen (physical and rheological aspects)
- Modification of bitumen
- Emulsions and mortars
- Conventional/Modified asphalt mix design
- Asphalt mixture conventional static and dynamic mechanical testing
- Asphalt mixture advanced static and dynamic mechanical testing and analysis
- Concrete mix design and analysis
- Novel testing methods
- Constitutive models and mechanics

DEMONSTRATION OF THE CONSISTENCY OF THE SYLLABUS WITH THE LEARNING OBJECTIVES OF THE COURSE

This course aims to train the next generation of experts in the field of pavement engineering. Hence, through the syllabus, the students will learn a set of concepts, utilization of conventional/advanced instruments to characterize and detect intrinsic/extrinsic properties of (un)modified bituminous materials, analysis techniques, and models to achieve the learning outcomes. The foreseen practical components of this course coupled with the assignment(s) guarantee the achievement of the learning objectives which provide students with opportunities to practice and apply the knowledge and skills they are expected to acquire.

TEACHING METHODS AND PLANNED LEARNING ACTIVITIES

Classroom activities

- The theory class will be delivered in 2-hour lectures. The classes will be organized mainly on campus, but there is a chance to have a few lectures online if guest lecturers are invited. The lab sessions will take approximately 2 hours and will be conducted in the SuPAR lab (short presentations will be delivered to the students before each lab session). However, due to the time consumption for sample preparation, conditioning, limitations, etc., the hours can be altered.

Outside-class activities

- A potential visit to asphalt plants and construction sites is foreseen during this course. This part includes preparation for the lectures and studying of theory. The students should also put effort into preparing assignments as explained below.

Assignment

- The assignment is to evaluate students' proficiency in characterizing materials. Thus, students, depending on the number of enrolments, will be divided into small groups to perform tests on specific topics (aligned with available topics within the SuPAR group) during the course. The findings should finally be reported in a professional way as the assignment.

Distribution of hours by activity type

DISTRIBUTION OF HOURS BY ACTIVITY TYPE			
ACTIVITY	WORK IN THE CLASSROOM	OUTSIDE CLASSROOM WORK	TOTAL
Lectures	24	24	48
Lab work	24	16	36
Assignments		80	80
TOTAL	48	120	168

ASSESSMENT METHODS AND CRITERIA

The assessment will be based on the assignments. Students should deliver a report which will have 2 folds including the written paper, and oral presentation. This is a group assignment so the evaluation will be based on the teamwork and their report (not individually).
Each group must achieve 50% on each component (written paper and oral presentation) to pass this course. All components may be retaken during the second session. **Important remark: "If a group does not achieve 10/20 on one or more components, the final score is equal to the lowest score."**

DEMONSTRATION OF THE CONSISTENCY OF THE TEACHING METHODOLOGIES WITH THE LEARNING OBJECTIVES OF THE CURRICULAR UNIT

In order to achieve the objectives, the teaching method of this lecture is divided into three folds including, theory classes, laboratory experiments, and assignments. The theory classes deliver foundational knowledge aligning with the core understanding of the objectives on how the bituminous materials behave when subjected to different circumstances such as different loading types/magnitudes or climatic conditions. Whereas, the laboratory experiments, which can increase student motivation and engagement with the subject, provide students with

hands-on learning/experience that bridge theory and application. Such training can help students connect abstract ideas to tangible outcomes in order to fulfill practical application goals and enhance their overall learning experience. Finally, the assignments that actively engage students can provide a scan of the level of understanding of the concepts covered during theory and experimental classes and subsequently deepen their grasp of the subjects. Through assignments, students also get to practice new skills such as critical/analytical thinking, research, writing, problem-solving, teamwork, collaboration, communication, time management, and planning as well as many more relevant technical skills. Assignments also help students to learn about their own understanding style, preferences, and capabilities which is essential for mastering the content and skills of the course. This comprehensive/cohesive approach ensures a balanced learning experience, directly serving the curricular unit's defined objectives.

COURSE MATERIALS

Slides and lecture notes as well as required references to perform tests and additional materials to delve into covered topics will be provided and uploaded on Blackboard.

ADVICE AND TIPS TO PROCESS LEARNING CONTENT – BIBLIOGRAPHY TO CONSULT

Effective learning is an ongoing process that involves active participation, organization, and a commitment to understanding and applying the knowledge gained in the course. It is advised that the students review the content of each section prior to the class. Some references (more info and references will be introduced during each lecture) that students can refer to are as follows:

- Anton Paar GmbH: e-learning course – Basics of Rheometry, part 1: Rotation; part 2: Oscillation. Graz, 2010
- Mezger, T.G.: Applied Rheology, 2017 (4th edition)
- Macosko, C.W.: Rheology, principles, measurements, and applications. Wiley, New York, 1994.
- Mezger, T.G.: Das Rheologie-Handbuch. Vincentz, Hannover, 2016 (5th edition)
- Mix Design Methods for Asphalt Concrete and Other Hot-mix Types by Asohakt Ubstutye
- The Shell Bitumen Handbook, Sixth Edition by Robert N. Hunter, Andy Self, and John Read
- SP-2 Superpave Mix Design (Asphalt Institute)
- SUPERPAVE asphalt mixture design illustrated
- Background of SUPERPAVE asphalt mixture design and analysis
- Background of SUPERPAVE asphalt binder test methods
- Fracture Mechanics by Chin-Teh Sun

COURSE 5: ELECTIVE COURSES

Degree			Academic year
JOINT MASTER'S DEGREE IN SUSTAINABLE AND RESILIENT PAVEMENT ENGINEERING			**2026/2027**
Course			Semester
Course 5	**Elective Courses**		**1**
Type	Language	ECTS Credits	Group/Language
Compulsory	**English**	**6**	**English**
Lecturer			
VAN DEN BERGH, WIM			

DESCRIPTION

In this course, the student can select different elective courses, organised by UAntwerpen during the first semester. The objective of this course is to give access to the students to elaborate and widen soft, technology and research skills.

PREREQUISITES

n.a.

LEARNING OUTCOMES IN TERMS OF GENERIC AND SPECIFIC COMPETENCES

General outcomes

- Adaptability and Continuous Learning: Cultivating a mindset of perpetual learning and adaptability to evolving technologies and methodologies.
- Problem-Solving Skills: The capability to recognize, dissect, and resolve intricate problems by employing critical thinking and innovative approaches.
- Teamwork and international collaboration: demonstrating the ability to collaborate within multidisciplinary and international teams.
- Competent Communication: effectively conveying technical information to diverse audiences.
- Ethical and Professional Integrity: Describe, select and assess the ethical implications of engineering decisions and demonstrate professionalism, integrity, and accountability in a professional context.
- Global Perspective: Understand and apply the global context of pavement engineering, considering different infrastructural needs, environmental impacts, and regional variations.

Specific outcomes are related to the selected course.

CONTENTS

Examples:

- Acoustics 2116FTIACO - Cedric Vuye
- Debating Development in Global Mobility - 9009UAOOUD - Janus Verrelst
- Safety and Resilience 2250FSWHUF - Anne Bergmans
- *Other courses are available at UAntwerp and will be listed at the beginning of the respective academic year.*

DEMONSTRATION OF THE CONSISTENCY OF THE SYLLABUS WITH THE LEARNING OBJECTIVES OF THE COURSE

Through the contents described in the selected course, the student will be able to widen expertise or gain new knowledge or soft skills. The student is free to choose one elective course from a list.

TEACHING METHODS AND PLANNED LEARNING ACTIVITIES

Classroom activities

- See elective course

Outside-class activities

- See elective course

Distribution of hours by activity type

DISTRIBUTION OF HOURS BY ACTIVITY TYPE			
ACTIVITY	WORK IN THE CLASSROOM	OUTSIDE CLASSROOM WORK	TOTAL
Lectures	-	-	-
Computer labs	-	-	-
Assignment	-	-	-
TOTAL	20-30		75-90

ASSESSMENT METHODS AND CRITERIA

The student is evaluated as a student of the elective course..

DEMONSTRATION OF THE CONSISTENCY OF THE TEACHING METHODOLOGIES WITH THE LEARNING OBJECTIVES OF THE CURRICULAR UNIT

n.a. see the selected elective course.

COURSE MATERIALS

Course notes will be provided to the students along with additional references to delve into specific topics.

ADVICE AND TIPS TO PROCESS LEARNING CONTENT – BIBLIOGRAPHY TO CONSULT

See elective course

COURSE 6: TRANSPORTATION GEOTECHNICS

Degree				Academic year
JOINT MASTER'S DEGREE IN SUSTAINABLE AND RESILIENT PAVEMENT ENGINEERING				**2026/2027**
				Semester
Course				**2**
Course 6	**Transportation Geotechnics**			Group/Language
Type	Language		ECTS Credits	**English**
Compulsory	**English**		**5**	
Lecturer				
MIRANDA, TIAGO				

DESCRIPTION

The main objective of this curricular unit is to provide both theoretical and practical knowledge on Geotechnics applied in the context of Transportation infrastructures.

PREREQUISITES

None

LEARNING OUTCOMES IN TERMS OF GENERIC AND SPECIFIC COMPETENCES

- Understand the specificities of Geotechnics applied in the context of Transportation Geotechnics.
- Gain knowledge related with asset management and monitoring of geotechnical structures.
- Conduct projects related with earthworks in the context of Transportation - Infrastructures.
- Conduct inspections and assess risk levels of Geotechnical Assets.
- Design monitoring plans for Geotechnical Structures.

CONTENTS

- Earthworks in transportation infrastructures
- Soil types, physical indexes, Laboratory characterization tests and soil classification.
- Compaction for transportation infrastructures and in situ and laboratory tests for compaction control.
- Laboratory compaction curves, compaction works and equipment.
- Asset management of geotechnical structures.
- Geotechnical inventory and visual inspections of slopes and retaining walls.
- Criticality and condition indexes.
- Risk matrix computation and risk maps.
- Monitoring of slopes and retaining walls.
- Remote sensing techniques – satellite observation (InSar) and image techniques (LiDAR and photogrammetry).

DEMONSTRATION OF THE CONSISTENCY OF THE SYLLABUS WITH THE LEARNING OBJECTIVES OF THE COURSE

Through the contents described in the syllabus, the student will learn a series of concepts, models, and tools (e.g., earthworks in the context of Transportation Infrastructures, asset management of Geotechnical assets and monitoring of slopes and retaining walls) that will enable achieving the learning objectives. The program covers the theoretical component of these concepts, models, and tools and their practical component through a series of course assignments to be solved by the students.

TEACHING METHODS AND PLANNED LEARNING ACTIVITIES

Classroom activities
Lectures, Practical sessions

Outside-class activities
Preparation for lectures and self-study, Assignments

Distribution of hours by activity type

DISTRIBUTION OF HOURS BY ACTIVITY TYPE			
ACTIVITY	WORK IN THE CLASSROOM	OUTSIDE CLASSROOM WORK	TOTAL
Lectures	20	20	40
Work in groups and pairs (Mini-projects)	25	75	100
TOTAL	45	95	140

ASSESSMENT METHODS AND CRITERIA

- Continuous evaluation (10-15%): attendance, participation in class
- Assignments to be submitted during the semester (30-40%)
- Final exam (40-50%)

DEMONSTRATION OF THE CONSISTENCY OF THE TEACHING METHODOLOGIES WITH THE LEARNING OBJECTIVES OF THE CURRICULAR UNIT

The teaching methodologies envisioned for this course combine slides, class printouts, discussions, and hands-on problem-solving assignments to meet the needs of different learner types. The continuous evaluation of attendance and participation in class provides information on the level of engagement of the student, which is a necessary component for effective learning. Furthermore, the assignments provide a scan of the level of understanding of the concepts covered in the syllabus, so the necessary corrective measures can be taken.

COURSE MATERIALS

Powerpoint slides, Software for visual inspections and asset management of slopes and retaining walls and support bibliography.

ADVICE AND TIPS TO PROCESS LEARNING CONTENT – BIBLIOGRAPHY TO CONSULT

- SETRA/LCPC (1992). Réalisation des remblais et des couches de forme – Fascicule 1 et 2.
- Korytynski, A. (2003). Compaction Control Article, Sabatini Earth Technologies Inc.
- Pinheiro, M., Sanches, S., Miranda, T., Neves, A., Tinoco, J., Ferreira, A. and Correia, A. (2015). A new empirical system for rock slope stability analysis in exploitation stage. International Journal of Rock Mechanics & Mining Sciences 76, p.182–191.
- Tomás, R.; Pinheiro, M.; Pinto, P.; Pereira, E.; Miranda, T. (2023). Preliminary analysis of the mechanisms, characteristics and causes of a recent catastrophic structurally-controlled rock planar slide in Esposende (northern Portugal). Landslides, volume 20, issue 8, p. 1657-1665.
- Pinto, P.; Barros, J.; Pinheiro, M.; Roberto, T.; Miranda, T.; Pereira, E. (2023). Landslide analysis combining laser scanning and photogrammetry. International Conference on Debris and Flow Hazard Mitigation, DFHM 2023, Torino, Italy, 26-29 June 2023, code 191741.

COURSE 7: SUSTAINABLE AND MULTIFUNCTIONAL PAVEMENT MATERIALS

Degree			Academic year
JOINT MASTER'S DEGREE IN SUSTAINABLE AND RESILIENT PAVEMENT ENGINEERING			**2026/2027**
			Semester
Course			**2**
Course 7	**Sustainable and Multifunctional Pavement Materials**		Group/Language
Type	Language	ECTS Credits	**English**
Compulsory	**English**	**5**	
Lecturer			
SILVA, HUGO **OLIVEIRA, JOEL**			

DESCRIPTION

This course focuses on the development of circular pavement materials and the evaluation of sustainable materials' properties. Students will assess sustainability through environmental product declarations and understand circular economy principles in recycling and waste incorporation. Topics include low-temperature asphalt techniques, designing sustainable paving solutions, and evaluating the environmental impact of new products.

PREREQUISITES

There are no prerequisites.

LEARNING OUTCOMES IN TERMS OF GENERIC AND SPECIFIC COMPETENCES

- Understand the current needs for the development of circular pavement materials.
- Evaluate the main properties of sustainable materials.
- Assess the sustainability of materials through environmental product declaration.
- Identify different pavement construction materials
- Understand the circular economy principle and its application to recycling and waste incorporation on road paving.
- Identify low or warm-temperature asphalt production techniques to improve energy efficiency.
- Design new solutions for road paving based on sustainable principles or using non-fossil materials.
- Comprehend the advantages of using multifunctional properties of paving materials.
- Assess the life cycle environmental impact of new sustainable products.

CONTENTS

- Circular economy principles for road paving materials
- Recycling and waste incorporation on road paving
- Low or warm-temperature asphalt production techniques
- Use of non-fossil materials as paving materials.
- Design and characterization of sustainable asphalt paving materials
- Multifunctional properties of paving materials
- Life cycle assessment and environmental product declaration

DEMONSTRATION OF THE CONSISTENCY OF THE SYLLABUS WITH THE LEARNING OBJECTIVES OF THE COURSE

The course aims to provide students with concepts, models, and tools to develop new sustainable and multifunctional pavement materials. Students should understand the current need to develop circular pavement materials, know how to evaluate their main properties and assess their sustainability through environmental product declaration. The syllabus presents these concepts, models, and tools theoretically and through practical implementation, using a project-based learning approach and frequently presenting practical examples. Thus, the learning objectives lead to a better understanding of the program, including the circular economy principles for road paving materials, recycling and waste incorporation, low or warm-temperature asphalt production techniques, design and characterization of sustainable and multifunctional asphalt paving materials and life cycle assessment.

TEACHING METHODS AND PLANNED LEARNING ACTIVITIES

The teaching methods for this course include class-contact teaching through lectures and practice sessions, personal work, and project-based learning.

Classroom activities
- Lectures (24 hours)
- Practical sessions (12 hours)
- Project Based Learning (24 hours)

Outside-class activities
- Preparation for lectures and self-study (48 hours)
- Project Based Learning (32 hours)

Distribution of hours by activity type

DISTRIBUTION OF HOURS BY ACTIVITY TYPE			
ACTIVITY	WORK IN THE CLASSROOM	OUTSIDE CLASSROOM WORK	TOTAL
Lectures	24	48	72
Practical sessions	12	0	12
Project Based Learning (work in groups or pairs)	24	32	56
TOTAL	60	80	140

ASSESSMENT METHODS AND CRITERIA

The evaluation includes:
- Continuous evaluation (15% to 25%): attendance, participation in class,
- Project carried out in COIL to be submitted and presented at the end of the semester (30% to 50%): Report (15% to 25%); Presentation (15% to 25%),
- Exam (30% to 50%).

DEMONSTRATION OF THE CONSISTENCY OF THE TEACHING METHODOLOGIES WITH THE LEARNING OBJECTIVES OF THE CURRICULAR UNIT

The type of classes implemented in this Curricular Unit will allow the transmission of theoretical concepts, which will then be evaluated individually through a written exam and their practical application through group work in COIL. The students must demonstrate that they have acquired the competencies mentioned in the learning objectives on topics (defined every academic year) related to the main objective of developing sustainable pavement materials. The work must include a literature review and a practical application of at least one of the learning objectives of this course.

COURSE MATERIALS

The following materials will be used during the course:
- Slides and videos will support the learning process.
- The materials for the laboratory classes or site visits will be provided.
- Bibliography.

ADVICE AND TIPS TO PROCESS LEARNING CONTENT – BIBLIOGRAPHY TO CONSULT

A set of slides and videos will support the learning process, complemented with laboratory classes or site visits for a practical learning experience. Bibliography to consult for this curricular unit:

- Loureiro C, et al. (2022). Steel Slag and Recycled Concrete Aggregates: Replacing Quarries to Supply Sustainable Materials for the Asphalt Paving Industry. Sustainability, 14, 5022.
- PIARC (2022). Use of Recycled Materials in Pavements. A PIARC Case Studies Collection.
- Zhang X, et al. (2020). Preparation of bio-oil and its application in asphalt modification and rejuvenation: A review of the properties, practical application and life cycle assessment. Constr. Build. Mater., 262, 120528.
- Cheraghian G, et al. (2020). Warm mix asphalt technology: An up-to-date review. J. Clean. Prod., 268.
- EN 15804:2012+A2:2019/AC:2021 (2021). Sustainability of Construction Works—Environmental Product Declarations—Core Rules for the Product Category of Construction Products. E.C.: Brussels, Belgium.

COURSE 8: AIRPORTS AND RAILWAYS

Degree			Academic year
JOINT MASTER'S DEGREE IN SUSTAINABLE AND RESILIENT PAVEMENT ENGINEERING			**2026/2027**
Course			Semester
Course 8	**Airports and Railways**		**2**
Type	Language	ECTS Credits	Group/Language
Compulsory	**English**	**5**	**English**
Lecturer			
PAIS, JORGE			

DESCRIPTION

This course aims to teach students about airports and railways to understand the concepts inherent to these transport infrastructures. This course presents all elements associated with the airports and railways, describing their characteristics, functions, and objectives for the infrastructure. Finally, the course explains the design of these infrastructures, covering the geometric and pavement design for airports and the geometric and all elements for the railways.

PREREQUISITES

n.a.

LEARNING OUTCOMES IN TERMS OF GENERIC AND SPECIFIC COMPETENCES

- Identify the various components of an airport system
- Calculate the length and orientation of an airport runway, and the pavement structure
- Define the layout of taxiways and airport aprons
- Define the Pavement Classification Rating of a runway
- Identify the elements that make up ballasted and slab track railways
- Define the curves in plan and the slopes of a railway and the loads to which the railway is subjected and with them the cant of the track
- Perform static design of a railway
- Identify the elements that make up the track switches and crossings of railways and the maintenance and renewal operations of the railways

CONTENTS

- The airport system
- Design of runways
- Design of taxiways and aprons
- Structural design of airport pavements
- Airport Pavement Strength - PCR
- Ballasted and slab track
- Curves and gradients
- Loads and cant
- Static track design
- Switches and crossings
- Track maintenance and renewal

DEMONSTRATION OF THE CONSISTENCY OF THE SYLLABUS WITH THE LEARNING OBJECTIVES OF THE COURSE

In this course unit, it is intended to transmit to the student a set of concepts, models, and tools related to the design and treatment of specificities about airports and railways projects (syllabus), in the context of identifying the elements of these infrastructures, design their components, and finally understanding how to maintain and renew these infrastructures (learning objective). The programme presents these concepts, models and instruments both theoretically and through practical implementation, in order to develop knowledge of the fundamental characteristics of airports and railways and skills such as static dimensioning of a railway.

TEACHING METHODS AND PLANNED LEARNING ACTIVITIES

This course unit consists of theoretical-practical classes having both a theoretical and a practical component that are interconnected. The teaching methodology in the theoretical classes involves teaching all the contents defined in the course unit's program, with practical examples provided to frame the students' understanding of the subjects. These classes are complemented in the practical sessions through exercise classes and project work, in which students can apply the programmatic contents to real cases.

ASSESSMENT METHODS AND CRITERIA

The assessment of this course unit includes two components:
- A summative test (40-60% of the final grade) to assess theoretical-practical knowledge;
- Two projects (40-60% of the final grade). In addition to the written part, the assessment of the projects includes their presentation, components that have the same weight in the final evaluation.

DEMONSTRATION OF THE CONSISTENCY OF THE TEACHING METHODOLOGIES WITH THE LEARNING OBJECTIVES OF THE CURRICULAR UNIT

In the theoretical classes, a dynamic teaching methodology is adopted that allows the student to understand fundamental issues related to the themes proposed in the course unit program. In addition to the presentation of theories, models, and concepts, practical examples and case studies are frequently presented and discussed, providing the student with the opportunity to actively participate in the learning process.

In the practical classes (project), students develop a set of activities that allow them to consolidate knowledge through the completion of projects, in which it is possible to realize various applications of knowledge. Occasionally, the pursuit of knowledge results from exercises in which research is also a fundamental element.

COURSE MATERIALS

Course slides, with references to the bibliography, will be provided to the students before the class.

ADVICE AND TIPS TO PROCESS LEARNING CONTENT – BIBLIOGRAPHY TO CONSULT

Esveld, C. (2012). Modern Railway Track (2nd ed). Zaltbommel : MRT-Productions.FAA. (2021). AC 150/5320-6G - Pavement Design. Federal Aviation Administration.

- FAA. (2022). AC 150/5300-13B - Airport Design. Federal Aviation Administration.
- Horonjeff, R., McKelvey, F. X., Sproule, W. J., & Young, S. B. (2010). Planning and Design of Airports (5th editio). McGraw-Hill Education.
- ICAO. (2020). Aerodrome Design Manual. Part 1: Runways (4th ed.). International Civil Aviation Organization.
- ICAO. (2022). Aerodrome Design Manual. Part 3: Pavements (3rd ed.). International Civil Aviation Organization.
- CEN. (2007). EN 13803/1. Railway applications - Track - Track alignment design parameters - Track gauges 1435 mm and wider - Part 1: Plain line.
- Tzanakakis, K. (2013). The Railway Track and Its Long Term Behaviour, STTT 2, Springer.

COURSE 9: ENHANCED AND SMART PAVEMENT SURFACE FUNCTIONS

Degree			Academic year
JOINT MASTER'S DEGREE IN SUSTAINABLE AND RESILIENT PAVEMENT ENGINEERING			**2026/2027**
			Semester
Course			**2**
Course 9	**Enhanced and Smart Pavement Surface Functions**		Group/Language
Type	Language	ECTS Credits	**English**
Compulsory	**English**	**5**	
Lecturer			
FREITAS, ELISABETE			

DESCRIPTION

This course is a component of the Specialization Area in Smart Pavements, Multifunctional Materials and Systems. It is a course with a high degree of innovation integration as it aims at preparing students with the skills and providing them with tools for assessing and developing smart solutions concerning pavement surfaces. Pavement surfaces are in direct contact with tyres. Their features are active factors for many environmental and safety issues, which justifies the late shift of focus to them. Besides lectures and invited seminars, this course involves a significant amount of time dedicated to problem-solving and elaboration of scenario-based strategies.

PREREQUISITES

None

LEARNING OUTCOMES IN TERMS OF GENERIC AND SPECIFIC COMPETENCES

- Estimate the impact of traditional and intelligent pavement surface characteristics on durability, comfort, safety and the environment.
- Support the selection of pavement surface layer alternatives based on structural, functional and environmental criteria.
- Describe the characteristics of traditional and innovative pavement surfaces such as texture, evenness, drainage, friction, noise, rolling resistance, thermochromism, thermal regulation, photocatalysis, self-cleaning, anti-icing, self-healing.
- Explain the interaction between these characteristics and the effect of tires.
- Identify the materials and their characteristics involved in each function.
- Identify methods of measuring or characterizing traditional and innovative surface characteristics.
- Interpretation of advanced indicators relating to each surface characteristic.
- Propose design, construction and maintenance strategies according to requirements scenarios with innovative functions.

CONTENTS

- Pavement functions.
- Principles, mechanisms of traditional and innovative surface characteristics such as texture, evenness, drainage, friction, noise, rolling resistance, thermochromism, thermal regulation, photocatalysis, self-cleaning, anti-icing, self-regeneration.
- Interaction between these characteristics and the effect of tires and their impact on comfort, safety and the environment.
- Characteristics of the materials involved in each function
- Standardized and recommended measurement or characterization methods for evaluating traditional and innovative surface characteristics.
- Traditional and advanced evaluation indicators for assessing the performance of traditional and innovative surface characteristics.
- Pavement design, construction and maintenance strategies based on requirements scenarios with innovative functions.

DEMONSTRATION OF THE CONSISTENCY OF THE SYLLABUS WITH THE LEARNING OBJECTIVES OF THE COURSE

In this course the students are asked to use a set of concepts, mechanisms, models and instruments mentioned in the objectives that are specified in the syllabus. The syllabus addresses these in a theoretical way, through seminars in a variety of contexts, and practical implementation with real data Each syllabus directly corresponds to one or more learning objectives, with the more complex ones requiring mastery of the simpler contents. For example, in order for students to propose design, construction and conservation strategies according to scenarios with intelligent function requirements (objective) they must - know the characteristics of the materials that make up each scenario, their performance, be able to interpret the indicators involved in relation to the interactions between the various surface characteristics (syllabus).

TEACHING METHODS AND PLANNED LEARNING ACTIVITIES

Classroom activities
Include attending lectures, invited seminars and solving several problems either in group or individually.

Outside-class activities
Include visits to companies and field works and performing problem-solving activities.

Distribution of hours by activity type

DISTRIBUTION OF HOURS BY ACTIVITY TYPE			
ACTIVITY	WORK IN THE CLASSROOM	OUTSIDE CLASSROOM WORK	TOTAL
Lectures	25	25	50
Work in groups and pairs (Mini-projects)	20	70	90
TOTAL	45	95.	140

ASSESSMENT METHODS AND CRITERIA

The assessment method adopted for this curricular unit is periodic assessment, which includes a summative test, various problem-based activities and presentations. The summative test is aimed at theoretical and practical subjects, assessed by the teacher. The activities aim to consolidate knowledge in an active way and the presentations consolidate communication skills.
Assessment will be based on the following elements: the summative test, with a weighting of (30-40%); activities (40-50%) and presentations (10-30%). The assessment of the presentations will include a peer evaluation component with a weight of less than 50%.

DEMONSTRATION OF THE CONSISTENCY OF THE TEACHING METHODOLOGIES WITH THE LEARNING OBJECTIVES OF THE CURRICULAR UNIT

In this course the students are asked to use a set of concepts, mechanisms, models and instruments mentioned in the objectives that are specified in the syllabus. The syllabus addresses these in a theoretical way, through seminars in a variety of contexts, and practical implementation with real data Each syllabus directly corresponds to one or more learning objectives, with the more complex ones requiring mastery of the simpler contents. For example, for students to propose design, construction and conservation strategies according to scenarios with intelligent function requirements (objective) they must - know the characteristics of the materials that make up each scenario, their performance, be able to interpret the indicators involved in relation to the interactions between the various surface characteristics (syllabus).

COURSE MATERIALS

- Laboratory facilities and monitoring equipment.
- Research papers and other bibliographic support.
- Course presentations in ppt format.
- Videos.

ADVICE AND TIPS TO PROCESS LEARNING CONTENT – BIBLIOGRAPHY TO CONSULT

- Deng, Z., et al. (2023). Multifunctional asphalt concrete pavement toward smart transport infrastructure: Design, performance and perspective. Composites Part B: Engineering, 110937.
- Segundo, I. R., et al. (2021). Review and analysis of advances in functionalized, smart, and multifunctional asphalt mixtures. Renewable and Sustainable Energy Reviews, 151, 111552.
- Dong, S., et al. (2023). New-generation pavement empowered by smart and multifunctional concretes: A review. Construction and Building Materials, 402, 132980.
- Chen, S., et al. (2022). A state-of-the-art review of asphalt pavement surface texture and its measurement techniques. Journal of Road Engineering, 2(2), 156-180.
- Freitas, E., et al. (2022). Tests and Surveillance on Pavement Surface Characteristics. In Advances on Testing and Experimentation in Civil Engineering: Geotechnics, Transportation, Hydraulics and Natural Resources (pp. 135-161). Cham: Springer International Publishing.

COURSE 10: DIGITALIZATION OF PAVEMENT MONITORING

Degree			Academic year
JOINT MASTER'S DEGREE IN SUSTAINABLE AND RESILIENT PAVEMENT ENGINEERING			**2026/2027**
			Semester
Course			**2**
Course 10	**Digitalization of Pavement Monitoring**		Group/Language
Type	Language	ECTS Credits	**English**
Compulsory	**English**	**5**	
Lecturer			
OLIVEIRA, JOEL			
SILVA, HUGO			

DESCRIPTION

This course aims to introduce the student to traffic and road pavement monitoring methods and highlight their importance for the management of this transport infrastructure. The course describes the different methods and equipment used for monitoring pavements and introduces the data analysis techniques that need to be used to process the information collected. Finally, the course discusses the tools used to develop pavement performance prediction models based on the large volumes of information collected in the monitoring systems.

PREREQUISITES

None

LEARNING OUTCOMES IN TERMS OF GENERIC AND SPECIFIC COMPETENCES

- Identify traffic and road pavement monitoring methods;
- Apply monitoring methods to a real case scenario;
- Describe the different types of equipment used;
- Understand the new challenges in digitalizing the information collected;
- Process large volumes of data to generate relevant information for road management;
- Use the processed information in pavement performance prediction models.

CONTENTS

- Pavement monitoring methods
- Road traffic assessment systems
- Static and dynamic monitoring equipment
- Digitalization of information in road pavements
- Techniques for processing large volumes of information
- Road pavement performance prediction models

DEMONSTRATION OF THE CONSISTENCY OF THE SYLLABUS WITH THE LEARNING OBJECTIVES OF THE COURSE

The aim of the course is to provide students with a set of concepts, models, and tools for digitalizing pavement monitoring. Students should be able to identify and apply traffic and road pavement monitoring methods to real cases, using the appropriate equipment, making it possible to digitalize and process the information collected for use in pavement performance prediction models. The syllabus presents these concepts, models, and tools theoretically and through practical implementation, using a case study and the frequent presentation of practical examples. Thus, these learning objectives lead to a better understanding of the program, including pavement monitoring and traffic assessment, digitalizing and processing the information for application in road pavement performance prediction models.

TEACHING METHODS AND PLANNED LEARNING ACTIVITIES

The teaching methods for this course include class-contact teaching through lectures and practice sessions, personal work, and project-based learning.

Classroom activities
- Lectures
- Practical sessions
- Project Based Learning

Outside-class activities
- Preparation for lectures and self-study
- Project Based Learning

Distribution of hours by activity type

DISTRIBUTION OF HOURS BY ACTIVITY TYPE			
ACTIVITY	WORK IN THE CLASSROOM	OUTSIDE CLASSROOM WORK	TOTAL
Lectures	15	30	45
Practical sessions	10	20	30
Project Based Learning	20	45	65
TOTAL	45	95	140

ASSESSMENT METHODS AND CRITERIA

- Continuous evaluation (10% to 30%): attendance, participation in class
- Project to be submitted at the end of the semester (40% to 60%): Report (10% to 30%); Presentation (10% to 30%)
- Exam (40% to 60%)

DEMONSTRATION OF THE CONSISTENCY OF THE TEACHING METHODOLOGIES WITH THE LEARNING OBJECTIVES OF THE CURRICULAR UNIT

The type of classes to be implemented in this Curricular Unit (theoretical-practical) will allow the transmission of theoretical concepts, which will then be evaluated through the exam, as well as their practical application, through group work, where the students will have to demonstrate that they are capable of evaluating the most appropriate monitoring methods for assessing traffic and the quality of road pavements, digitalizing and processing the information collected and applying it in road pavement performance prediction models.

COURSE MATERIALS

Course notes will be provided to the students along with additional references to delve into specific topics.

ADVICE AND TIPS TO PROCESS LEARNING CONTENT – BIBLIOGRAPHY TO CONSULT

It is advised that the students review the content provided in advance in preparation for the lectures. Likewise, students should go through the contents covered in class afterward and list all questions they may have so the instructor can answer them during the next lecture.

- Rebelo, Francisco J. P., Oliveira, Joel R. M., Silva, Hugo M. R. D., Sá, Jorge O., Marecos, Vânia, Afonso, João, Installation and Use of a Pavement Monitoring System Based on Fibre Bragg Grating Optical Sensors (2023). Infrastructures, 8 (10), DOI: 10.3390/infrastructures8100149.
- Thom, N. (2008). Principles of pavement engineering. Thomas Telford Ltd.
- Moreira, A. V., Tinoco, J., Oliveira, J. R. M., & Santos, A. (2018). An application of Markov chains to predict the evolution of performance indicators based on pavement historical data. International Journal of Pavement Engineering, 19(10), 937-948. DOI: 10.1080/10298436.2016.1224412.
- Moreira, A. V., Fwa, T. F., Oliveira, J. R. M., & Costa, L. (2017). Coordination of User and Agency Costs Using Two-Level Approach for Pavement Management Optimization. Transportation Research Record (2639), 110-118. DOI: 10.3141/2639-14.
- Denysiuk, R., Moreira, A. V., Matos, J. C., Oliveira, J. R. M., & Santos, A. (2017). Two-Stage Multiobjective Optimization of Maintenance Scheduling for Pavements. Journal of Infrastructure Systems, 23(3). DOI: 10.1061/(Asce)Is.1943-555x.0000355.

COURSE 11: HIGHWAY ENVIRONMENT MANAGEMENT SYSTEMS

Degree			Academic year
JOINT MASTER'S DEGREE IN SUSTAINABLE AND RESILIENT PAVEMENT ENGINEERING			**2026/2027**
			Semester
Course			**2**
Course 11	**Highway Environment Management Systems**		Group/Language
Type	Language	ECTS Credits	**English**
Compulsory	**English**	**5**	

Lecturer

RAMÍSIO, PAULO J.
Freitas, Elisabete
Oliveira, Joel
Silva, Hugo
Pais, Jorge

DESCRIPTION

This course focus on the concepts, processes, methodologies, instruments and systems that support the definition of environmental management plans specifically designed for the life cycle of motorways (objective), that must include the source of pollutants and the definition of appropriate methodologies for the of environmental management plans (syllabus).

PREREQUISITES

None

LEARNING OUTCOMES IN TERMS OF GENERIC AND SPECIFIC COMPETENCES

- Identify main road runoff management systems
- Estimate flows associated with different precipitation events
- Understand the characteristics of the different pollutants present in road runoff, estimate the associated pollutant loads, and understand their main retention mechanisms
- Explain the principles of sustainable management of associated systems.
- Explore current environmental management approaches applied to the life cycle phases of motorways
- Propose a road environmental management system based on a case study
- Apply performance indicators used in road environmental management plans
- Evaluate environmental management plans applied throughout highways life cycle
- Integrate the skills and knowledge related to sustainability and multifunctionality of highways in a comprehensive project.

CONTENTS

- Introduction to drainage systems
- Characterization of precipitation events
- Analysis of the processes associated with the formation of hydrographs
- Characterization of the main pollutants and estimation of their pollutant load
- Methodologies for managing and controlling runoff

- Operation, control, and maintenance of sustainable road runoff management systems
- Management systems for pollution control in highway lifecycle phases
- Performance indicators used in environmental management plans
- Environmental management plans in highway construction projects and operation

DEMONSTRATION OF THE CONSISTENCY OF THE SYLLABUS WITH THE LEARNING OBJECTIVES OF THE COURSE

The aim of the course is for the student to use a set of concepts, processes, methodologies, instruments and systems mentioned in the objectives in order to achieve the learning outcomes. Each programme content corresponds directly to one or more learning objectives, with the more complex ones requiring mastery of the simpler contents. For example, in order for students to propose environmental management plans applied throughout the life cycle of motorways (objective), they must know the pollutants and the most appropriate methodologies for managing them and be able to interpret the indicators involved in each part of the environmental management plans (syllabus).

TEACHING METHODS AND PLANNED LEARNING ACTIVITIES

Classroom activities

This course consists of theoretical-practical classes, in which the students learn the main theoretical concepts necessary for carrying out project work in the field of environmental management systems for highways, complemented by frequent presentations of practical examples.

Distribution of hours by activity type

DISTRIBUTION OF HOURS BY ACTIVITY TYPE

ACTIVITY	WORK IN THE CLASSROOM	OUTSIDE CLASSROOM WORK	TOTAL
Lectures	30	30	60
Work in groups and pairs (Mini-projects)	30	50	80
TOTAL	60	80	140

ASSESSMENT METHODS AND CRITERIA

The assessment method adopted for this curricular unit is based on a periodic assessment, which includes:
- one summative test (weight of 40 to 60% in the final grade) to evaluate the theoretical-practical knowledge;
- one project group work (weight of 40 to 60% in the final grade), including a joint report and an individual oral presentation. The evaluation of the report and presentation has a partial weight of 30 to 50% (each),
- continuous evaluation of student performance with a weight of 10 to 20%.

DEMONSTRATION OF THE CONSISTENCY OF THE TEACHING METHODOLOGIES WITH THE LEARNING OBJECTIVES OF THE CURRICULAR UNIT

In class, teaching methodologies are adopted which, a priori, enable the defined objectives to be achieved. Through expository methodology, students will have a first contact with concepts, methods, processes, and models. This phase is linked to the lower-level objectives, such as identifying systems, describing and explaining principles, while the project will develop higher level skills as to explore, estimate, analyse and propose informed environmental management solutions.

COURSE MATERIALS

- Kayhanian, M., Fruchtman, B. D., Gulliver, J. S., Montanaro, C., Ranieri, E., & Wuertz, S. (2012). Review of highway runoff characteristics: Comparative analysis and universal implications. Water research, 46(20), 6609-6624.
- Kim, L. H., Kayhanian, M., Zoh, K. D., & Stenstrom, M. K. (2005). Modeling of highway stormwater runoff. Science of the Total Environment, 348(1-3), 1-18.
- Pagotto, C., Legret, M., & Le Cloirec, P. (2000). Comparison of the hydraulic behaviour and the quality of highway runoff water according to the type of pavement. Water Research, 34(18), 4446-4454.
- Dahalan, N. H., Rahman, R. A., Ahmad, S. W., & Che Ibrahim, C. K. I. (2023). Public monitoring of environmental management plan implementation in road construction projects: key performance indicators. Journal of Engineering, Design and Technology.
- Highways England, Transport Scotland, Welsh Government and Department for Infrastructure Northern Ireland (2020). Design Manual for Roads and Bridges, LA 120 Environmental management plans, Revision 1.

ADVICE AND TIPS TO PROCESS LEARNING CONTENT – BIBLIOGRAPHY TO CONSULT

- Kayhanian, M., Fruchtman, B. D., Gulliver, J. S., Montanaro, C., Ranieri, E., & Wuertz, S. (2012). Review of highway runoff characteristics: Comparative analysis and universal implications. Water research, 46(20), 6609-6624.
- Kim, L. H., Kayhanian, M., Zoh, K. D., & Stenstrom, M. K. (2005). Modeling of highway stormwater runoff. Science of the Total Environment, 348(1-3), 1-18.
- Pagotto, C., Legret, M., & Le Cloirec, P. (2000). Comparison of the hydraulic behaviour and the quality of highway runoff water according to the type of pavement. Water Research, 34(18), 4446-4454.
- Dahalan, N. H., Rahman, R. A., Ahmad, S. W., & Che Ibrahim, C. K. I. (2023). Public monitoring of environmental management plan implementation in road construction projects: key performance indicators. Journal of Engineering, Design and Technology.
- Highways England, Transport Scotland, Welsh Government and Department for Infrastructure Northern Ireland (2020). Design Manual for Roads and Bridges, LA 120 Environmental management plans, Revision 1.

COURSE 12: SUSTAINABLE TRANSPORT INFRASTRUCTURE

Degree			Academic year
JOINT MASTER'S DEGREE IN SUSTAINABLE AND RESILIENT PAVEMENT ENGINEERING			**2026/2027**
			Semester
Course			**2**
Course 12	**Sustainable Transport Infrastructure**		Group/Language
Type	Language	ECTS Credits	**English**
Compulsory	**English**	**6**	
Lecturer			
Davide Lo Presti, **Gabriella Buttitta**			

DESCRIPTION

This course focuses on providing technical background and hands-on experience on the principles of Sustainability, the practices to measuring it in civil engineering and the latest cutting-edge "smart" solutions for implementing sustainability in pavement engineering. Students of different background will have the possibility to attend classes from international experts, getting involved in team project-based learning context and overall understand the importance of approaching a complex problem, such as Engineering Sustainability, by means of a multi-disciplinary and collaborative training.

PREREQUISITES

No prerequisite is mandatory;
However, students are should have already acquired basic knowledge in Sustainability principles

LEARNING OUTCOMES IN TERMS OF GENERIC AND SPECIFIC COMPETENCES

Generic Competences
- Ability to apply knowledge and understanding
- Communication skills
- Learning skills via innovative teaching methods

Specific Competences:
- Understand the importance of road infrastructures in the social and economic development of a country and some solutions to engineer more sustainable infrastructures
- Define the concept of sustainable development and know how to decline it to civil engineering and road infrastructures
- Recognize and apply the basic methodologies for the "Sustainability Assessment" of road infrastructures, including computation techniques based on "Life Cycle Thinking"
- Knowing the "SMART" solutions to implement sustainability in the production, construction, use and end-of-life phases of road infrastructures
- Produce effective presentations of project results by gaining teamwork experience

CONTENTS

- Sustainability and Human Resilience;
- Sustainable developments: philosophy and definitions;
- Life-cycle Thinking and Life-cycle cycle management
- Measuring Sustainability in civil engineering: International Standards and framework, Sustainability Rating Systems
- Life cycle-based impact evaluation techniques: Life cycle assessment (LCA), social life cycle assessment (SLCA), life cycle sustainability assessment (LCSA) and economical cost-based assessment.
- Implementing sustainable pavements through "SMART" solutions
- Lectures and seminars: sustainable and safe Infrastructure, multi-functional Infrastructure, automated Infrastructure, resilient Infrastructure
- Transition-ready Infrastructure: electrification, connected, cooperative and autonomous mobility, digitalization, BIM e digital twins

DEMONSTRATION OF THE CONSISTENCY OF THE SYLLABUS WITH THE LEARNING OBJECTIVES OF THE COURSE

This syllabus covers a structured learning path for understanding the principles of Sustainability principles and practices to measuring sustainability in civil engineering, with a workshop to apply learning outcomes from the first part of the module. Furthermore, the second part of the course will focus on implementing sustainability in road pavements through a dedicated module lectures on “smart” solutions including the latest research findings, cutting-edge technologies and seminars from international experts

TEACHING METHODS AND PLANNED LEARNING ACTIVITIES

The teaching methods for this course include class-contact teaching through lectures and practice sessions, personal work, and project-based learning.

Classroom activities
- Lectures
- Hands-on training

Outside-class activities
- Preparation for lectures and self-study
- Assignments

Assessment methodology
- Continuous evaluation (20%): attendance, participation in class
- Assignments to be submitted during the semester (30%)
- Exam with open questions (50%)

Distribution of hours by activity type

DISTRIBUTION OF HOURS BY ACTIVITY TYPE (1 ECTS = 25 students hrs)			
ACTIVITY	WORK IN THE CLASSROOM	OUTSIDE CLASSROOM WORK	TOTAL
Lectures	35 hrs	90 hrs	125 hrs
Project-based learning	12 hrs	13 hrs	25 hrs
TOTAL	47 hrs	103 hrs	150 hrs

ASSESSMENT METHODS AND CRITERIA

- Continuous evaluation (20%): attendance, participation in class
- Assignments to be submitted during the semester (30%)
- Oral Exam (50%)

DEMONSTRATION OF THE CONSISTENCY OF THE TEACHING METHODOLOGIES WITH THE LEARNING OBJECTIVES OF THE CURRICULAR UNIT

The teaching approaches designed for this course integrate slide presentations, class materials, interactive discussions, and practical problem-solving tasks to accommodate diverse learning styles. Tracking attendance and active participation in class serves as a gauge for students' engagement, a crucial aspect in facilitating effective learning. Moreover, assignments serve as an assessment tool to gauge comprehension of the syllabus content, enabling adjustments to be made if necessary. Additionally, surveys administered to students throughout the semester will offer direct feedback on the efficacy of the teaching methodologies employed.

COURSE MATERIALS

Course notes and Reference books will be provided to the students along during the course

ADVICE AND TIPS TO PROCESS LEARNING CONTENT – BIBLIOGRAPHY TO CONSULT

- PAVEMENTLCM website: http://pavementlcm.eu with Prototypes and Guidelines
- Lo Presti, D., Buttitta, G., Jiménez del Barco Carrión, A., Azhar Butt, A., Mattinzoli, T., & Keijzer, E. (2021). PavementLCM D5.1- Pavement LCM Guidelines. (http://pavementlcm.eu)
- Jiménez del Barco Carrión, A., Buttitta, G., & Lo Presti, D. (2021). Life Cycle Management of Green Asphalt Mixtures and Road Pavements Deliverable D2.1a-Pavement LCM State-of-the-Art. (http://pavementlcm.eu)
- SUP&R ITN website: http://superitn.eu with deliverables and library of papers
- SMARTI ETN website: http://smartietn.eu with Prototypes and Guidelines
- Lo Presti D., Chailleux E., Rubio M.C. 2022. SMARTI: Sustainable Multi-functional Automated Resilient Transport Infrastructure, Special Issue in "Infrastructure", MDPI, https://www.mdpi.com/journal/infrastructures/special_issues/SMARTI
- Lo Presti et al. 2023, "Guidelines for the implementation of SMARTI" https://www.sciencedirect.com/science/article/pii/S2352146523011407

COURSE 13: SUSTAINABLE PAVEMENT AND EMBANKMENT/SUBGRADE MATERIALS (COIL)

Degree			Academic year
JOINT MASTER'S DEGREE IN SUSTAINABLE AND RESILIENT PAVEMENT ENGINEERING			2026/2027
			Semester
Course			2
Course 13	Sustainable Pavement and Embankment/subgrade Materials (COIL)		Group/Language English
Type	Language	ECTS Credits	
Compulsory	English	6	
Lecturer			
Davie Lo Presti Clara Celauro			

DESCRIPTION

This course aims to deepen the student's knowledge of pavement materials and their sustainability, along with the techniques for proper stabilization/treatment of fine soils for embankment and subgrade layers

PREREQUISITES

None

LEARNING OUTCOMES IN TERMS OF GENERIC AND SPECIFIC COMPETENCES

Generic Competences:
- Understand the current needs for increasing the sustainability of the construction practice in road infrastructures
- Evaluate the main properties of sustainable materials.

Specific Competences:
- Identify different pavement and embankment materials
- Identify low or warm-temperature asphalt production techniques to improve energy efficiency.
- Design new solutions for road paving based on sustainable principles.
- Select appropriate treatment/stabilization technique for maximizing the reuse of fine soils in earthmoving

CONTENTS

- Recycling and waste incorporation on road paving
- Low or warm-temperature asphalt production techniques
- Design and characterization of sustainable asphalt paving materials
- Selection and Operation of Construction Equipment for recycling technologies
- Soil Stabilization Techniques
- Selection and Operation of Construction Equipment for stabilized soil in embankment/subgrade layers

DEMONSTRATION OF THE CONSISTENCY OF THE SYLLABUS WITH THE LEARNING OBJECTIVES OF THE COURSE

The course aims to provide students with concepts, models, and tools to develop sustainable materials for pavement and embankment or road subgrade construction.
The syllabus presents these concepts, models, and tools theoretically and through practical implementation, using a project-based learning approach (carried out in collaborative online international learning – COIL with teachers and students from MINHO and MAHE). Thus, the learning objectives lead to a better understanding of the program, recycling and waste incorporation, low or warm-temperature asphalt production techniques, design and characterization of sustainable asphalt paving materials as well as of treated soils for subgrade and embankment construction.

TEACHING METHODS AND PLANNED LEARNING ACTIVITIES

The teaching methods for this course include class-contact teaching through lectures and practice sessions, personal work, and project-based learning.

Classroom activities
- Lectures
- Project Based Learning

Outside-class activities
- Preparation for lectures and self-study
- Project Based Learning

Distribution of hours by activity type

DISTRIBUTION OF HOURS BY ACTIVITY TYPE			
ACTIVITY	WORK IN THE CLASSROOM	OUTSIDE CLASSROOM WORK	TOTAL
Lectures	28	72	100
Practical sessions			
Project Based Learning	24	26	50
TOTAL	52	98	150

ASSESSMENT METHODS AND CRITERIA

- Continuous evaluation (10%): attendance, participation in class
- Assignments to be submitted during the semester (30%)
- Oral exams (60%)

Criteria:
The oral exam consists in questions that allow to ascertain the level of knowledge of the contents of the course and the grade, dependent on the student's replies to the questions during the exam, will be expressed in the Italian national grading scale, i.e. marks given in numbers over 30 (in thirtieths):
Below 18/30: Unsatisfactory (EXAM FAILED)
18/30, Sufficient
from 19/30 to 21/30, Satisfactory
from 22/30 to 24/30, Fair
from 25/30 to 27/30,Good
from 28/30 to 29/30, Very Good
30/30 and 30/30 with laude, Excellent
The Project will be evaluated by all lecturers from the three Universities involved in this COIL (Report (20%); Presentation (20%)).
The result of the oral exam will be averaged with that of the Project, according to previous weight.

DEMONSTRATION OF THE CONSISTENCY OF THE TEACHING METHODOLOGIES WITH THE LEARNING OBJECTIVES OF THE CURRICULAR UNIT

The type of classes implemented in this Curricular Unit will allow the transmission of theoretical concepts, which will then be evaluated individually through an oral exam and their practical application through group work in COIL.
By developing the assigned project, the students will demonstrate to what extent they have acquired the competencies mentioned in the learning objectives by developing project-based work with students from Minho and MAHE on topics related to the syllabi of the three collaborative courses linked to the main objective of developing sustainable pavement materials.
The project will be designed to allow the students to transfer the theory detailed in the frontal lectures into practice and will include a literature review and a practical application of at least one of the learning objectives of this course (ability to apply the principles of sustainable materials selection and design, ability to use sustainable techniques in road construction, an ability to participate in multi-disciplinary teams when dealing with road infrastructure projects, etc)

COURSE MATERIALS

Course notes will be provided to the students, along with additional references to delve into specific topics.

ADVICE AND TIPS TO PROCESS LEARNING CONTENT – BIBLIOGRAPHY TO CONSULT

The students should review the content provided in advance to prepare for the lectures. Likewise, students should review the class contents afterwards and list all questions for the following lecture. Students should also work with colleagues from other Universities in COIL as soon as possible to facilitate the group work in the project.
Suggested references:

- Mallick, Rajib B., and Tahar El-Korchi. Pavement engineering: principles and practice. CRC Press, 3rd Ed. 2017.
- PIARC (2022). Use of Recycled Materials in Pavements. A PIARC Case Studies Collection. World Road Association. ISBN 978-2-84060-678-9.
- CEREMA/SETRA (2000) Technical Guide - Treatment of soils with lime and/or hydraulic binders. Service d'études sur les transports, les routes et leurs aménagements. Sourdun - France
- BRRC (2021) Soil treatment with lime – European experiences for soil improvement and soil stabilization. State of the art. Belgian Road Research Centre, Bruxelles, Belgium.

COURSE 14: CIRCULAR LIFE-CYCLE BASED PAVEMENT MANAGEMENT

Degree			Academic year
JOINT MASTER'S DEGREE IN SUSTAINABLE AND RESILIENT PAVEMENT ENGINEERING			**2026/2027**
			Semester
Course			**2**
Course 14	**Circular Life-cycle based pavement management**		Group/Language
Type	Language	ECTS Credits	**English**
Compulsory	**English**	**6**	
Lecturer			
Gaetano Di Mino			

DESCRIPTION

In full consistency with the vision and objectives of the Joint Master (JM) in *Sustainable and Resilient Pavement Engineering,* ***The Circular Life-cycle based pavement management*** course aims to show how the implementation of the principles of the Circular Economy (CE) and the application of related models to road pavement management can contribute to the achievement of resilient and sustainable road infrastructure. The CE refers to a restorative industrial economy (Resilience), aims to rely on renewable energy (Renewable Sources), minimises tracks and eliminates the use of toxic chemicals (No Pollution), eradicates waste through careful design (End of Waste is resource). The CE concept is grounded in the study of non-linear systems, particularly living ones, by optimising systems rather than components (*Thinking In Systems*).

Our industrial economy, as well as the road industrial sector, has never moved beyond one fundamental characteristic established in the early days of industrialisation: a linear model of resource consumption that follows a 'take-make-dispose' pattern. Companies extract materials, apply energy and labour to manufacture a product, and sell it to an end consumer, who then discards it when it no longer serves its purpose. Recently, many companies have also begun to notice that this linear system increases their exposure to risks, most notably higher resource prices. The start of the new millennium marks the turning point when real prices of natural resources began to surge upwards. Prices and volatility are likely to remain high as populations grow and urbanise, resource extraction moves to harder each location, and the environmental costs of the depletion of natural capital increase. The search for an industrial model that can further decouple sales revenues from material input has increased interest in concepts associated with the CE. Though still a theoretical construct, the term Circular Economy denotes an industrial economy that is restorative by intention and design. In a CE framework, products are designed for ease of reuse, disassembly and refurbishment, or recycling, with the understanding that it is the reuse of vast amounts of material reclaimed from end-of-life products, rather than the extraction of resources, is the foundation of economic growth. Even the most conservative projections for global economic growth over the next decade suggest that demand for oil, coal, iron ore, and other natural resources will rise by at least a third, with about 90% of that increase coming from growth in emerging markets. The linear production model provokes waste in the production chain, End-of-Life waste, loss of residual energy and erosion of ecosystem services. Also, on a global scale, phenomena such as the globalized market, the demographic trends, the infrastructure needs, the climate change as well the political risk, make anti-economic and unsustainable the linear model of development.

The Course explores the opportunity to implement the CE models in several phases of the entire industrial process, from the acquisition of raw materials to the road pavement's End of Life, by emphasizing the circular path including the treatment of the End of Waste and its own recycling. Initially the Course focuses on a survey of **Micro-Economy Basics**, with the aim to provide students with the essential concepts and correct terminology in

the field of micro-economic theory. Afterwards, the **Circular Economy** subject will be dealt with highlighting principle, concepts, perspectives and models in order to find out a new potential approach to the road pavement management. Therefore, the Course deals with **Life-Cycle Process of the Road Pavement,** according to two patterns, linear (take-make-dispose) and circular (take-make-reuse), from the raw materials acquisition stage to the road pavement dismantling one. With the aim to measure the rate of circularity of the products such as asphalts and aggregates as well as the companies, the Course addresses issues related to the Circular Economic Model (CEM) within the section **CE Metrics**. In this section also innovative whole full-scale (national or regional) CE indicators are addressed. Finally, the **Life Cycle Cost Analysis (LCCA)**, well-known tool to search for the better investment among different alternatives, i.e. different road pavement, is treated by taking in account the economic performance of each alternative with different CE rate.
The approach to the study of the various topics is centred on case-histories as well research and professional experiences, along with cutting-edge methods to understand the new market needs as well as the novel regulations concerning the road pavement due to ecological transition.
The lectures cover the Overview of the contents, learning objectives, examination methods, and all the topics above mentioned.
The Course includes Project Exercise focused on the conduction of LCCA in order to finalise most of all information gathered along the course. This task should be carried out by students, even in groups or in pairs, by simulating a typical professional environment.

PREREQUISITES

For a proper comprehension of the Course's contents and learning objectives, students should possess a broad understanding of subjects of Bachelor's degree in civil engineering with specific reference to road design, geotechnics, building technology and appraisal and economics. Participants are also expected to have a basic knowledge of the JM's first semester subjects.

LEARNING OUTCOMES IN TERMS OF GENERIC AND SPECIFIC COMPETENCES

Generic Competences
- To develop critical thinking as well as awareness of the global environmental, economic and social issues
- To analyze technical aspects under a circular economic point of view
- To develop specific communication skills consisting in written and verbal treatment
- To express their autonomy of judgment

Specific Competences
- Interpret and manage, the specific phases of the engineering process concerning road pavement according to a circular economic model
- Keep up with the ecological transition and the principles of environmental, economic and social sustainability, as criteria for the design, construction and maintenance of a road pavement, regulated by the legislator as well as by the market.

CONTENTS

- Micro-Economy Basics
- Circular Economy (CE)
- Life-Cycle Process of the Road Pavement
- CE Metrics
- Life Cycle Cost Analysis (LCCA)

DEMONSTRATION OF THE CONSISTENCY OF THE SYLLABUS WITH THE LEARNING OBJECTIVES OF THE COURSE

The course proposes to address the management of the life cycle of a road pavement with a view to an effective application of the circular economy, highlighting all those conceptual and analytical tools that allow the student, future engineer, to implement, in different phases such as design, production, construction, maintenance and end-of-life, to achieve the JM objectives (….*multidisciplinary approach can be presented for example the use of sensor*

technology to estimate asset maintenance, digitalisation processes related to materials and processes ***to increase circularity,*** *quality and effectiveness of the infrastructure sector, selection and* ***recycling of materials*** *in order to secure health of workers, users and surrounding residents*
Through teaching methods and learning activities, the course provides practical knowledge that is fully consistent with the JM program. Furthermore, the Course clearly shows how road pavement is a strategic asset, to achieve complete economic, environmental and social sustainability of the road infrastructure as a whole.

TEACHING METHODS AND PLANNED LEARNING ACTIVITIES

Classroom activities
- Lectures on the topics described in *CONTENTS section (see above)*; including meeting with stakeholders, joint seminars
- Project-based learning workshops

Outside-class activities
- Self-study for the lectures
- Project assignment and technical visits (in collaboration with other courses)

Distribution of hours by activity type

DISTRIBUTION OF HOURS BY ACTIVITY TYPE (1 ECTS = 25 student hours)

ACTIVITY	WORK IN THE CLASSROOM	OUTSIDE CLASSROOM WORK	TOTAL
Lectures	35 hrs	90 hrs	125 hrs
Project-based learning	12 hrs	13 hrs	25 hrs
TOTAL	47 hrs	103 hrs	150 hrs

ASSESSMENT METHODS AND CRITERIA

- Continuous evaluation (20%): attendance, participation in class
- Assignments to be submitted during the semester (30%)
- Oral exams (50%)

The candidate must deliver a report on Project Exercise work within 10 days from the examination booked; such a work, being focused on LCCA of a set of road pavement within Sicilian motorway network. The paper will be evaluated on the basis of four key criteria: the accuracy, the completeness, the text organization, in terms of the linguistic explanation and form, the depth degree. The assessment of such processed contribute to the final evaluation, which will be made on the basis of an oral examination by a score up to 30, according to the grading conversion criteria adopted by Unipa.

Criteria:
The candidate must answer at least four questions that cover the entire syllabus; the pivotal criteria of the oral exam are: the knowledge and the mastery of subject contents; the enforcement capacity and the conceptual rigor; the expressive and explaining capacity, multidisciplinary connection and original reworking. The evaluation in terms of 30/thirty is based on the following criteria within the voting range:
18/21 overall sufficient knowledge, skills and expression;
22/24 overall fair knowledge, skills and expression;
25/27 overall good knowledge, skills and expression;
28/30 overall very good knowledge, skills and expression;
30 cum laude/excellent knowledge, skills and expression.

DEMONSTRATION OF THE CONSISTENCY OF THE TEACHING METHODOLOGIES WITH THE LEARNING OBJECTIVES OF THE CURRICULAR UNIT

The teaching methodology aims at being inclusive and proactive, by involving actively the students, already during the lessons, and by stimulating them to provide their personal contribution to the outcomes and conduct of the lessons themselves, through questions and short role plays. The course includes, in addition to a final seminar, at least a technical visit (in collaboration with other courses) aimed at verifying concepts, method and information

covered in the classroom, over a full-scale. During these activities, any questions and comments from students will be welcome, making the event interactive and more profitable for learning. Therefore, it is very likely that such a teaching methodology could be decisive in promoting "dynamic" learning of the topics, which is also necessary in economic topics covered. Furthermore, the cooperative nature that characterizes the exercise activities will induce beneficial effects in terms of peer tutoring and the development of critical skills and knowledge. In this context, the use of IT equipment, software and specific aids is foreseen to improve the overall learning experience. Finally, the percentage distribution of hours according to the three categories (lectures 55%; outside classroom work 24%; project exercise 21%) shows a substantial balance of the course to the benefit of students who will therefore be more stimulated to participate actively.

COURSE MATERIALS

- Lecture notes and materials will be provided during the teaching activities to students through the download section of the teacher's educational website. Based on advancements in scientific research, bibliographic updates will be also provided to students.

Suggested bibliography:

- John Sloman, Dean Garratt – Essential of Economics – Pearson - ISBN-13: 978 -1292082240
- Yang H. Huang - Pavement Analysis and Design – Pearson - ISBN-13: 978–0–13–272610 – 8
- F. Pacheco-Torgal, Serji Amirkhanian, Hao Wang, Erik Schlangen - Eco-efficient Pavement Construction Materials – Elsevier - ISBN: 978-0-12-818981–8
- Growth within: a circular economy vision for a competitive Europe – Ellen Mac Arthur Foundation

ADVICE AND TIPS TO PROCESS LEARNING CONTENT – BIBLIOGRAPHY TO CONSULT

Personal deepening is strongly recommended through consulting books and journals available in the library, as well as on websites recommended by the university library system with open access for students.

COURSE 15: SUSTAINABLE GEOMETRIC DESIGN PRACTICES

Degree			Academic year
JOINT MASTER'S DEGREE IN SUSTAINABLE AND RESILIENT PAVEMENT ENGINEERING			**2026/2027**
			Semester
Course			**2**
Course 15	**Sustainable geometric design practices**		Group/Language
Type	Language	ECTS Credits	**English**
Compulsory	**English**	**6**	
Lecturer			
Anna Granà **Maria Luisa Tumminello**			

DESCRIPTION

The *Sustainable Geometric Design Practices* course aligns with the learning objectives of the Joint Master (JM) in *Sustainable and Resilient Pavement Engineering* by integrating the core theme into diverse road contexts. It addresses current challenges related to innovative geometric design practices for road infrastructures, encompassing ecological, digital, and energy transition aspects crucial across all productive sectors.
The Course explores sustainable transportation principles, emphasizing the 'interplay' between sustainability and mobility. Students gain insights into fundamental principles of geometric design for roads and intersections, applicable in various settings. The focus is on developing sustainable design strategies for rural and built environments, aligning them with the overarching objectives of smart, green, and safe mobility strategy. The Course delves into the role of geometric design in shaping environmentally conscious and technologically advanced mobility practices, considering the road infrastructure as a whole. It considers road entities and their cross-sections in a holistic manner, fostering interdisciplinary perspectives for a comprehensive understanding of sustainable geometric design for roads and intersections.
Through case studies, classroom discussions, and the examination of road space organization in different environments, the Course also highlights the role and location of road pavement in the road cross-section. This is particularly relevant concerning various road users, such as pedestrians, cyclists, cars, trucks, whose diverse needs require attention during design and construction phases.
Also, through inclusive teaching methodologies, the Course promotes a comprehensive understanding of economic, environmental, and social sustainability principles. This extends to the evolving 'landscape' of cooperative, connected, and automated driving technologies, as well as technological applications in road design and pavement engineering.
The lectures include the Overview of the contents, learning objectives, examination methods, the Fundamentals of Sustainable Geometric Design, Highway Geometric Design Principles, Road Geometric Design Integration in Urban Planning, Innovative Intersection Design in a Sustainable Transition, case studies and project exercises on 'what-if' scenarios of potential futures, and conclusions with reference to research opportunities and industry perspectives.

Specifically, **Fundamentals of Sustainable Geometric Design** concerns core concepts of sustainability in various road environments, the role of geometric design in shaping sustainable mobility, as well as interdisciplinary perspectives in road engineering.
Highway Geometric Design Principles considering sustainability as guiding factor, forms a significant component, addressing sustainable practices within the regulatory framework at international level. The topic also navigates through the challenges and opportunities inherent in highway design, road network and transport systems, traffic trends and traffic counts, drawing on real-world case studies to learn lessons from sustainable highway geometric design practices.

Starting from contemporary trends in sustainable urban mobility, **Road Geometric Design Integration in Urban Planning** also consider low-carbon and zero-crash paradigms. The course advocates for the seamless blending of urban aesthetics with road design principles, incorporating elements of urban design such as traffic calming, shared spaces, nature-based and resilient-based solutions for people and digital community of road users. Pedestrian and cyclist-centric approaches, along with methods for assessing the effectiveness of engineering measures, contribute to a comprehensive understanding of 'successful' urban road projects.
In the context of **Innovative Intersection Design** in the ongoing transition, students will acquire knowledge and skills in novel design practices and tools (e.g. microscopic traffic simulation models), life-cycle costing decision-making methodologies, methods for assessing the safety of road infrastructures, and they will learn lessons derived from groundbreaking intersection designs. The course advances towards sustainable and intelligent road intersections and interchanges by incorporating cooperative, connected, and automated vehicle driving technologies and their effects on the physical road infrastructure. Concerning the technological applications in road design, the contents explore the integration of smart technologies, data-driven decision-making processes, aided-design and digital solutions for road and intersection projects. This topic equips students with a forward-looking perspective, aligning road design with the evolving scenarios and long-term strategic goals of smart mobility, zero crashes, zero congestion, and zero emissions in traffic.
The Course includes **Project Exercises**, even in groups or in pairs, that challenge students to explore potential futures through 'what-if' scenarios for road infrastructure and traffic. This practical component, combined with discussions on research opportunities and industry perspectives, ensures that students not only grasp theoretical concepts but also develop the skills and insights necessary for real-world applications in sustainable geometric design practices. These are challenges they will encounter both in the professional sphere and in the world of work. Short seminars with experts and meetings with stakeholders will complete the training activities, enhancing understanding of research opportunities and industry perspectives.
Also, inclusive teaching methodologies will be employed to integrate the wealth of experience previously acquired by students from different countries with new incoming knowledge, with a focus on cooperative learning for the mini-projects (in the group and/or pair work), tutoring and peer tutoring to connect two students with varying levels of skills, and (eventual) digital learning to be implemented through the use of computer equipment, software, and specific aids. For classroom case study examinations, reference can be made to discovery learning to construct a participatory study path, also starting from students' prior knowledge and skills, and to contextualize learning, encourage research, and discovery.

PREREQUISITES

To fully comprehend the course's contents and learning objectives, students should have a broad understanding of subjects related to the ongoing transformation affecting diverse environments. This includes rural areas, cities, and cities in transitions, such as smart, resilient, green, and circular cities, as well as territories at various scales. With road and intersection design addressing novel challenges in mobility, prerequisites for the course involve a basic understanding of economic, social, environmental, infrastructural, and design topics. Additionally, students should be aware of current scenarios leading to substantial transitions and cultural changes in both people and society.

LEARNING OUTCOMES IN TERMS OF GENERIC AND SPECIFIC COMPETENCES

- Solve problems by integrating sustainable principles into road design processes and effective communication.
- Demonstrate adaptability, ethical responsibility and contribute to the creation of environmentally conscious and socially responsible urban solutions.
- Master sustainable geometric design practices
- Analyse environmental impacts,
- Apply ecological design principles
- Design environmentally friendly urban and infrastructure solutions,
- Demonstrate expertise in sustainable materials, energy efficiency strategies and holistic design.
- Be proficient in interdisciplinary collaboration, contributing to the creation of resilient and environmentally friendly environments.

CONTENTS

- Fundamentals of Sustainable Geometric Design: core concepts, role of geometric design in shaping sustainable mobility; interdisciplinary perspectives in road engineering.
- Highway Geometric Design Principles: the international regulatory framework; traffic trends and counts; sustainable practices, challenges and opportunities in highway design
- Road Geometric Design Integration in Urban Planning: trends in sustainable urban mobility; Urban Design and Traffic Calming; pedestrian and cyclist-centric approaches.
- Innovative Intersection Design in a Sustainable Transition: life-cycle costing decision-making methodologies; Sustainable Intersection Design - Incorporating Cooperative, Connected, and Automated Vehicle Driving Technologies, Aided-design and Digital Solutions for intersection projects.
- What-if scenarios envisioning potential futures through Mini-projects.
- Conclusions: research opportunities and industry perspectives.

DEMONSTRATION OF THE CONSISTENCY OF THE SYLLABUS WITH THE LEARNING OBJECTIVES OF THE COURSE

The course contextualizes the core theme of the JM within diverse scenarios, examining the intersection of Sustainability and Mobility through the lens of road geometric design. The Syllabus articulates the synchronization of road and intersection geometric design with the goals of smart, safe, and green mobility. It guides students in understanding essential elements of road geometric design and pavement engineering, with sustainability as the guiding principle. The teaching methods aim to impart practical knowledge, expanding the professional dimension of the JM. By emphasizing the role and location of road pavement in the road cross-section, the course addresses aspects related to the mobility needs of road users. This alignment ensures that students acquire fundamental knowledge and skills, preparing them for the dynamic and professional landscape of sustainable and resilient pavement engineering and the complexities they may encounter in their future roles in the working world.

TEACHING METHODS AND PLANNED LEARNING ACTIVITIES

Classroom activities

- Lectures on the topics described in *CONTENTS section (see above), mini-projects with possible organization:* Mini-project 1: Designing an urban street and functional arrangement of spaces; Mini-project 2: Architectural planning for an urban intersection situated along the road from mini-project 1; Meeting with stakeholders, and joint seminars
- Project-based learning workshops in class

Outside-class activities

- Self-study related to lectures
- Project assignment, including field visit.

Distribution of hours by activity type

DISTRIBUTION OF HOURS BY ACTIVITY TYPE (1 ECTS = 25 student's hours)			
ACTIVITY	WORK IN THE CLASSROOM	OUTSIDE CLASSROOM WORK	TOTAL
Lectures	35 hrs	90 hrs	125 hrs
Project-based learning	12 hrs	13 hrs	25 hrs
TOTAL	47 hrs	103 hrs	150 hrs

ASSESSMENT METHODS AND CRITERIA

- Continuous evaluation (20%): attendance, participation in class
- Assignments to be submitted during the semester (30%)
- Oral exams (50%)

Criteria:
The student must answer at least four oral questions on all topics of the program, also with reference to the recommended texts, and (eventual) presentation of one or two case studies discussed during the course. The final evaluation for each student (each questioned) aims at appraising whether he/she possesses a good knowledge and understanding of the topics and whether he/she has acquired interpretative expertise and autonomous assessments with reference to the project exercises (see "Contents"), assigned during the Course and also developed in group.
The pass mark will be reached if the student will demonstrate knowledge and understanding of the topics specified in the program (and explained during the teaching activities), and the student will have minimal application skills to solve the mini-projects assigned during the course and discussed during the exam. The student must be able to present to the examiner and to discuss the issues related to the geometric design of urban streets and highways, and intersections in a sustainable transition. Below this threshold, the student will not be able to pass the examination.
On the contrary, the more the student will be able to interact with the examiner and discuss the topics, and the more he/she will prove to have acquired in-depth knowledge and practical skills on the topics of the course, the higher the evaluation grade will rise towards the top marks.
The grading conversion criteria adopted by Unipa will be applied to students from other Universities adhering to the Joint Master.

The range of evaluation grade is comprised between 18 and 30 cum laude, according to the following criteria:
Excellent (30 – 30 e lode): Excellent knowledge of the subjects studied in the course, good analytical and interpretative capacity; the student is fully able to apply the knowledge and methods.
Very good (26-29): Good mastery of the subjects studied in the course; the student is able to apply the knowledge and methods learnt for road geometric design.
Good (24-25): Knowledge of the main subjects studied in the course; the student shows a limited ability to apply knowledge and methods learnt for road geometric design.
Average (21-23): Basic knowledge of some subjects studied in the course, adequate language skills; poor ability to autonomously apply knowledge and methods learnt for road geometric design.
Pass (18-20): Minimal knowledge of some geographic subjects and the technical language; very poor ability to autonomously apply knowledge and methods learnt for road geometric design.
Fail: The student does not have an acceptable knowledge of the subjects studied during the teaching activities

DEMONSTRATION OF THE CONSISTENCY OF THE TEACHING METHODOLOGIES WITH THE LEARNING OBJECTIVES OF THE CURRICULAR UNIT

The alignment of teaching methodologies with the learning objectives of the curricular unit is guaranteed by fostering an inclusive and enriching educational environment.
The course incorporates Project Exercises, conducted individually, in groups, or in pairs, challenging students to explore potential futures through 'what-if' scenarios for road infrastructure and traffic. This practical component, coupled with discussions on research opportunities and industry perspectives, ensures that students not only grasp theoretical concepts but also develop the skills and insights required for real-world applications in sustainable geometric design practices. These challenges mirror those encountered in both the professional sphere and the world of work. The training activities will be complemented by short seminars with experts and meetings with stakeholders, enriching understanding of research opportunities and industry perspectives.
In this context, inclusive teaching methodologies will play a key role in integrating the wealth of experience previously acquired by students from different countries with new incoming knowledge. The active engagement of students during lectures, facilitated by questions posed by the lecturer, will enhance the understanding of issues and the recognition of specific problems in the real world, facilitating the approach to case studies.
Classroom case study examinations will draw inspiration from discovery learning, constructing participatory study paths that consider students' prior knowledge and skills. This approach aims to contextualize learning, foster research, and encourage a spirit of discovery, ensuring the alignment of teaching strategies with the overarching objectives of the JM. The emphasis will be on cooperative learning within group or pair work for mini-projects, facilitating peer tutoring, and employing tutoring methods to bridge skill-level gaps, if present, among the students. Furthermore, the integration of digital learning, utilizing computer equipment, software, and specific aids, could be explored to enhance the overall learning experience.

COURSE MATERIALS

- Lecture notes and materials will be provided during the teaching activities to students through the download section of the teacher's educational website. Based on advancements in scientific research, bibliographic updates will be also provided to students.

Suggested bibliography
- Global Street Design Guide. Global Design Cities Initiatives (2016) NACTO. ISBN: 9781610917018 (hardback).
- A Policy on Geometric Design of Highways and Streets (2018) 7th Edition. American Association of State Highway and Transportation Officials.

ADVICE AND TIPS TO PROCESS LEARNING CONTENT – BIBLIOGRAPHY TO CONSULT

Personal deepening is recommended through consulting books and journals available in the library, as well as on websites recommended by the university library system with open access for students.
Suggested bibliography to consult:
- Wolhuter, Keith M. "Geometric Design of Roads Handbook" (Boca Raton: CRC Press, 29 apr 2015).
- Urban Street Design Guide, National Association of City Transportation Officials (2013). ISBN: 9781610914949 (hardback)

COURSE 16: SMART SOLUTIONS FOR TRANSPORT INFRASTRUCTURE

Degree			Academic year
JOINT MASTER'S DEGREE IN SUSTAINABLE AND RESILIENT PAVEMENT ENGINEERING			**2026/2027**
			Semester
Course			**2**
Course 16	**Smart solutions for transport Infrastructure**		Group/Language
Type	Language	ECTS Credits	**English**
Compulsory	**English**	**6**	
Lecturer			
Davide Lo Presti **Gabriella Buttitta** **and guest lecturers**			

DESCRIPTION

This course focuses on providing technical background and hands-on experience on the principles and practices of implementing "SMARt solutions for more sustainable Transport Infrastructure" (SMARTI) with a focus on pavement engineering. Students will attend classes from international experts, will be involved in site visits and in a team project-based learning context to explore innovative approaches to infrastructure design, maintenance with a focus on implementing cutting-edge innovations and implementation programmes in Europe towards conceiving roads, airports and railways able to cope with global challenges such as decarbonisation, longevity, and adaptability to changing conditions.

PREREQUISITES

Students should have already acquired basic knowledge and skills in road design and transport engineering.

LEARNING OUTCOMES IN TERMS OF GENERIC AND SPECIFIC COMPETENCES

Generic Competences
- Collaborate effectively in a team-based project environment
- Understanding the importance of a multi-disciplinary approach
- Produce effective presentations of project results with teamwork experience

Specific Competences:
- Understand the vision and principles of SMARTI: Smart solutions for Sustainable Transport Infrastructure
- Get to know latest programmes and technologies related to the implementation of Smart Roads
- Analyze the necessary requirements for the planning, designing and management of airports;
- Examine the aspects inherent to railway infrastructures
- Attend guest lectures from international experts from road, airport and railway sector
- Experience smartening of roads, railways and airports with site visits

CONTENTS

- SMART ROADS - General information, history and future, European programmes and existing implementation
- AIRPORTS and pavements - General information, history and future, sustainable airports: smart solutions for Planning, Design and Management
- RAILWAYS and pavements - General information, history and future, sustainable railways: smart solutions for Planning, Design and Management
- SEMINARS (guest lectures)
- WORKSHOPS –Laboratory group projects on implementing smart solutions into the Planning/Design and/or Management phase for more sustainable roads/ airport-railways infrastructure network and components
- TECHNICAL VISITS - Students will also be involved in exclusive site visits to experience the issues linked with planning, designing, building and maintaining transport infrastructure through the implementation of smart solutions

DEMONSTRATION OF THE CONSISTENCY OF THE SYLLABUS WITH THE LEARNING OBJECTIVES OF THE COURSE

This syllabus covers a structured learning path for understanding the vision and principles of SMARTI: Smart solutions for sustainable Transport Infrastructure, get to know latest research findings and cutting-edge technologies and experiences on using smart solutions for more sustainable roads, railways and airports with site visits and seminars from international experts

TEACHING METHODS AND PLANNED LEARNING ACTIVITIES

The teaching methods for this course include class-contact teaching through lectures and practice sessions, personal work, and project-based learning.

Classroom activities
- Lectures
- Hands-on training

Outside-class activities
- Preparation for lectures and self-study
- Assignments

Assessment methodology
- Continuous evaluation (20%): attendance, participation in class
- Assignments to be submitted during the semester (30%)
- Exam with open questions (50%)

Distribution of hours by activity type

DISTRIBUTION OF HOURS BY ACTIVITY TYPE			
ACTIVITY	WORK IN THE CLASSROOM	OUTSIDE CLASSROOM WORK	TOTAL
Lectures and Site visits	35 hrs	90 hrs	125 hrs
Project-based learning	12 hrs	13 hrs	25 hrs
TOTAL	47 hrs	103 hrs	150 hrs

**site visits is intended as a lecture*

ASSESSMENT METHODS AND CRITERIA

- Continuous evaluation (20%): attendance, participation in class
- Assignments to be submitted during the semester (30%)
- Oral Exam (50%)

DEMONSTRATION OF THE CONSISTENCY OF THE TEACHING METHODOLOGIES WITH THE LEARNING OBJECTIVES OF THE CURRICULAR UNIT

The teaching approaches designed for this course integrate slide presentations, class materials, interactive discussions, and practical problem-solving tasks to accommodate diverse learning styles. Tracking attendance and active participation in class serves as a gauge for students' engagement, a crucial aspect in facilitating effective learning. Moreover, assignments serve as an assessment tool to gauge comprehension of the syllabus content, enabling adjustments to be made if necessary. Additionally, surveys administered to students throughout the semester will offer direct feedback on the efficacy of the teaching methodologies employed.

COURSE MATERIALS

Course notes will be provided to the students along with additional references to delve into specific topics.

- Lecturers notes for Smart Roads and SMARTI
- Horonjeff, R., McKelvet, F., 2010. Planning and design of airports, MacGraw- Hill, 5th Edition.
- Guerreri, M., 2023 Fundamentals Of Railway Design – Springer

ADVICE AND TIPS TO PROCESS LEARNING CONTENT – BIBLIOGRAPHY TO CONSULT

- EU Green Deal: https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en
- FOREVEROPENROAD https://www.foreveropenroad.eu/
- What is a SMART airport? - https://www.faa.gov/sites/faa.gov/files/2022-02/5MarkFlaniganNATS_FAA_Final.pdf
- UN ESCAPE - Smart Railway Solutions to Support Railways Challenges: https://www.unescap.org/sites/default/files/Smart%20railway%20solutions%20to%20support%20railways.pdf

COURSE 17: ADVANCED SUSTAINABLE PAVEMENT MATERIALS AND TECHNOLOGIES

Degree			Academic year
JOINT MASTER'S DEGREE IN SUSTAINABLE AND RESILIENT PAVEMENT ENGINEERING			**2026/2027**
			Semester
Course			**2**
Course 17	**Advanced Sustainable Pavement Materials and Technologies**		Group/Language
			English
Type	Language	ECTS Credits	
Compulsory	**English**	**6**	
Lecturer			
Girish Murgod Gururaj			

DESCRIPTION

This course aims to provide an in-depth understanding of sustainable pavement materials and their application in the design and construction of climate-resilient roads. The course will cover the latest advancements and techniques in sustainable pavement materials, including materials characterization, testing, and evaluation. Students will also learn about the importance of sustainability and environmental impact in pavement material selection and design.

PREREQUISITES

None

LEARNING OUTCOMES IN TERMS OF GENERIC AND SPECIFIC COMPETENCES

- Discuss the latest advancements in sustainable pavement materials research and development
- Explore the environmental impact of pavement materials and the importance of sustainability in material selection and design

Specific Competences:

- Understanding advanced materials used in pavement construction, such as recycled materials, reclaimed asphalt pavement (RAP), reclaimed concrete aggregate (RCA), and innovative sustainable alternatives
- Evaluate the environmental impact of pavement materials and technologies
- Predict the durability and performance of sustainable pavements through advanced testing methods, modeling techniques, and simulation tools
- Integrating sustainability principles into pavement engineering practices, considering factors like longevity, resilience, environmental impact, and cost-effectiveness over the life cycle
- Contribute to research and development in the field of sustainable pavement materials and technologies

CONTENTS

- Introduction to Sustainable Pavement Materials
- Traditional vs. Sustainable Pavement Materials
- Material Properties and Characteristics
- Sustainable Pavement Design Principles
- Recycled and Reclaimed Materials
- Green Binders and Additives
- Advanced Technologies for Sustainable Pavements
- Maintenance and Rehabilitation of Sustainable Pavements
- Future Trends and Research Directions

DEMONSTRATION OF THE CONSISTENCY OF THE SYLLABUS WITH THE LEARNING OBJECTIVES OF THE COURSE

Each syllabus component aligns directly with the specific learning objectives, ensuring that the course content and structure are coherent and targeted toward achieving the desired competencies in understanding, applying, and advancing the field of sustainable pavement materials and technologies.

TEACHING METHODS AND PLANNED LEARNING ACTIVITIES

The teaching methods for this course include class-contact teaching through lectures, personal work, and project-based learning.

Classroom activities
- Lectures
- Quizzes

Outside-class activities
- Preparation for lectures and self-study
- Assignments

Distribution of hours by activity type

DISTRIBUTION OF HOURS BY ACTIVITY TYPE			
ACTIVITY	WORK IN THE CLASSROOM	OUTSIDE CLASSROOM WORK	TOTAL
Lectures	45	-	45
Assignments	-	24	24
TOTAL	45	24	69

ASSESSMENT METHODS AND CRITERIA

- Continuous evaluation (20%): attendance, participation in class
- Assignments to be submitted during the semester (30%)
- Exam with open questions (50%)

DEMONSTRATION OF THE CONSISTENCY OF THE TEACHING METHODOLOGIES WITH THE LEARNING OBJECTIVES OF THE CURRICULAR UNIT

The teaching approaches designed for this course integrate slide presentations, class materials, interactive discussions, and practical problem-solving tasks to accommodate diverse learning styles. Tracking attendance and active participation in class serves as a gauge for students' engagement, a crucial aspect in facilitating effective learning. Moreover, assignments serve as an assessment tool to gauge comprehension of the syllabus content, enabling adjustments to be made if necessary. Additionally, surveys administered to students throughout the semester will offer direct feedback on the efficacy of the teaching methodologies employed.

COURSE MATERIALS

Course notes will be provided to the students along with additional references to delve into specific topics.

ADVICE AND TIPS TO PROCESS LEARNING CONTENT – BIBLIOGRAPHY TO CONSULT

- Gardoni, P. (Ed.). (2018). Routledge Handbook of Sustainable and Resilient Infrastructure (1st ed.).
- Eco-efficient Pavement Construction Materials. (2020). United Kingdom: Elsevier Science.
- Gopalakrishnan, K. (2011). Sustainable Highways, Pavements and Materials: An Introduction. United States: CreateSpace Independent Publishing Platform.
- FHWA (Federal Highway Administration). (2017). "Sustainable Pavements." U.S. Department of Transportation.
- TRB (Transportation Research Board). (2018). "Guide for Integrating Sustainability into Traditional Transportation Models and Practices." National Cooperative Highway Research Program (NCHRP) Report 855.

COURSE 18: SOIL STABILIZATION TECHNIQUES FOR RESILIENT ROADS

Degree			Academic year
JOINT MASTER'S DEGREE IN SUSTAINABLE AND RESILIENT PAVEMENT ENGINEERING			**2026/2027**
Course			Semester
Course 18	**Soil stabilization techniques for resilient roads**		**2**
Type	Language	ECTS Credits	Group/Language
Compulsory	**English**	**6**	**English**
Lecturer			
Radhika Bhandari			

DESCRIPTION

This course provides a comprehensive understanding of soil stabilization methods for designing and constructing resilient roads. It covers various techniques, materials, and procedures essential for enhancing the strength, durability, and sustainability of road infrastructure. Students will delve into the principles behind soil stabilization, explore different stabilizers, and analyze case studies to grasp practical applications.

PREREQUISITES

None

LEARNING OUTCOMES IN TERMS OF GENERIC AND SPECIFIC COMPETENCES

Generic Competences:
- Comprehend the fundamental principles of soil stabilization.
- Evaluate different soil stabilization techniques and their suitability for road construction.
- Apply theoretical knowledge to solve practical problems related to road resilience.
- Communicate effectively about soil stabilization methods and their impacts on road infrastructure.

Specific Competences:
- Identify the key properties of soils relevant to stabilization techniques.- Evaluate the suitability of various stabilization techniques based on soil types and road requirements.
- Solve practical problems related to soil stabilization for road construction.
- Justify the selection of specific stabilization techniques considering technical, economic, and environmental factors.

CONTENTS

- Introduction to ground improvement techniques
- Shallow compaction techniques
- Deep compaction techniques
- Preloading and vertical drains for accelerating consolidation process
- Subgrade modification using admixtures.
- Use of geosynthetics in pavements
- Design of unpaved roads
- Soil reinforcement application for excavation and embankments
- Thermal treatments for soil in road construction

DEMONSTRATION OF THE CONSISTENCY OF THE SYLLABUS WITH THE LEARNING OBJECTIVES OF THE COURSE

Through the contents described in the syllabus, the students will receive comprehensive instruction and practical experience relevant to soil stabilization techniques for resilient road construction, fostering their growth in knowledge, skills, and application within this field of study.

TEACHING METHODS AND PLANNED LEARNING ACTIVITIES

The teaching methods for this course include class-contact teaching through lectures, personal work, and project-based learning.

Classroom activities
- Lectures
- Quizzes

Outside-class activities
- Preparation for lectures and self-study
- Assignments

Distribution of hours by activity type

DISTRIBUTION OF HOURS BY ACTIVITY TYPE			
ACTIVITY	WORK IN THE CLASSROOM	OUTSIDE CLASSROOM WORK	TOTAL
Lectures	45	-	45
Assignments	-	24	24
TOTAL	45	24	69

ASSESSMENT METHODS AND CRITERIA

- Continuous evaluation (20%): attendance, participation in class
- Assignments to be submitted during the semester (30%)
- Exam with open questions (50%)

DEMONSTRATION OF THE CONSISTENCY OF THE TEACHING METHODOLOGIES WITH THE LEARNING OBJECTIVES OF THE CURRICULAR UNIT

The teaching approaches designed for this course integrate slide presentations, class materials, interactive discussions, and practical problem-solving tasks to accommodate diverse learning styles. Tracking attendance and active participation in class serves as a gauge for students' engagement, a crucial aspect in facilitating effective learning. Moreover, assignments serve as an assessment tool to gauge comprehension of the syllabus content, enabling adjustments to be made if necessary. Additionally, surveys administered to students throughout the semester will offer direct feedback on the efficacy of the teaching methodologies employed.

COURSE MATERIALS

Course notes will be provided to the students along with additional references to delve into specific topics.

ADVICE AND TIPS TO PROCESS LEARNING CONTENT – BIBLIOGRAPHY TO CONSULT

- Koerner R.M., “Construction and Geotechnical methods in Foundation Engineering” McGraw Hill
- M.R. Hausmann, “Engineering Principles of Ground Modifications”, McGraw Hill Publishing Co.
- Alam Singh, “International Overviews Current Practices in Geotechnical Engineering”, IBT Publishers and Distributors, New Delhi.

- Fang H.Y., “Foundation Engineering Hand book”, 2nd edition, CBS publishers and Distributors, New Delhi.
- Purushotham Raj, “Ground Improvement Techniques”, Laxmi Publications, New Delhi.
- Bikash Chandra Chattopadhyay and Joyanta Maity, “Ground Improvement Techniques”, PHI learning Pvt.Ltd., New Delhi.
- Sanjay Kumar Shukla, “Introduction to Geosynthetic Engineering”, CRC Press, London.
- Das.B.M., “Principles of Foundation Engineering” Thomson Books
- Jones J.E.P., “Earth Reinforcement and Soil Structure”, Butterworths.

COURSE 19: SPATIAL TECHNOLOGIES FOR SMART ROADS

Degree			Academic year
JOINT MASTER'S DEGREE IN SUSTAINABLE AND RESILIENT PAVEMENT ENGINEERING			**2026/2027**
			Semester
Course			**2**
Course 19	**Spatial Technologies for Smart Roads**		Group/Language
Type	Language	ECTS Credits	**English**
Compulsory	**English**	**6**	
Lecturer			
Praveen Kumar			

DESCRIPTION

This course provides an in-depth understanding of spatial technologies and their applications in road network planning, design, construction, and management. Students will learn about Geographic Information System (GIS), Remote Sensing (RS), Global Positioning System (GPS), and their integration for data collection, analysis, visualization, and decision-making in road network projects.

PREREQUISITES

None

LEARNING OUTCOMES IN TERMS OF GENERIC AND SPECIFIC COMPETENCES

Generic Competences:
- Understand the principles and concepts of spatial technologies and their applications in road network projects.
- Develop skills in data collection, analysis, visualization, and decision-making using GIS, RS, GPS, and their integration.
- Apply spatial technologies to real-world road network projects and solve problems.

Specific Competences:
- Ability employ various methods and technologies for collecting spatial data related to road networks, such as GPS, LiDAR, remote sensing, and surveying techniques.
- Proficiency in utilizing Geographic Information Systems (GIS) software and tools to analyse and interpret spatial data pertaining to road networks.
- Proficiency in applying spatial technologies to solve real-world problems such as congestion management, safety improvement, and environmental impact assessment.
- Application of spatial technologies in managing and maintaining transportation infrastructure, including asset management, and monitoring.

CONTENTS

- Introduction to the course, spatial technologies, and smart roads.
- GIS Fundamentals for Road Design.
- Remote Sensing in Road Geometric Design.
- GPS and Surveying Techniques.
- Spatial Data Analysis for Road Optimization.
- Design Principles of Smart Roads.
- Sensors and IoT in Smart Roads.
- Smart Road Safety.
- Sustainability and LCA of Smart Road.
- Future Trends in Smart Road Technology.

DEMONSTRATION OF THE CONSISTENCY OF THE SYLLABUS WITH THE LEARNING OBJECTIVES OF THE COURSE

By aligning each syllabus component with specific learning objectives, this course ensures consistency in delivering the necessary knowledge and skills required to meet the stated objectives for mastering Spatial Technologies for Road Networks.

TEACHING METHODS AND PLANNED LEARNING ACTIVITIES

The teaching methods for this course include class-contact teaching through lectures, personal work, and project-based learning.

Classroom activities
- Lectures
- Quizzes

Outside-class activities
- Preparation for lectures and self-study
- Assignments

Distribution of hours by activity type

DISTRIBUTION OF HOURS BY ACTIVITY TYPE			
ACTIVITY	WORK IN THE CLASSROOM	OUTSIDE CLASSROOM WORK	TOTAL
Lectures	45	-	45
Assignments	-	24	24
TOTAL	45	24	69

ASSESSMENT METHODS AND CRITERIA

- Continuous evaluation (20%): attendance, participation in class
- Assignments to be submitted during the semester (30%)
- Exam with open questions (50%)

DEMONSTRATION OF THE CONSISTENCY OF THE TEACHING METHODOLOGIES WITH THE LEARNING OBJECTIVES OF THE CURRICULAR UNIT

The teaching approaches designed for this course integrate slide presentations, class materials, interactive discussions, and practical problem-solving tasks to accommodate diverse learning styles. Tracking attendance and active participation in class serves as a gauge for students' engagement, a crucial aspect in facilitating effective learning. Moreover, assignments serve as an assessment tool to gauge comprehension of the syllabus content, enabling adjustments to be made if necessary. Additionally, surveys administered to students throughout the semester will offer direct feedback on the efficacy of the teaching methodologies employed.

COURSE MATERIALS

Course notes will be provided to the students along with additional references to delve into specific topics.

ADVICE AND TIPS TO PROCESS LEARNING CONTENT – BIBLIOGRAPHY TO CONSULT

- Longley, P. A., Goodchild, M., Maguire, D. J., & Rhind, D. W. (2010). Geographic Information Systems and Science. John Wiley & Sons.
- Bolstad, P. (2005). GIS Fundamentals. XanEdu Publishing Inc
- Lillesand, T., Kiefer, R. W., & Chipman, J. (2015). Remote Sensing and Image Interpretation. John Wiley & Sons.
- Ghosh, S., & Lee, T. S. (2010). Intelligent Transportation Systems. CRC Press.
- Tomar, P., & Kaur, G. (2019). Green and Smart Technologies for Smart Cities. CRC Press.

COURSE 20: ECONOMICS OF ECO-FRIENDLY ROAD INFRASTRUCTURE

Degree			Academic year
JOINT MASTER'S DEGREE IN SUSTAINABLE AND RESILIENT PAVEMENT ENGINEERING			**2026/2027**
			Semester
Course			**2**
Course 20	**Economics of Eco-friendly Road Infrastructure**		Group/Language
Type	Language	ECTS Credits	**English**
Compulsory	**English**	**6**	
Lecturer			
Teena Thomas			

DESCRIPTION

This course provides an in-depth understanding of the environmental and socioeconomic impacts of roads, including their effects on air and water quality, wildlife, and communities. Students will learn about best practices for minimizing the negative impacts of road development and improving sustainability.

PREREQUISITES

None

LEARNING OUTCOMES IN TERMS OF GENERIC AND SPECIFIC COMPETENCES

- Understand the environmental and socioeconomic impacts of road development (RD).
- Identify the best practices for minimizing negative impacts of RD.
- Develop strategies to improve the sustainability of RD.
- Understand fundamental economic principles, theories relevant to RD, and economic evaluation methods.
- Understand the concept of eco-friendly road infrastructure, including its environmental impact, sustainability factors, and integration of green technologies.
- Conduct economic assessments for road infrastructure projects, considering factors like construction costs, life-cycle analysis, and economic viability.
- Understand financial mechanisms, funding sources, and innovative models for financing eco-friendly road infrastructure projects.
- Analyse the socio-economic impacts of eco-friendly road infrastructure.

CONTENTS

- Introduction to Economics of Road Infrastructure
- Economic Theory and Sustainable Development
- Cost-Benefit Analysis in Transportation Projects
- Economic Evaluation Methods
- Environmental and Social Cost Assessment
- Project Appraisal and Decision-making
- Economic Policy Instruments for Sustainable Transport

DEMONSTRATION OF THE CONSISTENCY OF THE SYLLABUS WITH THE LEARNING OBJECTIVES OF THE COURSE

Each syllabus component aligns with specific learning objectives, ensuring a consistent approach to delivering the necessary knowledge and skills required to meet the objectives of studying economic aspects in the context of eco-friendly road infrastructure on a global scale.

TEACHING METHODS AND PLANNED LEARNING ACTIVITIES

The teaching methods for this course include class-contact teaching through lectures, personal work, and project-based learning.

Classroom activities
- Lectures
- Quizzes

Outside-class activities
- Preparation for lectures and self-study
- Assignments

Distribution of hours by activity type

DISTRIBUTION OF HOURS BY ACTIVITY TYPE			
ACTIVITY	WORK IN THE CLASSROOM	OUTSIDE CLASSROOM WORK	TOTAL
Lectures	45	-	45
Assignments	-	24	24
TOTAL	45	24	69

ASSESSMENT METHODS AND CRITERIA

- Continuous evaluation (20%): attendance, participation in class
- Assignments to be submitted during the semester (30%)
- Exam with open questions (50%)

DEMONSTRATION OF THE CONSISTENCY OF THE TEACHING METHODOLOGIES WITH THE LEARNING OBJECTIVES OF THE CURRICULAR UNIT

The teaching approaches designed for this course integrate slide presentations, class materials, interactive discussions, and practical problem-solving tasks to accommodate diverse learning styles. Tracking attendance and active participation in class serves as a gauge for students' engagement, a crucial aspect in facilitating effective learning. Moreover, assignments serve as an assessment tool to gauge comprehension of the syllabus content, enabling adjustments to be made if necessary. Additionally, surveys administered to students throughout the semester will offer direct feedback on the efficacy of the teaching methodologies employed.

COURSE MATERIALS

Course notes will be provided to the students along with additional references to delve into specific topics.

ADVICE AND TIPS TO PROCESS LEARNING CONTENT – BIBLIOGRAPHY TO CONSULT

- Daly, H. E. (2014). Beyond growth: the economics of sustainable development. Beacon Press.
- Field, B. C., & Field, M. K. (2017). Environmental economics: an introduction. McGraw-Hill.
- Hussen, A. (2012). Principles of environmental economics and sustainability: an integrated economic and ecological approach. Routledge.
- Grigg, N. S. (2010). Infrastructure finance: the business of infrastructure for a sustainable future (Vol. 536). John Wiley & Sons.
- Baietti, A., Shlyakhtenko, A., La Rocca, R., & Patel, U. D. (2012). Green infrastructure finance: leading initiatives and research. World Bank Publications.

COURSE 21: COMPUTER-AIDED ROAD DESIGN

Degree			Academic year
JOINT MASTER'S DEGREE IN SUSTAINABLE AND RESILIENT PAVEMENT ENGINEERING			**2026/2027**
			Semester
Course			**2**
Course 21	**Computer-Aided Road Design**		Group/Language
Type	Language	ECTS Credits	**English**
Compulsory	**English**	**6**	
Lecturer			
Girish Murgod Gururaj, Praveen Kumar **Teena Thomas**			

DESCRIPTION

The course aims to provide comprehensive training in utilizing InRoads software for civil engineering design and modeling of transportation infrastructure, focusing primarily on roadway design. Participants will gain hands-on experience in creating alignments, profiles, corridors, surfaces, and generating detailed drawings for roadway projects using InRoads.

PREREQUISITES

None

LEARNING OUTCOMES IN TERMS OF GENERIC AND SPECIFIC COMPETENCES

Generic Competences:
- Understanding InRoads Interface and Basic Tools.
- Carry out horizontal and vertical profiling of highway.
- Carry out drainage and cross drainage design.

Specific Competences:
- Create horizontal alignments, editing alignments, and applying design criteria.
- Develop vertical profiles, incorporating superelevation, and managing profile views.
- Build roadway cross-sections, defining assemblies, and creating corridor models.
- Conducting quantity takeoffs, producing reports, and understanding project documentation.

CONTENTS

- Understanding InRoads Interface and Basic Tools
- Alignment Design
- Profile Design Environmental and Social Cost Assessment
- Cross-Section and Corridor Modeling
- Surface Creation and Analysis

DEMONSTRATION OF THE CONSISTENCY OF THE SYLLABUS WITH THE LEARNING OBJECTIVES OF THE COURSE

This syllabus covers a structured learning path for mastering InRoads software, focusing on comprehensive training in roadway design and transportation infrastructure modeling.

TEACHING METHODS AND PLANNED LEARNING ACTIVITIES

The teaching methods for this course include class-contact teaching through lectures, personal work, and project-based learning.

Classroom activities
- Lectures
- Hands-on training

Outside-class activities
- Preparation for lectures and self-study
- Assignments

Distribution of hours by activity type

DISTRIBUTION OF HOURS BY ACTIVITY TYPE			
ACTIVITY	WORK IN THE CLASSROOM	OUTSIDE CLASSROOM WORK	TOTAL
Lectures	45	-	45
Assignments	-	24	24
TOTAL	45	24	69

ASSESSMENT METHODS AND CRITERIA

- Continuous evaluation (20%): attendance, participation in class
- Assignments to be submitted during the semester (30%)
- Exam with open questions (50%)

DEMONSTRATION OF THE CONSISTENCY OF THE TEACHING METHODOLOGIES WITH THE LEARNING OBJECTIVES OF THE CURRICULAR UNIT

The teaching approaches designed for this course integrate slide presentations, class materials, interactive discussions, and practical problem-solving tasks to accommodate diverse learning styles. Tracking attendance and active participation in class serves as a gauge for students' engagement, a crucial aspect in facilitating effective learning. Moreover, assignments serve as an assessment tool to gauge comprehension of the syllabus content, enabling adjustments to be made if necessary. Additionally, surveys administered to students throughout the semester will offer direct feedback on the efficacy of the teaching methodologies employed.

COURSE MATERIALS

Course notes will be provided to the students along with additional references to delve into specific topics.

ADVICE AND TIPS TO PROCESS LEARNING CONTENT – BIBLIOGRAPHY TO CONSULT

Capel N.J. (2011). A Practical Guide to Road Design with InRoads V8i. Colorado Department of Transportation, Denver.

COURSE 22: INDUSTRIAL TRAINING PROJECT ON PAVEMENTS

Degree			Academic year
JOINT MASTER'S DEGREE IN SUSTAINABLE AND RESILIENT PAVEMENT ENGINEERING			**2027/2028**
			Semester
Course			**3**
Course 22	**Industrial Training Project on Pavements**		Group/Language
Type	Language	ECTS Credits	**English**
Compulsory	**English**	**18**	
Lecturer			
Lo Presti, Davide			

DESCRIPTION

The Industrial Training Project on Pavements course is designed to provide students with the opportunity to conduct a work placement integrating academic learning, employability skills and attributes, and an improved knowledge of organisations, workplace culture and career pathways. The placement should draw on specific discipline skills associated with the course of enrolment. The placement is designed to be a standalone internship not integrated into any other subject. The students will be guided by both an academic and industry tutor that together will define an internship plan to identify goals of the training, including the content of a final report

PREREQUISITES

None.

LEARNING OUTCOMES IN TERMS OF GENERIC AND SPECIFIC COMPETENCES

- Demonstrate a broad comprehension of technologies used in pavement engineering and collaborate with experts from these domains.
- Conduct independent studies, innovate, and contribute to advancements in sustainable and resilient technologies through academic or industry-focused projects.
- Collaborate within multidisciplinary and international teams, harnessing diverse perspectives to solve engineering challenges and achieve shared goals in a global context.

Specific Competences:

- Reflect on personal strengths, weaknesses, and areas for improvement through self-assessment and feedback from supervisors.
- Adapt to new environments, technologies, and workflows, fostering flexibility in professional settings.
- Solve practical problems and challenges encountered in the industrial environment.
- Work in an international environment, paying attention to the local economic, social, environmental, ethical, and security contexts

CONTENTS

The syllabus of the Industrial project course unit is specific to each student, depending on the assigned Industrial partner. This is a work based on the resolution of an industrial problem and involves the development of a written document that synthesizes the work carried out as a project.

DEMONSTRATION OF THE CONSISTENCY OF THE SYLLABUS WITH THE LEARNING OBJECTIVES OF THE COURSE

Based on the Industrial Training plan, the student will have an international, research experience, guided by experts, from both industry and academia that will enable achieving the learning objectives. The program covers the academic research component of the master by applying the learning outcomes and contents of the former semesters. The student will work out the Final report on an independent basis, partly under supervision. It will give the students the required skills to learn the approach of the industry towards sustainable and climate-related challenges.

TEACHING METHODS AND PLANNED LEARNING ACTIVITIES

The teaching methods for this course includes an individual research work at one of the academic or industrial research partners under supervision of a supervisor and research team. During the stay, ad hoc training organized by research team is included. The student will have an individual research work to elaborate and report. Frequently meetings are organized by the supervisor (academic partner) to support the student in the current project. The student will elaborate the industry training project independently.

Distribution of hours by activity type

DISTRIBUTION OF HOURS BY ACTIVITY TYPE			
ACTIVITY	REPORTING	ACTIVTIES AT THE INDUSTRY PARTNER	TOTAL
Industry training project	50	400	450
TOTAL	50	400	450

ASSESSMENT METHODS AND CRITERIA

Evaluation of this course is based on two elements:

(1) the work done in the company, which will be assessed by the tutor of the company, taking into account technical and learning abilities, oral and written communication, involvement, motivation and sense of responsibility, ease of adaptation, creativity and initiative, teamwork and ethical behavior and ethics (30% of total)

(2) personal work that is reflected in the development of a specification and tutorial sessions of the university, whether individual or group, which will be assessed by the tutor of the University (70% of total).

While placement work is directed by industrial supervisor, the placement tutor has at least two meetings with student and industrial supervisor during the year; the first, near the start of the placement, to check that integration into the workplace is proceeding, that the work being required is appropriate by defining the Industry Training project plan, and a second at a later stage to assist and advise both student and employer as to the requirements of the assessment process. The student's performance during this placement (including a monthly diary, industrial placement report, oral presentation and industrial supervisor assessment) will form the basis for consideration for the award of a Degree in Sustainable and Resilient Pavement Engineering. The pass mark for

the diploma is 50%. Students must undertake all aspects of the assessment to pass the module. There is no opportunity for supplementary assessment.

COMPETENCES ASSESSMENT SUMMARY TABLE (%)			
INDICATORS	CONTINUOUS ASSESSMENT	FINAL ASSESSMENT	TOTAL
Company advisor	30%	0%	30%
Industrial project report	70%	0%	70%
TOTAL	100%	0%	100%

DEMONSTRATION OF THE CONSISTENCY OF THE TEACHING METHODOLOGIES WITH THE LEARNING OBJECTIVES OF THE CURRICULAR UNIT

The teaching methods envisioned for this class combine training, independent work and presentation/communication of the results. The Industry training project is largely an independent work under both industrial and academic supervision, allowing the student to dive into a current challenge and enlarge the student's skills to initiate, process and carry out a professional experience. The daily working environment at an industry partner gives the student a broad view of the method to approach problems and the methodology to achieve solutions. The student will gain regular feedback from the supervisor in order to adjust on a personal and/or technical base.

COURSE MATERIALS

The course materials depend on the industrial partner and on the subject to be treated.

ADVICE AND TIPS TO PROCESS LEARNING CONTENT – BIBLIOGRAPHY TO CONSULT

- E4E Engineers for Europe - Skills Strategy: Anticipating Skills Requirements for the Engineering Profession https://engineers4europe.eu/sites/default/files/2024-04/2024%20E4E%20First%20Skills%20Strategy%20%28summarized%29.pdf (accessed Jun 2024)
- A. Ayob *, S.A. Osman, M.Z. Omar, N. Jamaluddin, N.T. Kofli, S. Johar (2020). Industrial Training as Gateway to Engineering Career: Experience Sharing, 6th International Forum on Engineering Education (IFEE 2012) Procedia-Social and Behavioral Sciences 102 (2013) 48-54
- 12 books that have inspired civil engineers. Institute of Civil Engineering (ICE), United Kingdom https://www.ice.org.uk/news-insight/news-and-blogs/ice-blogs/ice-community-blog/books-that-have-inspired-civil-engineers (accessed Jun 2024)

COURSE 23: RESEARCH AND COMMUNICATION SKILLS (ONLINE)

Degree			Academic year
JOINT MASTER'S DEGREE IN SUSTAINABLE AND RESILIENT PAVEMENT ENGINEERING			**2027/2028**
			Semester
Course			**3**
Course 23	**Research and Communication Skills (online)**		Group/Language
Type	Language	ECTS Credits	**English**
Elective	**English**	**6**	
Lecturers			

- **DAVIDE LO PRESTI**
- **SALVATORE DI DIO**
- **GABRIELLA BUTTITTA**
- **Other Guest lecturers**

DESCRIPTION

This course aims to provide the students with "Research and Communication Skills". The course aims to prepare all the students to approach a research-based master thesis as well as being ready to approach a research-based path in academia and/or industry. This course aims to equip postgraduates with essential complementary skills necessary for success in today's dynamic work environment. Emphasis will be placed on team working, effective communication, and innovative learning methodologies.

PREREQUISITES

None

LEARNING OUTCOMES IN TERMS OF GENERIC AND SPECIFIC COMPETENCES

- Effective analysis of research problems.
- Clear communication of research findings.
- Innovation and Independent Study
- Understand the research process and its meaning through reading articles, academic writing and technological literacy
- Carry out a literature review
- Develop research proposals and experimental designs
- Be proficient in basic statistical analysis, interpretation and visualisation of data and results
- Master academic and professional communication
- Writing a dissertation manuscript
- Design effective scientific presentations

CONTENTS

- Introduction to Research Skills
- Reading Papers and academic writing
- Literature Review
- Developing a comprehensive research proposal
- Experimental Design
- Basic Statistical Analysis

- Data and results interpretation and visualization techniques
- Academic and Professional Communication
- Dissertation Manuscript
- Designing Effective Scientific Presentations

DEMONSTRATION OF THE CONSISTENCY OF THE SYLLABUS WITH THE LEARNING OBJECTIVES OF THE COURSE

Through the contents described in the syllabus, the student will learn a series of concepts, models, and tools (e.g., life cycle cost analysis, life cycle assessment, circularity, resilience, etc.) that will enable achieving the learning objectives. The program covers the theoretical component of these concepts, models, and tools and their practical component through a series of course assignments to be solved by the students.

TEACHING METHODS AND PLANNED LEARNING ACTIVITIES

The teaching methods for this course include class-contact teaching through lectures and practice sessions, personal work, and project-based learning.

Classroom Activities:
- Lectures
- Practical sessions
- Quizzes

Outside-class Activities:
- Preparation for lectures and self-study
- Assignments

Distribution of Hours by Activity Type (Total: 125 hours)

Lectures: 28 hours
Practical sessions: 12 hours
Outside-class work: 85 hours

ASSESSMENT METHODS AND CRITERIA

- Continuous evaluation (30%): attendance, participation in class
- Assignments to be submitted during the semester (40%)
- Quizzes with open questions and multiple choice (30%)

DEMONSTRATION OF THE CONSISTENCY OF THE TEACHING METHODOLOGIES WITH THE LEARNING OBJECTIVES OF THE CURRICULAR UNIT

This course integrates theoretical knowledge with hands-on experience, emphasizing research skills, communication, and collaboration for postgraduate engineers. Students will engage in practical activities, group projects, and assessments to apply and reinforce their learning.

COURSE MATERIALS

Course notes and Various resources on research skills, communication, and technology tools

ADVICE AND TIPS TO PROCESS LEARNING CONTENT – BIBLIOGRAPHY TO CONSULT
- Zaumanis. M. - Peer Recognized Book 2: Research Data Visualization and Scientific Graphics https://peerrecognized.com/visualization/ - Zaumanis. M. - Peer Recognized Book 3: "Scientific Presentation Skills" https://peerrecognized.com/presenting/

COURSE 24: SUSTAINABLE MOBILITY POLICIES (ONLINE)

Degree			Academic year
JOINT MASTER'S DEGREE IN SUSTAINABLE AND RESILIENT PAVEMENT ENGINEERING			**2027/2028**
			Semester
Course			**3**
Course 24	**SUSTAINABLE MOBILITY POLICIES (online)**		Group/Language
Type	Language	ECTS Credits	**English**
Elective	**English**	**6**	
Lecturers			
Marco Migliore **Gabriele D'Orso**			

DESCRIPTION

The course provides a broad overview of transportation planning in urban areas and sustainable mobility policies. The course is divided into 3 sections. 1) Transport plans: the first section analyses the main elements, the development process, and the implementation process of Urban Traffic Plans and Sustainable Urban Mobility Plans. Actions and policies typically implemented in PUT and SUMP are also examined. 2) The transportation planning process: this section provides a broad introduction to the transportation planning process, analysing the traditional models for transportation supply modelling, travel demand modelling, and traffic assignment. Exercises on transportation supply models and travel demand models are proposed. 3) Sustainable mobility policies: this section analyses the different policies and measures that can be implemented for increasing the environmental sustainability of the transport system and the territory in the short-, medium- and long term, also using case studies and GIS software. Particular attention is paid to public transport, shared mobility services, walkability, and cycling.

PREREQUISITES

None

LEARNING OUTCOMES IN TERMS OF GENERIC AND SPECIFIC COMPETENCES

Generic Competences
- Acquire knowledge and methodologies to address and to solve strategic issues in an original way.
- Model the behaviour of the transport system users
- Plan interventions on transport system, considering the interaction between the supply and the demand and using different transport modes.

Specific Competence:
- Know the structure and development methodologies of the main urban transport plans
- Perform common analyses in transport planning.
- Use GIS software to carry out several analyses on the urban transport system and
- Propose sustainable mobility policies and measures that solve transportation issues and are suitable for the territorial context.

CONTENTS

- Transport Plans: analyse of the main elements, the development process, and the implementation process of Urban Traffic Plans and Sustainable Urban Mobility Plans. Actions and policies typically implemented in PUT and SUMP.
- The transportation planning process: broad introduction to the transportation planning process, analysis of the traditional models for transportation supply modelling, travel demand modelling, and traffic assignment. Exercises on transportation supply models and travel demand models.
- Sustainable mobility policies analysis of the different policies and measures that can be implemented for increasing the environmental sustainability of the transport system in the short-medium- and long term, also using case studies and GIS software. Particular attention is paid to public transport, shared mobility services, walkability, and cycling.

DEMONSTRATION OF THE CONSISTENCY OF THE SYLLABUS WITH THE LEARNING OBJECTIVES OF THE COURSE

Through the contents described in the syllabus, the student will learn methodologies to investigate and to solve problems of interaction between transport supply and demand. He will be able to formulate strategies, model the effect of interdependence, locate the outputs of the strategic planning, and assess their consequences regarding original and innovative contexts.

TEACHING METHODS AND PLANNED LEARNING ACTIVITIES

The teaching methods for this course include class-contact teaching through lectures and practical sessions, and personal work.

Classroom activities

Lectures and practical sessions on the topics described in the CONTENTS *section (see above).*

Distribution of hours by activity type

DISTRIBUTION OF HOURS BY ACTIVITY TYPE			
ACTIVITY	WORK IN THE CLASSROOM	OUTSIDE CLASSROOM WORK	TOTAL
Lectures	Sustainable Urban Mobility Plans: objectives, development process, implementation, principles, and policies	-	4 hrs
Lectures	Urban Traffic Plans: objectives, development process, implementation and design contents.		4 hrs
Lectures	Supply-side policies.	-	4 hrs
Lectures	Demand-side policies.	-	4 hrs
Lectures	Travel demand modelling		4 hrs
Lectures	Transportation supply modelling and trip assignment models.		4 hrs
Lectures	Public transport systems.		4 hrs
Practice	Survey methods for transport planning		2 hrs
Practice	Exercises on travel demand models and traffic assignment models		4 hrs
Practice	Case studies in the field of transportation planning		6 hrs
TOTAL			40 hrs

Outside-class Activities: preparation for lectures and self-study (85 hrs)

Distribution of Hours by Activity Type (Total: 125 hours)
Lectures: 28 hours
Practical sessions: 12 hours
Outside-class work: 85 hours

ASSESSMENT METHODS AND CRITERIA

- Continuous evaluation (20%): attendance, participation in class
- Assignments to be submitted during the semester (30%)
- Oral exams (50%)

The oral examination consists of a discussion about the study of planning carried out individually or in groups during the course and an interview about other topics studied during the course.

Criteria:
The score, expressed in thirtieths, will be assessed on the basis of achievement relating to points previously exposed to a minimum (18/30) which implies a knowledge of the subjects and sufficient competence until the highest level (30/30 honours) of knowledge, competence, autonomy and language.
In order to achieve a rating from 19/30 to 29/30 the student must demonstrate increasing levels of knowledge that exceed the sufficiency and approach the maximum score possible, demonstrating different degrees (more than enough to more than good) of knowledge, synthesis and judgment, properties of language.

DEMONSTRATION OF THE CONSISTENCY OF THE TEACHING METHODOLOGIES WITH THE LEARNING OBJECTIVES OF THE CURRICULAR UNIT

The alignment of teaching methodologies with the learning objectives of the curricular unit is guaranteed by fostering an inclusive and enriching educational environment. In this context, inclusive teaching methodologies will play a key role in integrating the wealth of experience previously acquired by students from different countries with new incoming knowledge. The active engagement of students during lectures, facilitated by questions posed by the lecturer, will enhance the understanding of issues and the recognition of the specific problem in the real world, and will facilitate the approach to case studies. Classroom case study examinations will draw inspiration from discovery learning, constructing participatory study paths that consider students' prior knowledge and skills. This approach aims to contextualize learning, foster research, and encourage a spirit of discovery, ensuring the alignment of teaching strategies with the overarching objectives of the JM.

COURSE MATERIALS

- Lecture notes and materials will be provided during the teaching activities to students through the download section of the teacher's educational website. Based on advancements in scientific research, bibliographic updates will be also provided to students.

Suggested bibliography
- Ortuzar J de D, Willumsen L.G., Modelling Transport. Edition: Fourth edition. John Wiley & Sons, Ltd. ISBN: 9780470760390

ADVICE AND TIPS TO PROCESS LEARNING CONTENT – BIBLIOGRAPHY TO CONSULT

Personal deepening is recommended through consulting books and journals available in the library, as well as on websites recommended by the university library system with open access for students.
Suggested bibliography to consult:
- ITE (Institute of Transportation Engineers), Meyer, M. D., Transportation Planning Handbook. Edition: Fourth edition. Hoboken, New Jersey, Wiley, 2016. ISBN: 9781118762356.
- "Guidelines for developing and implementing a Sustainable Urban Mobility Plan", second edition (2019). European platform on sustainable urban mobility plans. Open Access

COURSE 25: THEORY AND DESIGN OF BRIDGES (ONLINE)

Degree			Academic year
JOINT MASTER'S DEGREE IN SUSTAINABLE AND RESILIENT PAVEMENT ENGINEERING			**2027/2028**
			Semester
Course			**3**
Course 25	**THEORY AND DESIGN OF BRIDGES (online)**		Group/Language
Type	Language	ECTS Credits	**English**
Elective	**English**	**6**	
Lecturers			
Michele Fabio Granata **Piero Colajanni**			

DESCRIPTION

The course aims to provide the fundamental tools for the design and construction of bridges through the study of typologies, construction technologies and structural calculation methods. The theoretical aspects as well as the design, construction and economic problems that arise in the construction of bridges and in the assessment of the existing ones are addressed in their entirety. Specifically, the problems relating to moving loads and their distribution on the deck are addressed, as well as the problems concerning prestressed concrete and composite steel-concrete structures. Substructures (piers, abutments,.) and construction methods are also considered. To complete the course, the development of a design theme is proposed for the construction of a bridge. At the end of the course the student will have learned how to deal with structural problems related to the construction of bridges and what are the tools of the bridge designer for searching design solutions to actual infrastructure case-studies. He will have the ability to understand and apply the instructions of codes for the structural design of prestressed concrete and steel-concrete composite bridges, applying classical structural analysis methods in the elastic and plastic fields aimed at structural verification at the limit states.

PREREQUISITES

Theory of reinforced concrete structures; Theory of steel structures; Limit state theory; Theory of single-dimensional elements; Semi-probabilistic method to limit states.

LEARNING OUTCOMES IN TERMS OF GENERIC AND SPECIFIC COMPETENCES

- Acquire knowledge both on the theory of bridge structures and on the construction techniques for their construction, also in relation to the most used typologies such as girder and arch bridges
- Address both the design of the new and the critical evaluation of the state of existing structures and their maintenance
- Develop design ability
- Critically analyze executive documents of completed projects in addition to their possible drafting.
- Critically analyze construction technologies
- Make design and operational choices in future professional practice.

CONTENTS

- Bridge history and classification.
- Slab, beams, grids, boxes, arches, cable bridges.
- Theory of influence lines and moving loads. Vehicle loads. Transverse distribution of moving loads.
- Prestressed concrete and steel-concrete composite decks. Piers, abutments, bearings and joints.
- Bridge in seismic areas. Seismic isolation. Monitoring, safety and maintenance. Design code loads; Influence lines. Longitudinal and transverse distribution of loads.
- Design of prestressed concrete bridge structures with beams, grids and boxes. Design of steel-concrete composite sections.
- Guide-lines bridge safety assessment and monitoring.
- Technology of bridge construction. The influence of shrinkage and creep. Rheological models and applications.
- Design of a bridge deck with post-tensioned beams. Steel-concrete composite decks. Box-girder bridges. - Effects of load eccentricity and section design. Design of piers and abutments, bearing supports and joints. Seismic devices.
- Arch bridges.

DEMONSTRATION OF THE CONSISTENCY OF THE SYLLABUS WITH THE LEARNING OBJECTIVES OF THE COURSE

The course aims to provide the fundamental tools for the design and construction of bridges through the study of typologies, construction technologies and structural calculation methods. The theoretical aspects as well as the design, construction and economic problems that arise in the construction of bridges and in the assessment of the existing ones are addressed in their entirety. Specifically, the problems relating to moving loads and their distribution on the deck are addressed, as well as the problems concerning prestressed concrete and composite steel-concrete structures. Substructures (piers, abutments,….) and construction methods are also considered. To complete the course, the development of a design theme is proposed for the construction of a bridge.

TEACHING METHODS AND PLANNED LEARNING ACTIVITIES

The teaching methods for this course include lectures, classroom practical applications; design workshop., and personal work.

Classroom activities

Lectures and practical sessions on the topics described in *CONTENTS section (see above).*

Distribution of hours by activity type

DISTRIBUTION OF HOURS BY ACTIVITY TYPE

ACTIVITY	WORK IN THE CLASSROOM	OUTSIDE CLASSROOM WORK	TOTAL
Lectures	Bridge history	-	2 hrs
Lectures	Classification of bridges. Static schemes: slab, beams, grids, boxes, arches, cable bridges		2 hrs
Lectures	. The theory of influence lines and moving loads	-	4 hrs
Lectures	Vehicle loads. The transverse distribution of moving loads on the deck	-	4 hrs
Lectures	Prestressed concrete decks		3 hrs
Lectures	Steel-concrete composite decks		3hrs
Lectures	The bridge substructure: piers, abutments, bearings and joints		3 hrs
Lectures	Bridge in seismic areas. Seismic isolation		2 hrs
Lectures	Arch bridges		3 hrs
Lectures	Monitoring, safety assessment and maintenance		2 hrs

Practice	The sequence and technology of bridge construction. Examples of existing structures.	4 hrs
Practice	The influence of shrinkage and creep in the design of bridges. Rheological models and applications	3 hrs
Practice	Prestressed concrete: design of a bridge deck with post-tensioned beams	3 hrs
Practice	Steel-concrete composite decks: design of steel beams with open sections.	3 hrs
Practice	Box-girder bridges. Effects of load eccentricity and section design.	2 hrs
Practice	Design of piers and abutments, bearing supports and joints. Seismic devices	3 hrs
Practice	Arch bridges. Dimensioning issues for tied-arches and combined systems	2 hrs
TOTAL		48 hrs

Outside-class A tivities: preparation for lectures and self-study (102 hrs)
Distribution of Ho rs by Activity Type (Total: 150 hours)
Lectures: 28 hou s
Practical session : 20 hours
Outside-class wo k: 102 hours

ASSESSMENT METHODS AND CRITERIA

- Continuous evaluation (20%): attendance, participation in class
- Assignments to be submitted during the semester (30%)
- Oral exams (50%)

The exam consists of an oral exam with an assigned practical application.
The test is passed if the student responds sufficiently to at least two questions. Sufficient grade will be achieved when the student has shown good exposure skills and minimal autonomy in developing and applying the techniques and knowledge acquired using a technically correct language on the content of the lesson.

Criteria:
The score, expressed in thirtieths, will be assessed on the basis of achievement relating to points previously exposed to a minimum (18/30) which implies a knowledge of the subjects and sufficient competence until the highest level (30/30 honours) of knowledge, competence, autonomy and language.
In order to achieve a rating from 19/30 to 29/30 the student must demonstrate increasing levels of knowledge that exceed the sufficiency and approach the maximum score possible, demonstrating different degrees (more than enough to more than good) of knowledge, synthesis and judgment, properties of language.

DEMONSTRATION OF THE CONSISTENCY OF THE TEACHING METHODOLOGIES WITH THE LEARNING OBJECTIVES OF THE CURRICULAR UNIT

The alignment of teaching methodologies with the learning objectives of the curricular unit is guaranteed by fostering an inclusive and enriching educational environment. In this context, inclusive teaching methodologies will play a key role in integrating the wealth of experience previously acquired by students from different countries with new incoming knowledge. The active engagement of students during lectures, facilitated by questions posed by the lecturer, will enhance the understanding of issues and the recognition of the specific problem in the real world, and will facilitate the approach to case studies. Classroom case study examinations will draw inspiration from discovery learning, constructing participatory study paths that consider students' prior knowledge and skills. This approach aims to contextualize learning, foster research, and encourage a spirit of discovery, ensuring the alignment of teaching strategies with the overarching objectives of the JM.

COURSE MATERIALS

- Lecture notes and materials will be provided during the teaching activities to students through the download section of the teacher's educational website. Based on advancements in scientific research, bibliographic updates will be also provided to students.

Suggested bibliography
- Wai-Fah Chen, Lian Duan. Bridge Engineering Handbook. CRC Press. 1999
- Hewson N.R. Prestressed Concrete Bridge. Thomas Telford 2003
- EC1 – Part 2: Traffic loads on bridges – EN1991-2_2003

ADVICE AND TIPS TO PROCESS LEARNING CONTENT – BIBLIOGRAPHY TO CONSULT

Personal deepening is recommended through consulting books and journals available in the library, as well as on websites recommended by the university library system with open access for students.
Suggested bibliography to consult:
- Sukhen Chatterjee: The Design of Modern Steel Bridges. Blackwell Science 2003
- Preisteley, Seible, Calvi. Seismic Design and Retrofit of Bridges. John Wiley and Sons, 1996

COURSE 26: DISSERTATION

Degree			Academic year
JOINT MASTER'S DEGREE IN SUSTAINABLE AND RESILIENT PAVEMENT ENGINEERING			**2027/2028**
			Semester
Course			**4**
Course 1	**Dissertation**		Group/Language
Type	Language	ECTS Credits	**English**
Compulsory	**English**	**30**	
Lecturer			
Freitas, Elisabete			

DESCRIPTION

The Dissertation course is designed to provide students with the opportunity to conduct independent research on a topic of their choice within the field of Sustainable and Climate-Resilient Pavements. This course is the culmination of the Master's program and allows students to apply the knowledge and skills they have acquired during their studies to a significant research project in an academic or industrial context. After the selection of the dissertation topic, the students will draw a work plan (Dissertation Plan) to develop during the semester. There are no formal classes; the students will be guided by a tutor and assessed at the end by a jury.

PREREQUISITES

None.

LEARNING OUTCOMES IN TERMS OF GENERIC AND SPECIFIC COMPETENCES

- Resolve intricate problems by employing critical thinking and innovative approaches
- Control of both quantitative and qualitative analytical techniques
- Perform experiments and fostering innovation to contribute to new knowledge or advancements
- Process scientific information on an individual and purposeful basis
- Work in an industrial and multidisciplinary environment
- Communicate in an international environment, paying attention to the local economic, social, environmental, ethical, and security contexts
- Provide solutions of a complex pavement-related sustainable and/or resilient challenge, considering environmental, economic, and social factors, and has proficiency in applying engineering principles

CONTENTS

The syllabus of the dissertation course unit is specific to each student, depending on the assigned topic. This is a work based on literature review, case studies or research and involves the development of a written document that synthesizes the work carried out. The work should implement all tasks defined in the Dissertation Plan.

DEMONSTRATION OF THE CONSISTENCY OF THE SYLLABUS WITH THE LEARNING OBJECTIVES OF THE COURSE

Based on the Dissertation plan, the student will have an international, research experience, guided by experts, that will enable achieving the learning objectives. The program covers the academic research component of the master by applying the learning outcomes and contents of the former semesters. The student will work out the Dissertation on an independent basis, partly under supervision. It will give the students the required skills to select an appropriate approach towards sustainable and climate-related challenges.

TEACHING METHODS AND PLANNED LEARNING ACTIVITIES

The teaching methods for this course includes an individual research work at one of the academic or industrial research partners under supervision of a supervisor and research team. During the stay, ad hoc training organized by research team is included. The student will have an individual research work to elaborate and report. Frequently meetings are organized by the supervisor (academic partner) to support the student in the current project. The student will elaborate the research project independently.

Distribution of hours by activity type

DISTRIBUTION OF HOURS BY ACTIVITY TYPE			
ACTIVITY	TUTORIAL	PLAN DEVELOPMENT	TOTAL
Dissertation project	15	825	840
TOTAL	15	825	840

ASSESSMENT METHODS AND CRITERIA

The evaluation of the work consists of its examination by a juri/committee, considering the quality of the original written document that should reflect the research work carried out (60-70% of the final grade). The public presentation and discussion are also considered in the final evaluation (30-40% of the final grade).

DEMONSTRATION OF THE CONSISTENCY OF THE TEACHING METHODOLOGIES WITH THE LEARNING OBJECTIVES OF THE CURRICULAR UNIT

The teaching methods envisioned for this class combine independent research work and presentation/communication of the results. The research project is, to a great extent an independent work under academic or industrial supervision, allowing the student to dive into a current challenge and enlarge the student's skills to initiate, process and carry out a research project. The continuous daily working research environment gives the student a broad view of the method to approach problems and the methodology to achieve solutions. The student will gain regular feedback from the supervisor in order to adjust on a personal and/or technical base.

COURSE MATERIALS

The course materials depend on the subject to be treated. Given the research base of the dissertation, students will intensively use indexing and citation databases available at each university.

ADVICE AND TIPS TO PROCESS LEARNING CONTENT – BIBLIOGRAPHY TO CONSULT

- Bailey. S. (2015). Academic Writing: A Handbook for International Students. London and New York: Routledge.
- Gratton. P., Gratton G. (2020). Achieving Success with the Engineering Dissertation, Springer. ISBN 10: 3030331911 – ISBN 13: 9783030331917.

Joint Master's Degree in Sustainable and Resilient Pavement Engineering

Industrial Training Project

Handbook

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The Industrial Training Project is one of the largest single components of the Joint Master's Degree in Sustainable and Resilient Pavement Engineering (SURPAVE). It allows students to develop and demonstrate their ability to apply scientific and engineering principles to the solution of practical problems in pavement engineering. It is a comprehensive individual project on pavement engineering synthesizing the skills acquired in the master subjects and developing those corresponding to this one. It will be a professional and applied project, and includes the writing of an Industrial Training Project report that will be evaluated by a jury composed at least of the academic and professional supervisors.

The Steering Committee of the Joint Master will annually review the procedure for its organization, rules, assignment of supervisors, monitoring, evaluation, reports, forms, key dates, etc. for approval and publication. This handbook explains the regulations governing the conduct of the Industrial Training Project, describes its various activities and offers students advice on how to tackle it.

This document should be read and understood before you begin your Industrial Training Project.

Queries should be addressed to the Industrial Training Project Coordinator of SURPAVE:

Name: Davide Lo Presti

E-mail: davide.lopresti@unipa.it

Tel. +393515009359 (whatsapp) - +3909123899721

And to info@surpave.eu

1. Introduction

The Industrial Training Project is one of the largest single pieces of work that you will be asked to undertake during your master studies. For all students this Industrial Training Project is worth 18 ECTS credits and therefore it is a key part of your degree programme, which contributes much to your overall final mark.

This Industrial Training Project can be composed of one global project or several small projects but in any case, these projects must lead to practical skills acquisition. Industrial Training Project focus is all about how it is to work in a company as an engineer, how to solve its concrete problems.

To guide you in your Industrial Training Project you will be allocated at least one Industrial Training Project academic supervisor and one professional supervisor in the organisation where the Industrial Training Project takes place. You will need to meet your supervisors regularly. However, you must keep continuously in mind that ultimately, it is “your project” and its success depends on the level of commitment and effort that you are prepared to devote to its execution.

A well-planned and carefully managed project should be a positive and rewarding learning experience, which can provide you long term benefits in professional life after graduation as well as benefits for the organisation where the Industrial Training Project takes place. The project is supposed to be the product of minimum 3 months’ work. Those assessing the project will expect to see a report and hear about work that reflects the considerable length of time you had to work upon it. Nevertheless, the students must keep in mind that the Industrial Training Project will lead to two complementary results: the work done on one hand and the report on the other hand and that these two results are inseparable and must be considered at the same level of importance. Both will be evaluated.

This handbook applies to the Industrial Training Project course for students on the SURPAVE.

The Industrial Training Project provides an opportunity for you to develop and demonstrate your ability to apply scientific and engineering principles to the solution of practical problems in pavement engineering. The project demonstrates the relevance of theory and analytical techniques, including the ability to develop and use theoretical models from which the behaviour of the physical world can be predicted. This Industrial Training Project aims also to develop the capacity of the students to manage a real project, to communicate in a project team, to adapt the work to company/organisation constraints and finally to achieve the results which are expected by the company/organisation.

To complete a pavement engineering project of a professional nature that synthesizes and applies the competencies acquired in the program in a contextualized way, implies to develop even deeper the following essential abilities:

- Plan and time-manage project activity so that all project objectives are met by the agreed deadlines.
- Develop a strategy for problem solving, and an optimum plan for its implementation.

- Devise and implement top-down design methodology both, for hardware and/or software, to produce reliable solutions.
- Communicate with all the stakeholders (tutors, people in and outside the company..) involved in the project.
- Work in a team and develop team skills.
- Develop also a self-evaluation of their own work in order to improve himself/herself.
- Discover what is the job of an engineer in a company.
- Communicate the project results by means of a written report.

The results of the work done can be published through an article in a conference or in a scientific journal, under the agreement of the company/organisation and the laboratory.

2. Organisation

During their Industrial Training Project, the students must respect the rules of operation, the rules of security and generally the rules of work (schedule, place…) of the company/organisation in which they are doing their Industrial Training Project.

Moreover, the students cannot begin their Industrial Training Project if the Industrial Training Project agreement is not signed by all the concerned parties (company, student, academic tutor) and of course if the student is not enrolled at the University of Antwerp, University of Palermo and the University of UMinho. Therefore, the students must start organising their Industrial Training Project in time in order to have all the administrative matter finished at the right time.

General communication between the Industrial Training Project Coordinator and students will be by announcements on the Blackboard course and e-mail. Students should consult Blackboard and read their e-mail regularly.

Industrial Training Project work involves a number of tightly timed activities which, to be successful, rely upon the co-operation of many stakeholders or team members. Missed deadlines cause considerable inconvenience and are unprofessional. Students must make careful note of the deadlines shown in the Project Timetable (see section 3.1). If, for any reason, students are unlikely to meet a deadline, they should discuss problems with their Industrial Training Project Supervisors (academic and professional).

The Consortium partners are concerned to ensure the safety of all students at all times and particularly when undertaking their Industrial Training Project. Students will be required to discuss the safety aspects of their Industrial Training Project with their Industrial Training Project Supervisors. Students who do not co-operate in these activities or who are deemed to have acted in an unsafe manner will not be permitted to continue their Industrial Training Project.

Industrial Training Project could include (but not exhaustive):

- Theoretical and applied studies, applied mathematical analysis, development of computer programs for modelling, calculus, simulation, using the tools that you have learnt during the master or others. In case of a specific tool, the training will be ensured by the company;
- Design or design and build original electronic or mechanical systems;
- Design and construct experimental apparatus, planning and execution of experimental work on industrial or University system;
- Team work;
- Project management work to reach the objectives.

The project should demonstrate the relevance of theory and analytical techniques, including the ability to develop and use theoretical models, from which the behaviour of the physical world can be predicted. Pure literature reviews are not acceptable.

Anyway, each Industrial Training Project subject will be evaluated first by the Academic Committee. Complementary information could be asked to the company regarding the topic and to ensure that the level, the content, and the working conditions are met for a master's level Industrial Training Project. (E.g. the Industrial Training Project must give to the students some autonomy to organise their work and to make decisions.

2.1. Industrial Training Project Process

2.1.1. Industrial Training Project Allocation

The Industrial Training Project opportunities are listed on the Blackboard platform (page of Industrial Training Project). If students have their own suggestion, that should be then discussed with an appropriate member of staff beforehand as mentioned previously.

All students are required to submit their preference choices by mid of February before their next academic year. Please note that if you do not submit your choices on time as required, you may have to accept a project much lower down your personal preferences and will have to accept a remaining project title.

The students are encouraged to discuss the Industrial Training Projects offered with potential supervisors. Whilst every effort will be made to accommodate the individual preferences of students it needs to be appreciated that inevitably there may be more than one student wishing to undertake a particular Industrial Training Project.

Students are permitted to propose their own projects in a subject area in which they are particularly interested. However, it will be the responsibility of the student to clearly discuss with the company to identify a supervisor, who is prepared to supervise such a project and agree with the supervisor the objective of the project. If an industrial organisation is involved, the name and address of a suitable contact should be provided as well as the location where the internship will take place. The supervisor has to agree explicitly to take the project. You should add other choices about different academic supervisors, to take into account in case your chosen supervisor is already fully allocated.

The Industrial Training Project allocation will be done during week 9 (around end of February) and students should be informed of their allocated supervisor. The Academic Committee will allocate any student who does not submit any choices an Industrial Training Project.

The Intellectual Property Rights (IPR) to any Project generated by University staff or intellectually supported by staff will be vested in the Universities of the Consortium. For projects proposed by outside organizations and supported in whole or in part by them, an agreement as to ownership of the IPR must be reached.

It is important that the student realizes that this Industrial Training Project work must be their own work. It is also important for the sake of fairness that the work presented is work carried out during the Industrial Training Project period and not previously done. Where any such previous work is made use of in the Industrial Training Project, this must be made clear. Where relevant, copies of Industrial Training Project reports will be circulated to markers.

Students must complete a declaration including any previous work related study carried out and any concurrent related projects, and handed in to the Project Coordinator. Students will also need to add this to their final report.

2.1.2. Timetables – Key Dates

Normally, the Industrial Training Project ends when the Industrial Training Project report is submitted to the Academic Committee. No extension will be possible.

Detailed timetable will be published via Blackboard.

2.1.3. Project Work

The Industrial Training Project is a 18 ECTS credit subject (450 to 540 learning hours) over one semester.

It would be good practice to complete, in advance, the design and planning activities involved and a thorough understanding of the problem (objectives, milestones, etc.). A realistic forward planning of the Industrial Training Project should be developed at the start.

2.1.4. Meetings with Project Supervisor

The Project work can take place in companies, research and educational centres in any country with a signed Industrial Training Project agreement, and in any case, always under the supervision of one of the universities of the Consortium. Thus, every student has a company supervisor and an academic tutor appointed by the University.

Regular meetings with the supervisor/s are an essential aspect of the Industrial Training Project process and all students are expected to arrange and attend them. At such meetings, you will have the opportunity to discuss how your project is progressing and explore any problems or issues that you have encountered. However, the responsibility for arranging regular meetings lies firmly with the student.

Please remember that the company supervisor assigns a mark, which is part of the Industrial Training Project evaluation based upon student attendance, as well as student engagement with the project and student logbook. We monitor attendance at project meetings as part of the attendance monitoring within the university. The meeting can be done at distance but a meeting could be organised with all parties in the company if necessary.

2.1.5. Experimental Projects (special resources or needs)

The expenditure on projects, purchasing special items, software licences for the internship are under the responsibility of the company.

Some projects may involve the use of expensive equipment provided by the University or by a company. Security and insurance issues should be discussed with the supervisor and Technician Supervisor.

Every fieldwork or work outside the company must have the prior written approval of the project supervisor and must be supported by a full risk assessment.

2.1.6. Difficulties and Problems

Students must notify the company supervisor before the Examination Committee meets, of any circumstances such as medical evidence which might have affected your performance, and which could influence the decision made by the Committee. These circumstances should be supported by documentary evidence.

As example of grounds:

a) Occurrence of an extensive period of illness or other personal mishap.
b) Occurrence of an unforeseen circumstance in the implementation of the project (for example failure or late delivery of equipment).

3. SCIENTIFIC OR PRACTICAL METHODS FOR PROJECT EXECUTION

There is no single correct method for carrying out a project in an Industrial Training. The approach taken will depend on the area of investigation, aims and objectives of the project and on the lead-time available.

Whichever method is chosen, it is important to make sure that the problem situation or context is clearly specified.

4. DELIVERABLES AND ASSESSMENT

The deliverables listed are compulsory and must be submitted by the date issued in this handbook. Failure to submit any one of these elements will result in you failing the subject.

4.1. Industrial Training Project report

The details and format of the Industrial Training Project report are presented in APPENDIX A.

Students are responsible for the production and submission of the final document. The complete Industrial Training Project report work plan must be submitted no later than two weeks after the beginning of the project and will be updated regularly.

4.1.1. Plagiarism

When the Industrial Training Project report is submitted, it must include a signed declaration that the work is your own work.

> *I understand that all my project work must be my own unaided work. If I make use of material from any other source, I must clearly identify it as such in any interviews, reports or examinations. I understand that my reports must be written unaided in my own words, apart from any quoted material, which I must identify clearly in the correct manner.*
>
> *I understand that the work, which I shall present for assessment, must be work carried out by myself only during the project period, which has not been previously prepared. Where any such previous work is made use of in the project, I shall make this clear in any interviews, reports or examinations.*
>
> *I understand that violation of these conditions may result in a mark of zero for the component or components of assessed work affected.*
>
> *(See also article 17 in Student Agreement).*

As part of normal procedures, up to 10% of all student work will be checked on plagiarism.

Besides, any work submitted by a student, which is suspected of containing plagiarised sources, will be analysed by plagiarism detection software.

4.1.2. Requirements for the presentation of the Industrial Training Project report

The specific requirements for the presentation of the Industrial Training Project report are the following:

a) Style and Layout:

- Must be written on A4 paper. Sheets exceeding A4 size should be kept to a minimum and folded so as to be openable when bound into an A4 volume.
- 11-point font size text.
- 1.5 space line text.
- Calibri.
- Page margins: 25 mm left, 20 mm right, 25 mm top and 25 mm bottom.
- Equations should be produce with a math editor and be placed on a separate line. The significant ones should be numbered sequentially in round brackets on the right-hand side.
- Each diagram must be numbered sequentially and have a suitable caption included

below the diagram.

- Graphs must be treated as figures in the numbering system. Axes should be labeled with quantity and units and all data points clearly shown.
- Tables should be numbered in a separate series but should also have a title placed underneath. Units should be included in the table headings.
- Figures and short tables can be placed as near as possible to the text which first refers to them or together at the end of each chapter.
- All figures, tables, diagrams and graphs should be referenced in the text.

b) Two hard copies and an electronic one (in pdf and .doc) of the report must be submitted on the given deadline.

c) The production of the two copies of the report by the deadline is the responsibility of the student. Students should take care to ensure that report production and communication facilities are reliable and are available in time for the submission date. No compensation for the unavailability of these resources will be allowed.

d) The report could be a confidential document. In this case, it will not be made available for consultation and may not be published in whole or in part without the permission from the company/organization.

APPENDIX A: Content of the Industrial Training Project report

The Industrial Training Project (ITP) report must include the following chapters:

- Title: Agreed project title
- Introduction: Highlight what project is about:
  - Presentation of the company and in particular the location where the ITP takes place. This part must highlight the context of the work and must justify the definition of the ITP subject (brief history, business figures, products/ services, competitors; brief summary of all the departments)
  - What is the demand of the company (problem identification): description of the ITP subject to be solved (if several subjects, all must be detailed)
- Project plan: This part will allow appreciating how the project was carried out, how the targets were met, how the problems were overcome, how the work was done (teamwork, freelance…)
  - Methodology
  - Time chart: Graphical display of tasks & milestones.
  - Tasks: What needs to be done to meet the aim & objectives
  - Milestones: dates for completion of tasks
  - Brief description of tasks & milestones
  - Meetings with Project Supervisors
- Technical part: What are the results achieved in the project (solution process). If there are many results, some of them will be detailed (the main ones) and other will be mentioned.
- Soft skills: This part must describe the soft skills you achieved during your Industrial Training Project: team work, management skills, communication skills, language skills, …
  - SWOT analysis regarding your Industrial Training Project and the way you solved problems
  - Knowledge gained in relationship to what has been learned in specific courses of SURPAVE
  - Which skills acquired during the 1ste year of SURPAVE have been useful during the Industrial Training Project
  - Major areas of responsibility and how your responsibilities fit into the activities of your overall department
  - Describe how you feel your various job tasks contributed to your skills or knowledge base. These may be specific tasks you accomplished or may be of more general nature.
    - I learned the configuration of the network system by…

        - I gained information on the _____software and found out how to compare.
        - I gained practice in analysing and problem solving through the process of/when ….
    - What did you learn during your Industrial Training Project ? What did you enjoy the most and what did you like the least? What did you find most rewarding and most challenging? What motivates you to excel at your job? What did you like best/least about the corporate culture?
    - Conclusions and perspectives (summarizing overall experience of the Industrial Training Project)
        - of this work from a technical point of view
        - of this experience from a satisfaction point of view of this kind of job
    - Identification of key references: bibliography and webography

APPENDIX B: Questionnaire completed by the Industrial Training Project supervisor in the company

INTERNSHIP - ENTERPRISE EVALUATION

Name of the student	
Name of the company	
Name of the supervisor in the company	

Evaluation of the behavior	Non-existent	Very Insufficient	Insufficient	Medium	Pretty good	Good	Very good	Professional
Attendance and punctuality	☐	☐	☐	☐	☐	☐	☐	☐
Presentation, dress code and sense of human relations (respect for people and places)	☐	☐	☐	☐	☐	☐	☐	☐
Interest for the proposed work	☐	☐	☐	☐	☐	☐	☐	☐
Team spirit and integration in the team	☐	☐	☐	☐	☐	☐	☐	☐
Initiative, curiosity	☐	☐	☐	☐	☐	☐	☐	☐
Rigor and precision in the work (organization, methodology and planning)	☐	☐	☐	☐	☐	☐	☐	☐
Practical sense	☐	☐	☐	☐	☐	☐	☐	☐
Evaluation on the knowledge and skills								
Use of the theoritical knowledge	☐	☐	☐	☐	☐	☐	☐	☐
Use of the technical knowledge	☐	☐	☐	☐	☐	☐	☐	☐
Conformity and quality of the work (application of instructions)	☐	☐	☐	☐	☐	☐	☐	☐
Capacity to report orally (discussions and exchanges)	☐	☐	☐	☐	☐	☐	☐	☐
Capacity to provide written report (autonomy in the writing : minutes, e-mail...)	☐	☐	☐	☐	☐	☐	☐	☐
General evaluation								
Difficulty of the internship subject (non-existent= very easy ; professionnal= very hard)	☐	☐	☐	☐	☐	☐	☐	☐
Adequation training programme / enterprise	☐	☐	☐	☐	☐	☐	☐	☐
General evaluation of the internship	☐	☐	☐	☐	☐	☐	☐	☐

Main comments regarding the internship and the student	Grade / 20

Done at ..... the ...../...../..... Signature

APPENDIX C: Declaration of originality

Declaration

I understand that all my project work must be my own work. If I make use of material from any other source, I must clearly identify it as such in any interviews, reports or examinations. I understand that my reports must be written unaided in my own words, apart from any quoted material, which I must identify clearly in the correct manner.

I understand that the work, which I shall present for assessment, must be work carried out by myself only during the project period, which has not been previously prepared. Where any such previous work is made use of in the project, I shall make this clear in any interviews, reports or examinations.

I understand that violation of these conditions may result in a mark of zero for the whole subject, the component or components of assessed work affected.

(See also Article 17 Student Agreement)

Student name _____

DNI/ID Card/Passport _____

Signature

Date _____

Joint Master's Degree in Sustainable and Resilient Pavement Engineering

Dissertation Handbook

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The Master's final project is one of the largest single components of the Joint Master's Degree in Sustainable and Resilient Pavement Engineering (SURPAVE). It allows students to develop and demonstrate their ability to apply scientific and engineering principles to the solution of practical problems in Pavement Engineering. It is a comprehensive individual project on pavement engineering synthesizing the skills acquired in the master subjects and developing those corresponding to this one. It can be either professional or research according to the orientation that the student wants to contribute to their training, and includes writing a dissertation and defending publicly it before a tribunal.

The Steering Committee of the Master will annually review the procedure for its organization, rules, assignment of tutors, monitoring, evaluation, reports, forms, defence, key dates, etc. for approval and publication. This handbook explains the regulations governing the conduct of the project, describes its various activities and offers students advice on how to tackle it.

This document should be read and understood before you begin your project.

Queries should be addressed to the Dissertation Project Coordinator: Elisabete Fraga de Freitas.

E-mail: efreitas@civil.uminho.pt

Tel. +351 934594335

And to info@surpave.eu

1. Introduction

The Dissertation is one of the largest single pieces of work that you will be asked to undertake during your course. For all students, this project is worth 30 ECTS credits, and therefore, it is a key part of your degree programme, which contributes much to your overall final mark.

To guide you in your project you will be allocated two project supervisors, whom you will need to meet regularly. However, it needs to be borne in mind that, ultimately, it is your project and that success depends on the level of commitment and effort that you are prepared to devote to its preparation.

A well-planned and carefully managed project should be a positive and rewarding learning experience, which can provide long-term benefits in professional life after graduation. The project is supposed to be the product of one semester work. Those assessing the project will expect to see a report and hear about work that reflects the considerable length of time you had to work upon it. A project “thrown together” in haste to meet the submission deadline will typically read very poorly and even fail.

This handbook applies to the Dissertation subject for students on the SURPAVE.

The SURPAVE Final Project provides an opportunity for you to develop and demonstrate your ability to apply scientific and engineering principles to the solution of practical problems in pavement engineering. The project demonstrates the relevance of theory and analytical techniques, including the ability to develop and use theoretical models from which the behaviour of the physical world can be predicted.

To complete a pavement engineering project of a research or professional nature that synthesizes and applies the competences acquired in the program in a contextualized way, implies to develop even deeper the following essential abilities:

- Plan and time-manage project activity, so that all project objectives are met by the agreed deadlines.
- Develop a strategy for problem solution and an optimum plan for its implementation.
- Devise and implement top-down design methodology both, for hardware and software, to produce reliable solutions.
- Communicate the project results by means of a written report, and formal and public demonstration before a University Tribunal.
- Communicate the project results by means of a paper to be published.

2. Organisation

General communication between the Project Coordinator and students will be by announcements on the Blackboard platform and by e-mail. Students should consult Blackboard and read their e-mail regularly.

Postgraduate project work involves a number of tightly timed activities which, to be successful, rely upon the cooperation of the student. Missed deadlines cause considerable inconvenience and are unprofessional. Students must make careful note of the deadlines shown in the Project Timetable (published on Blackboard). If, for any reason, a student is unlikely to meet a deadline, he/she/it should discuss it with his/her/its Project Supervisors.

The Consortium partners are concerned with ensuring the safety of all students at all times, particularly when undertaking their projects. Students will be required to discuss the safety aspects of their project with their Project Supervisors. Students who do not cooperate in these activities or who are deemed to have acted in an unsafe manner will not be permitted to continue their project.

Projects can include:

- theoretical studies, applied mathematical analysis, and development of computer programs;
- design or design and build original road-related engineering systems;
- design and construct experimental apparatus, planning and execution of experimental work on industrial or university systems.

The project should demonstrate the relevance of theory and analytical techniques, including the ability to develop and use theoretical models, from which the behaviour of the physical world can be predicted. Clearly, pure literature reviews are not acceptable.

2.1. Project Process

2.1.1. Project Allocation

The titles and description of available projects will be shared with the students via google sheets so they can rank their preferences before the deadline indicated. If you have an idea of your own for a project, you should discuss it with the Dissertation Project Coordinator beforehand.

Once the student's preferences are received by the Academic Committee, it decides on the final placement and communicates it to the students via blackboard.

Every effort will be made to accommodate the individual preferences of students. It needs to be appreciated that inevitably there may be more than one student wishing to undertake a particular project.

Please note that if you do not submit your preferences on time as required, you may have to accept a project much lower down your personal preferences and will have to accept a remaining project title.

Students are permitted to propose their own projects in situations where there is not a project on the list that is not particularly attractive to them or in an area in which they are particularly interested. However, it will be the responsibility of the student to identify a supervisor, who is prepared to supervise such a project and agree with the supervisor on the objective of the project. If an industrial organisation is involved, the name and address of a suitable contact should be provided. The supervisor has to agree explicitly to take the project. Therefore, if you don't agree with the assigned project, you should look for an alternative project on your own, communicate it to the Dissertation Coordinator, so the Academic Committee can decide on its adequacy.

The Intellectual Property Rights (IPR) to any project generated by University staff or intellectually supported by staff will be vested in the Universities of the Consortium. For projects proposed by outside organizations and supported in whole or in part by them, an agreement as to ownership of the IPR must be reached.

It is important that you realise that this project work, must be your own work. It is also important for the sake of fairness that the work presented is work carried out during the project period and not previously prepared, for example in an Industrial Placement. Where any such previous work is made use of in the project, this must be made clear. Where relevant, copies of Industrial Training reports will be circulated to markers.

You must complete a declaration including any previous work related study carried out and any concurrent related projects, and hand it to the Project Coordinator. You will also need to add this to your final report - an electronic version of the declaration can be found on the Blackboard (Dissertation portal).

2.1.2. Timetables – Key Dates

Vivas will be timetabled once projects have been submitted.

Detailed timetable will be published via Blackboard. Note that dates in the table are deadlines by which viva must have taken place. If you don't defend in June, then it is automatically re-sit in September.

2.1.3. Project Workload

The Dissertation Project is a 30 ECTS credit subject (840 learning hours approx.) over one semester.

It would be good practice to complete, in advance, the design and planning activities involved and a thorough understanding of the problem (objectives, milestones, etc.). A realistic forward planning of the project should be developed at the start.

2.1.4. Meetings with the Project Supervisor

The project work can take place in universities, companies or research/technology centres in any country with a signed agreement, and in any case, always under the supervision of two universities of the Consortium (University of Antwerp, University of Palermo, University of Minho, Manipal Academy of Higher Education). Thus, every student has an academic tutor (project supervisor) appointed by the university, and if the project is done in another collaborating institution, also another supervisor has to be appointed by that entity.

Regular meetings with your supervisor/s are an essential aspect of the project process and all students are expected to arrange and attend them. At such meetings, you will have the opportunity to discuss how your project is progressing and explore any problems or issues that you have encountered. However, the responsibility for arranging regular meetings lies firmly with you, the student.

Please remember that your supervisor assigns a mark which is part of your dissertation mark based upon your attendance, as well as your engagement with the project and your log-sheets. If you fail to attend meetings, or only do so on a very infrequent basis, then this is likely to be reflected in the mark awarded.

2.1.5. Experimental projects and projects with special resources or needs

Some projects may involve the use of expensive equipment provided by the university or by a company.

Security and insurance issues should be discussed with the supervisor/s and assured in advance. (See Annex “Risk Analyses”)

Every fieldwork or work outside the university must have the prior written approval of the project supervisor and must be supported by a full risk assessment.

2.1.6. Difficulties and problems

You must notify the Master’s Thesis Coordinator before the Board of Examiners meets of any circumstances such as medical evidence which might have affected your performance, and which could influence the decision made by the Board. These circumstances should be supported by documentary evidence. As example of grounds:

a) Occurrence of an extensive period of illness or other personal mishap.
b) Occurrence of an unforeseen circumstance in the implementation of the project (such as failure or late delivery of equipment).

3. Scientific method for project execution

There is no single correct method for carrying out a project. The approach taken will depend on the area of investigation, aims and objectives of the project.

Whichever method is chosen, it is important to make sure that the problem situation or context is clearly specified, together with the reasoned chosen method.

4. Deliverables and assessment

The deliverables listed are compulsory and must be submitted by the date issued on the Blackboard platform. Failure to submit any one of these elements will result in you failing the subject.

4.1. Work plan

The work plan is the document that defines the problem that is to be solved, states the objectives to be met, and also outlines a plan for completing the objectives in the allowed time-scale and within the available resources.

The planning phase must be carried out as a joint activity between you and your supervisor. You are responsible for producing a time plan for the project and a list of resources required. You should consult your project supervisors during this process to confirm that the time allocation to individual activities is reasonable. A Gantt chart is a good way of demonstrating good planning. The details and format of the work plan are presented in APPENDIX A.

You are responsible for the production and submission of the final document. The complete work plan must be submitted by the date published on Blackboard.

4.2. Log-Sheets

You are required to maintain an up-to-date logbook. This should usually be a bound A4 book in which you record all the work you do at the time you do it. This includes any work done incorrectly or that later turns out to be irrelevant. It should be written at the time rather than copied up later.

A logbook is an important record of what an engineer does during a project in terms of design, implementation, results, etc. The reasons why an engineer should always keep a logbook are for example:

a) It provides evidence of work carried out and the reasons for certain decisions.

This can be used in the case of later disputes (commercial, legal, etc.);

b) It provides evidence to your supervisor/employer of what was done when and why;
c) It helps you clarify your objectives and make efficient use of your time;
d) It provides vitally important information when you need to write a report;
e) It may record interesting ideas and activities that may not be directly useful in the project being worked on, but might be used in another project at a later date.

Your project supervisor can demand to see your logbook at any time in order to judge your progress, and it should also be submitted with your final dissertation.

4.3. Paper presentation

There is an increasing awareness in the profession of the importance of communication, and the project provides an opportunity for practice in the delivery of technical information.

You should individually write a technical paper discussing the project background and objectives, the methods for achieving these, the work carried out so far, and the most significant deliverables.

4.4. Project dissertation

The dissertation is the major way you present your work for assessment. The report will be marked by the supervisor/s, and the tribunal. This tribunal will be composed of at least three members (see Student Agreement 8.7.1).

In general, the project is assessed by comparing the final results and conclusions with the objectives agreed in the project proposal, the assessment being weighted by the significance of the work. Work originality, technical modifications, new ideas, theories or methods might attract higher marks. Sometimes open-ended projects are attempted, in which final completion is beyond the scope of a single student. In these cases, it is the individual contribution to the agreed end- point which is important.

The marking assessment scheme of this report is given in APPENDIX C.

4.4.1. Plagiarism

When the project is submitted, it must have included a signed declaration that the work is your own work. (See format in APPENDIX D).

As part of normal procedures, up to 10% of all student work will randomly be assessed for plagiarism.

Besides, any work submitted by a student, which is suspected of containing plagiarised sources, will be analysed by plagiarism detection software.

4.4.2. Requirements for the presentation of the postgraduate dissertations

The specific requirements for the presentation of the postgraduate dissertations are the following:

a) Style and layout:
   - Must be printed on A4 paper. Sheets exceeding A4 size should be kept to a minimum and folded so as to be openable when bound into an A4 volume.
   - 11-point font size text.
   - 1.5 space line text.
   - Calibri
   - Page margins: 25 mm left, 20 mm right, 25 mm top and 25 mm bottom.
   - Equations should be produced with a math editor and be placed on a separate line. The significant ones should be numbered sequentially in round brackets on the right-hand side.
   - Each diagram must be numbered sequentially and have a suitable caption included below the diagram.
   - Graphs must be treated as figures in the numbering system. Axes should be labeled with quantity and units and all data points clearly shown
   - Tables should be numbered in a separate series but should also have a title placed underneath. Units should be included in the table headings.
   - Figures and short tables can be placed as near as possible to the text which first refers to them or together at the end of each chapter
   - All figures, tables, diagrams and graphs should be referenced in the text.

b) Two copies of the report must be submitted on the given deadline to the Master's Thesis Coordinator.

c) The production of the two copies of the report by the deadline is the responsibility of the student. Students should take care to ensure that report production facilities are reliable and are available in time for the submission date. No compensation for the unavailability of these resources will be allowed.

d) The report could be a confidential document. In this case, it will not be made available for consultation and may not be published in whole or in part without the permission in writing to the Steering Committee.

In APPENDIX E there is guidelines for report writing

4.5. Dissertation defence

This compulsory element will be an individual session with you presenting your work (15 min) and then answering questions from a panel of academics/experts. You will be assessed on what is presented in your dissertation and your understanding of the work. It is at this point that your final project mark will be decided. A very good defence may help you to get a good mark, whereas a poor viva may result in you failing.

APPENDIX A: Work plan

Contents of the work plan should be:

- Title: Agreed project title
- Introduction: Highlight what the project is about.
- Aim & Objectives:
  - Overall aim of project
  - Objectives: Defined objectives to meet aim – using SMART[1] as a guideline for writing objectives
- Project plan:
  - Methodology
  - Time chart: Graphical display of tasks & milestones
  - Tasks: What needs to be done to meet the aim & objectives
  - Milestones: dates for completion of tasks
  - Brief description of tasks & milestones
  - Meetings with Project Supervisor
- Idea/List of resource requirements
- Identification of key references

[1] S: specific, M-: measurable, A: attainable, R: realistic, relevant, T: time-bound

APPENDIX B: Declaration of originality

Declaration

I understand that all my project work must be my own work. If I make use of material from any other source I must clearly identify it as such in any interviews, reports or examinations. I understand that my reports must be written unaided in my own words, apart from any quoted material which I must identify clearly in the correct manner.

I understand that the work which I shall present for assessment must be work carried out by myself only during the project period which has not been previously prepared. Where any such previous work is made use of in the project, I shall make this clear in any interviews, reports or examinations.

I understand that violation of these conditions may result in a mark of zero for the whole subject, the component or components of assessed work affected.

Student name _____DNI/ID Card/Passport _

Signature

Date _____

APPENDIX C: Marking assessment scheme for

- **Project Workplan Assessment Criteria**

  Clarity and quality of objectives
  Project Plan: Methodology

  Project plan: Time chart and tasks & milestones

- **Project Supervisor Assessment Criteria**

  Planning

  Engagement and communication with supervisor
  Organization, innovation, motivation and independence
  Logbook

- **Report Assessment Criteria**

  Understanding of advanced field of study / citation Clarity and quality of objectives

  Explanation of advanced methodology Application of advanced methodology Analysis and explanation of results

  Abstract and conclusions (ability to provide succinct summary and interpretation) Attainment of objectives/ value of work

  Report structure and format

  Clarity of language and illustration, grammar, spelling, clear & succinct communication of complex ideas, quality of figures

  Safety, ethics & sustainability

- **Viva Assessment Criteria**

  Engages an Engineering Audience: Technical content and level, whilst accessible, engages, convinces, informs engineering audience.

  Appropriate Scope and content: Presents an appropriate summary of the project title, aims and objectives, background, methodology, approach, preliminary results, conclusions and future work. Effective Communication: Organized and presently

clearly, effectively communicates the essential message through appropriate use of images and text.

Confident, engaging, command and ownership: The presentation is delivered in a confident, competent and engaging manner. Displays a thorough grasp and ownership of project strategy and detail.

Clarity and structure: Logically presented with clarity of aim, rationale, approach and achievement.

Depth of understanding: A thorough understanding is portrayed of technical aspects and background.

Response to Questions: Able to understand questions and provide competent and convincing responses.

APPENDIX D: Guidelines for Report Writing

The criteria against which reports are assessed are clearly discernible from the assessment guidelines given in Appendix D.

Though every engineering report must have a purpose, which differs from report to report, in general the order of the contents remains similar and should typically include the following:

1. Cover
2. Title page
3. Declaration
4. Abstract
5. Table of Contents
6. List of Figures
    a. List of Tables
    b. List of Plates
    c. List of Abbreviations and/or Symbols
    d. Acknowledgments
7. Text of the Report

7.1. Introduction

7.2. Literature Review

7.3. Methodology

7.4. Results

7.5. Discussion of results

7.6. Conclusions, with any proposals for future work

8. References
9. Appendices

Besides, a report should facilitate browsing by the reader when searching for material of interest. This implies clear headings and sub-headings together with attractive diagrams and figures, which are complete in themselves with adequate titles and annotation.

Title Page

Project titles should be the fewest possible words which adequately describe the contents of the report. The title should be showed by typed using all capital letters.

(The cover and title page format can be found at the end of this appendix)

Declaration

Following the title page, there must be a signed declaration by you that the report contains only your original work or fully acknowledged work by others. (See APPENDIX D)

Abstract

The report must include an abstract on a separate page. It is a brief (no more than 250 words) but comprehensive summary of the whole report: from formulation of the project statement, methodology, results to conclusions, in one concise page. It should be written in the present tense.

Table of Contents

The report should be paginated and should contain a Table of Contents indicating where each section may be found. All main sections and sub-sections should be numbered using the decimal system. Normally, not more than three levels of numbering should be needed. Pages should be numbered sequentially starting at the first page of the main report (normally the Introduction). Preliminary pages will be numbered in a separate sequence in lower case using Roman numerals.

Acknowledgement

This section is to acknowledge any help you have received in carrying out your project work.

Introduction

A brief presentation of the problem to be addressed by your project. The following points should be covered:

- Brief background information.
- Description of the nature and broad purpose of your study.
- A brief description of your findings, in particular the main problems and lack of solutions in the literature, the significance and justification of your project, which should form the aim of your project.
- The aim of the project (broad description of purpose) should clearly be spelled out, followed by a few specific objectives (specific measurable outcome).
- Outline of your research and report.
- Explanation of the project planning and a brief guide to the composition and contents of the report, chapter by chapter.

Literature Review

This provides a clear and detailed knowledge of the “state of the art” with a critical examination of the most relevant literature in the area of investigation. The purpose of this section is to provide the background to the project work and to show how and where the investigation fits in.

The literature review should lead to a critical analysis or work done previously, the main achievements and the remaining main problems and lack of solutions in the literature, and the significance and justification of your project, which should form the aim of your project.

Methodology

Description of the method used to carry out the investigation and a comprehensive physical, hardware or software-based model or system for investigation.

For example, materials and mechanical properties, geometry and dimensions, loading conditions, etc. including assumptions, simplifications and justifications.

For modelling projects using software models:

- Transformation of the simplified physical model into the software model.
- Steps required to use the software model and implementation to solve a

problem. For experimental projects:

- Design and construction of apparatus to approximate the simplified physical model.
- Instrumentation/equipment (including design/build/test standard of hardware or software systems).
- Experimental procedures: complete, accurate and precise, listing all the steps in the correct order.

For modelling/experimental project: a combination of both.

Results

- First you should present selected preliminary results concerning validation, confirmation, comparison, repeatability and statistical treatment of your experimental data, …
- Then you should present your detailed results under a set of nominal conditions.
- Followed by organisation and presentation of your results in a logical/systematic manner (parametric study).
- It is essential that you include some brief relevant discussion of the results presented.
- The results should only be presented in graphical form or tabular form, but not both for the same results. If necessary, you can present your results in graphical form in the chapters and include the details of the data in tabular form in the appendices.
- All tables and illustrations used should be mentioned in the text, with appropriate titles or captions with enough explanation to make them readily identifiable/self-contained.

Discussion

- You should first discuss how valid/good your model/investigation is.
- Then the details of the results under the nominal condition: trend, maximum, minimum…
- Followed by summarising, comparing, evaluating and interpreting with respect to the original research questions/hypotheses.
- The discussion should be focused upon the physical meaning and significance of your results, any limitations of the model.

Conclusions and further work

This should be the last main section of the report. It should summarize the technical conclusions to be drawn from the work. Conclusions are a reiteration of the key points made in the discussions and should contain no new material. They constitute a review of the project as previously stated in the aims and objectives.

Inevitably there will always be further work which could have been carried out to improve a project, to extend the ideas generated or techniques adopted. Far from detracting from the objectives actually achieved, this demonstrates an ability to think around the subject, to display an awareness of relevance to other applications, to be critical about one's achievement and to stimulate further study. Any ideas here must indicate how the further work might be undertaken.

Further work is not simply a list of aspirations, rather the limits of failure should be explored further by undertaking more tests to produce a more statistically valid data set!

Citations and Referencing

A citation is a source of information referred to in the text. The reference list is a list of all the items you have referred to in the main text. Your project must contain both citations in the text and a list of references used at the end. Please use the IEEE referencing system.

You need to evaluate your sources, especially when you are using information you have found on the internet. It is important that you reference your work accurately and consistently. Improper use of information from the internet is one of the main reasons that students may be reported for plagiarism.

Appendices

Appendices are usually necessary to support longer reports. If used they should contain information which would impede reading of the main text, such as data sheets, computer programs, lengthy mathematical derivations, similar patterns of figures from finite element modelling projects, planning, etc.

Software Listings

If the project involves the development of software, you should include a copy of that software on a disc including the source and executable files. The disc should be securely attached to the report, at the discretion of the supervisor/

Joint Master's Degree in Sustainable and Resilient Pavement Engineering

Dissertation

[*Title*]

[*Student name*]

Academic Supervisor:
Industrial Supervisor:
[*Place, date*]

APPENDIX E – Action Report Form

Use this form to report any problem (e.g. lack of meetings, poor co-operation, computer system difficulties, workshop problems, etc.) which require action from the Master's Thesis coordinator or which you wish to put on record for consideration by the examiners at the final projects exam board.

This report may be generated by either the student, the supervisor, or both. The template can be downloaded from the Master's Thesis portal on Blackboard.

Report of project problem

Description of the problem:

Action required:

Student name _____

DNI/ID Card/Passport _____

Consortium university _____

Signature(s)

Date:

APPENDIX F – Risk Analysis

RISK ANALYSIS – WORKSITE

FORM

STUDENT-TRAINEE

Name generic RA (if applicable)

Year-Location-Department-Specification:

…….

The worksite form is a result of the risk analysis. This form is a document in which the training organisation writes down health and safety information and communicates it to the Trainee. This communication should be done both orally and in writing. All parties involved in the training agreement must sign this document. If the Trainee is under 18, the legal representative should sign as well.

Purpose and Scope

- ✓ A Student-Trainee is any pupil or student who performs work for an employer within the framework of a learning program organized by an educational institution, for the purpose of gaining work experience.
- ✓ The worksite form should be completed and signed before the start of the Traineeship.
- ✓ A worksite form is primarily a communication tool to ensure a safe working environment for the Student-Trainee.
- ✓ Based on the obtained information, the Student-Trainee is informed about the content of the tasks, the risks of the Traineeship and the precautions that should be taken (including personal protective equipment and work clothing).
- ✓ In case of questions, problems or an accident, this information will serve as reference to determine whether the agreements have been followed and the actual tasks are in line with the agreed-upon assignment.

Roles and responsibilities

- ✓ The **Traineeship coordinator** informs the students about possible traineeships and any prior obligations. He/she is responsible for the follow-up of the contract administration and the documents required by law (traineeship agreement, risk analysis and worksite form).
- ✓ The **Traineeship organisation supervisor** goes over the risk analysis and the required prevention measures.
- ✓ The **Occupational Physician of the Trainee post** decides whether a health assessment or medical follow-up should be performed.
- ✓ For outgoing student-trainees of UAntwerp, the appropriate type of health monitoring and vaccination is carried out by the **medical service** of the Traineeship organisation, unless this is delegated to the medical service of the University of Antwerp. For incoming student-trainees, the health monitoring is delegated to their educational institution. A copy of the health assessment and vaccinations must be submitted to the **mentor** where the Trainee is employed, at the latest at the start of the Traineeship.
- ✓ The content of this document is explained upon arrival at the Trainee post.
- ✓ The **Trainee** respects the **prevention measures** so that the risks involved are reduced to a minimum in the interest of his/her own safety and that of other persons.
- ✓ The Traineeship organisation provides the relevant collective protective equipment (fume hood, biosafety cabinet, shield…) and personal protective equipment (gloves, goggles, face mask…) depending on the specific activities and risks.

- ✓ Maternity protection: the **Student-Trainee** immediately informs the training **supervisor and the Traineeship coordinator** in case of pregnancy or breastfeeding. Advice from the Occupational Physician is obligatory. If necessary, appropriate work will be provided to protect the unborn child. Guidelines on **Maternity protection** are available on the intranet of the Health and Safety Department (PINTRA) or on request.
- ✓ Depending on the nature of the Traineeship, **work clothing** is required. This is preferably provided by the training site.

PART I:

RISK ANALYSIS TRAINEE POST

Name generic RA (if applicable)

Year – Location – Department - Specification:

.....

GENERAL INFORMATION ABOUT THE TRAINEE POST

Traineeship Organisation: .....

Department/Office: .....

Employment address:.....

Traineeship org. supervisor: ..... Phone/E-mail:.....

Secretariat (optional): ..... Phone/E-mail: .....

Company Occupational Physician: ..... Phone/E-mail:.....

Health & Safety Officer: ..... Phone/E-mail:.....

Description of the training activity / job description

.....

.....

.....

1. RISK ANALYSIS / EXPOSURE TO SPECIFIC AGENTS

General Risks – Risks for other persons ☐ **not applicable**

☐ Contact with food for human consumption (catering)

☐ Travelling to high-risk areas (risk of infection, natural disaster, riot, …)

☐ Youngster < 18 y

☐ Night work/shift work

☐ Ergonomic overload (repetitive work, work at predetermined tempo)

☐ Psychosocial aspects

☐ Function requiring increased vigilance (e.g. process control high-risk installations) with risk for other persons

- Safety function (operating heavy equipment, e.g. forklifts, stacking cranes, retractable bridge, …) with risk for other persons.

Chemical agents (gases, solids, liquids) ..... ☐ Toxic, hazardous, sensitizing, irritating, corrosive	not applicable ☐ Nanoparticles ☐
☐ Carcinogenic, mutagenic, teratogenic, reprotoxic	⛔ Asbestos, carbon-nanotubes
☐ Narcotic, psychotropic	Other: .....

Comments on chemical agents:

.....

.....

.....

Biological agents (please specify in the comments) not applicable ☐

.....

☐ Contact with patients
☐ Laboratory and other animals, specify the species:
☐ Human fluids, tissues, cells, cell cultures (please indicate any that are applicable)
☐ Animal fluids, tissues, cells, cell cultures (please indicate any that are applicable)

☐ Infectious or parasitic agents
If yes, which agents? ..... ☐ Bacteria ☐ Viruses ☐ Fungi ☐ Parasites
Highest risk class? ..... 1 ☐ 2 ☐ 3 ☐ 4 ☐

☐ Potentially contaminated environmental samples (e.g. soil, sediment, water, plants …)
☐ Other:……

Comments on biological agents/species:

……

……

……

Physical agents (please specify in the comments!) ☐ **not applicable**

☐ Non-ionizing radiation (radiowaves, microwaves, IR, UV and laser radiation)
☐ Ionizing radiation (x-rays, radio-isotopes, sealed sources)
☐ Operation / use of machines with moving parts with risk for injuries
☐ Electrical risks
☐ Other: ……

Comments on physical agents (open/closed system, with full/partial shielding):

……

……

……

Environmental risks (please specify in the comments!) ☐ **not applicable**

☐ Working on location (e.g. fieldwork, site visits, surveys, different company locations, …)
☐ Working on the public road
☐ Working at heights (> 2m)
☐ Working at high/low atmospheric pressure
☐ Confined space (cellar, basement, tank, …)
☐ Noise > 80 dB (8 hours/day) or peak load > 105 dB
☐ Fine particles (e.g. wood, stone, plants, …)
☐ Working on the water/at the waterfront
☐ Extreme temperature, humidity
☐ Heat (danger of burn injury)
☐ Cryogenic liquids
☐ Vibrations (body, limbs)
☐ Other: ……

Comments on environmental factors:

……

……

……

Other risks:

……

……

2. PREVENTION MEASURES

Orientation/Instructions: ALWAYS obligatory – to be organized by the traineeship organization supervisor!

☒ Orientation/supervision ☒ Emergency procedures ☒ First aid and emergency facilities

Guidelines, instructions, specific training: required if applicable

- ☐ Chemical safety guidelines
- ☐ Biosafety guidelines
- ☐ Radioprotection guidelines
- ☐ Machine Safety guidelines
- ☐ Training for working at heights
- ☐ Safety Data Sheet (SDS)
- ☐ Procedure for needle, cut and splash incidents
- ☐ Specific first aid (if needed)
- ☐ Other:
- ☐ Other:

Comments on specific risks and prevention measures related to the Traineeship:

……

……

……

Personal protective equipment: (pay attention to proper choice and use)

- ☐ Lab coat / Dust jacket
- ☐ Gloves (latex prohibited)
  specify: ……
- ☐ Safety goggles / Face protection
- ☐ Respiratory protection
- ☐ Dosimeter
  High visibility vest (public road, construction site,…)
- ☐ Life jacket
- ☐ Coveralls / Work trousers / Jacket
- ☐ Safety shoes
- ☐ Safety helmet
- ☐ Hearing protection
- ☐ Falling protection
- Other: ……..

3. HEALTH SUPERVISION (to be filled in obligatory!)

3.1 Need for health assessment: to be filled in by the Occupational Physician of the Traineeship organisation!

- ☐ Food safety certificate required for handling food for human consumption (issued by the family doctor)
- ☐ Health assessment not required
- ☐ Health assessment required due to: ……
- ☐ Periodic health assessment required due to: ……
- ☐ Health assessment not required if the indicated vaccinations are current:
  Vaccination/test: ☐ tetanus ☐ hepatitis B ☐ tuberculosis test ☐ hepatitis A ☐ other: ……
- ☐ Prevention measures for maternity protection + obligatory advice from the occupational physician

3.2 Implementation of the health assessment

3.2.1 A traineeship outside the University of Antwerp: to be filled in by the Traineeship organisation supervisor!

- ☐ Health assessment carried out by the medical service of the Traineeship organisation
- ☐ Health assessment is delegated to the medical service of the University of Antwerp

3.2.2 The health assessment of incoming student-trainees who perform a traineeship within

the University of Antwerp is delegated to the educational institution of the student-trainee.

4. **SOLEMN DECLARATION (NAME/DATE/SIGNATURE)**

External Traineeship: Traineeship organisation supervisor

Internal Traineeship: Hierarchical line manager of the Receiving Unit

Name: ……

Date:……

Signature:

Occupational Physician of the Traineeship organisation

Name:……

Date:……

Signature:

PART II: WORKSITE FORM STUDENT-TRAINEE

This form must be accompanied by:

- **the individual risk analysis of the worksite,**
- **or refer to the generic risk analysis.**

Name generic RA (if applicable)

Year-Location-Department-Specification:……..

1. GENERAL INFORMATION ON THE STUDENT-TRAINEE

Student (Name-First name): .....Phone: ……

Email: ……

Education: .....

Educational institution (if other than UAntwerp): ……

Starting date Traineeship: ..... Final date Traineeship: ……

Traineeship coordinator: ..... Phone: ……

E-mail: ……

2. THE STUDENT-TRAINEE DECLARES TO HAVE READ THE GUIDELINES AND TO RESPECT THEM

- ☒ Orientation brochure
- ☒ Emergency procedures
- ☐ Chemical Safety Guidelines
- ☐ Biosafety Guidelines
- ☐ Radioprotection Guidelines
- ☐ Machine Safety Guidelines
- ☐ Training for working at heights
- ☐ Other:……

3. ALL PARTIES DECLARE TO HAVE TAKEN NOTE OF THE FOLLOWING INFORMATION

- ☒ Assigning a training supervisor
- ☒ Job description
- ☒ Risks of the worksite
- ☒ Prevention measures
- ☐ Health assessment form / proof of vaccinations (if required)
- ☐ Specific training requirements according to the risk analysis

4. DECLARATION (NAME/DATE/SIGNATURE)

Training organisation, Mentor	Student-Trainee	Legal representative (if Student- Trainee is < 18 years old)
Name:	*Name:.....*	*Name:.....*
Date:.....	*Date:.....*	*Date:.....*
Signature:	*Signature:*	*Signature:*