Funded by the
Erasmus+ Programme
of the European Union

Circular Economy in Wooden Construction (Wood in Circle)

Project code: 2020-1-LT01-KA203-077939

O2. CURRICULUM OF THE COURSE "CIRCULAR ECONOMY IN WOODEN CONSTRUCTION"

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Hämeenlinna, 2022

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INTRODUCTION

The circular economy is a prominent action to tackle climate change and the need for sustainable development. As wood is the only significant renewable construction material, wood can also contribute to a more circular construction sector. Wood is renewable. It uses low energy processes and generates little waste that cannot be recycled or used as a renewable fuel source.

Circular construction is not only about resource recovery, reuse, and recycling; it is a much broader concept. Civil Engineers must apply the circular economy principles across a building's life cycle: starting from growth and extraction of materials, production, continuing with design, construction, building maintenance, and ending with building demolition and recycling of waste.

There is a significant body of literature on the drivers and benefits of the circular economy; however, little research or wide-scale application has been undertaken within a wooden construction context. Challenges of circular economy in wooden construction require scientific research and well-educated graduates, who can think holistically and interdisciplinary, to study, assess and model sustainable construction solutions.

Project "Wood in Circle" aims at delivering innovative student-centered transdisciplinary education in circular economy-based wooden construction to postgraduate students across European countries.

The specific objectives of the project are:

1. To integrate innovative student-centered phenomenon-based, research-based, blended learning and social leadership approaches into Master's degree study programs;

2. To develop a new course, educate and involve postgraduate students and teachers in scientific research on the whole life cycle of wooden construction;

3. To ensure strategic transdisciplinary, transnational cooperation among higher education institutions and business enterprises in the development of new learning methodology and the course;

4. To increase academic and public awareness and promote sustainability and circular economy in the construction sector;

By combining all the previously mentioned aspects the students should have an outline for a holistic approach to the building process of the timber structures.

DESCRIPTION OF THE MODULE

The 12 ECTS trans-disciplinary innovative module “Circular Economy in Wooden Construction” is addressed to MSc students of the planning disciplines: architecture, civil engineering and building site management.
Through lectures, technical literature, excursions to production halls and construction sites, analysis of case studies and elaboration of timber-specific topics the participants will acquire professional knowledge and competences about timber materials and systems and the various aspects needed to plan and construct all timber and hybrid timber structures, taking into account the circular economy and the life cycle assessment characteristics. The students will apply the contents on a project, going through all real-life phases (from preliminary design to detailed planning and building site management). This trans-disciplinary, student-centred and research-based learning approach will provide a holistic view and an actual know-how about the planning of timber structures.
The structure of the module is flexible, so it can be offered as a whole, as well as individual courses.
The overall aim of the module is to raise the awareness of different actors at local, national, EU and international level about the potentials of timber as building material and promote the concept of circular economy.

LEARNING STRATEGIES AND TEACHING METHODOLOGIES

A methodological framework has been developed. The framework guides partners in the planning process of the pedagogical design of their modules. The framework presents constructivism as an umbrella concept of student-centered pedagogies phenomenon-based learning, blended learning, and research-based learning. These approaches invite partners to examine their teaching and renew it to a more student-centered direction.

The pedagogical triangle points any pedagogical action to be defined as a space between the triangle's three points: the teacher, the student, and knowledge. Triangle adds to the relationship between these points. Considering these relationships, the pedagogical design grows in a more holistic direction.

Detailed information about the methodology can be found in https://woodincircle.eu/outputs/.

PREREQUISITE

The course is intended for master program students with a strong background in civil engineering or related disciplines. Parts of the module can also be studied by last year undergraduate students.

LEARNING OBJECTIVES

After completing this module, the student acquires knowledge and skills required for furthering their engineering competencies regarding the life cycle assessment of timber buildings. This module guides the students to a smooth start of their studies in a sustainable building environment.

The students can apply the circular economy concept in civil engineering and its future directions. In addition, they develop learning, planning, and managing skills needed to complete building projects that align with low carbon emission requirements.

The most appropriate and standardized methodology for assessing the environmental impacts that occur along the life cycle of a product is the Life Cycle Assessment, with which it is possible to evaluate the sustainability performance of a building throughout its life cycle. It is therefore essential to know this methodology.

For the purposes of the course, it is proposed to explain to students the application of LCA to wooden buildings by illustrating a case study for which a restructuring and recycling action is proposed.

At the end of the course the students will not only have acquired the knowledge of an important methodology for evaluating the performance of a product, but they will also be able to apply some simple analysis procedures and will be able to choose a product thanks to the identification of some technical and environmental parameters, indicated in all commercial products (brands, certificates, environmental labels) and which up to now have not been considered discriminatory elements for the choice of a product or service.

The detailed learning objectives for each topic are described in the following chapters.

PARTS OF THE MODULE – DESCRIPTION AND CONTENT

The module consists of themes capturing the essential basic skills for engineering studies related to the circular economy and sustainable building environment.

Parts of the Module:	Duration
1. Sustainability & Circular Economy in Wooden Construction	**6h**
Global Environmental Challenges and General Framework of Sustainability	1h
Circular Economy – General Framework and Principles	1h
Sustainable Wooden Construction	1h
Circular Economy in Wooden Construction	1h
Social leadership	2h
2. Forestry and Wood Manufacturing	**2h**
Forest Resource Management and Sustainable Forestry Planning	1h
Wood as a building material. From forest to construction material	1h
3. Design of Timber Buildings	**5h**
The general design of timber buildings	1h
Structural systems of timber buildings	1h
Timber connections	1h
Structural design of timber elements EC5	1h
Fire safety design of sustainable timber structure	1h
4. Construction of Timber Buildings	**2h**
Project management and construction management	1h
Moisture management in the construction of timber buildings	1h
5. Life Cycle Assessment	**3h**
Energy life cycle performance of buildings	1h
Building thermal balance	1h
LCA Application in Building	1h
6. Building Occupancy & Maintenance	**2h**
Maintenance of Timber Buildings	2h
7. Building Disposal, Reuse and Recycling	**3h**
Site management / Demolition of a building	1h
Waste Management	1h
Secondary Use of Timber	1h

1. Sustainability & Circular Economy in Wooden Construction

1.1. Global Environmental Challenges and General Framework of Sustainability

Lecture stresses the importance of climate change mitigation and the role of the environmental dimension for the long-term existence of humanity. It illustrates exponential growth of population, production and consumption. Lecture considers the planetary boundaries and limits to growth. It shows what will happen according to 'business as usual' scenario if no action is taken. Term 'sustainability' and Sustainable Development concept are being introduced, tackling the dimensions of Sustainable Development as well as United Nations Sustainable Development Goals.

1. LEARNING OBJECTIVES	
Students gain understanding about global environmental challenges, increase environmental awareness and can justify why it is important to implement concepts like circular economy.	
2. ASSESSMENT CRITERIA	
Assessment Methods	Test, Group discussion, Presentation
Fail	The student failed to meet the minimum requirements.
Satisfactory	Student has basic understanding of global environmental challenges and sustainability (40% in Test)
Good	Student has good understanding of global environmental challenges and sustainability (70% in Test)
Excellent	Student has advanced understanding of global environmental challenges and sustainability. Student is able to link global issues, activities, processes to UN Sustainable Development Goals (90%+ in Test)
3. THE QUALIFICATION CRITERIA CONCERNING THE GOALS OF THE CURRICULUM	
One of the introductory lectures emphasising global environmental challenges and the importance of sustainability.	
4. PEDAGOGICAL METHODS AND THE RATIONALE FOR THEM	
The pedagogical methods implemented in the lecture will be blended learning and research based learning. Students should be able to link global problems and potential solutions to related Sustainable Development Goals.	
5. TEACHING MATERIALS AND GUIDANCE METHODS	
Lectures, video materials, readings.	

1.2. Circular Economy – General Framework and Principles

Global society is using the resources today that are meant for satisfying the needs of tomorrow, consuming resources like we would have 1.75 planets Earth. Circular economy is a concept that can offer potential solutions for such emerging global challenges as climate change, depletion of natural resources and loss of biodiversity. Current part stresses the importance of transition from linear economy to circular economy. It helps to understand what are the elements hiding behind the words “circular economy”, revealing general framework and principles of circular economy.

1. LEARNING OBJECTIVES	
Students gain understanding about the concept of circular economy and general principles. Students understand how to apply circular economy principles in different sectors and management levels.	
2. ASSESSMENT CRITERIA	
Assessment Methods	Test
Fail	The student failed to meet the minimum requirements.
Satisfactory	Student has basic understanding of circular economy concept and general principles (40% in Test)
Good	Student has good understanding of circular economy concept and general principles (70% in Test)
Excellent	Student has advanced understanding of circular economy concept and general principles. (90%+ in Test)
3. THE QUALIFICATION CRITERIA CONCERNING THE GOALS OF THE CURRICULUM	
Introduction to general framework and principles of circular economy	
4. PEDAGOGICAL METHODS AND THE RATIONALE FOR THEM	
The pedagogical methods implemented in the lecture will be phenomenon-based learning, blended learning and research-based learning. Students will have to give a holistic answer to the questions: what is circular economy? what are the principles of circular economy? what are the elements of circular economy?	
5. TEACHING MATERIALS AND GUIDANCE METHODS	
Lectures, video materials, readings.	

1.3. Sustainable Wooden Construction

Buildings account for around 40% of overall energy consumption and approximately 36% of the greenhouse gas emissions associated with energy use in the EU. One of the options to mitigate negative environmental impacts in the built environment is to build with sustainable materials, like wood. The topic helps to answer the question why building with timber is sustainable? It also provides understanding about promotion of sustainable timber construction across European and other countries.

1. LEARNING OBJECTIVES	
The student recognizes the importance of sustainable wooden construction.	
2. ASSESSMENT CRITERIA	
Assessment Methods	Test (online)
Fail	The student failed to meet the minimum requirements
Satisfactory	The student has a basic understanding of the importance of sustainable wooden construction
Good	The student has a good understanding of the importance of sustainable timber construction
Excellent	The student has an advanced understanding of the importance of sustainable timber construction
3. THE QUALIFICATION CRITERIA CONCERNING THE GOALS OF THE CURRICULUM	
Emphasis on sustainable wooden construction	
4. PEDAGOGICAL METHODS AND THE RATIONALE FOR THEM	
The pedagogical method implemented in the lecture will be research-based learning. Students will be given a task to analyse learning materials to answer the questions: Why construction with timber is a sustainable construction? Why shall wooden construction be promoted in European countries?	
5. TEACHING MATERIALS AND GUIDANCE METHODS	
Teaching materials: lecture notes, interactive presentation, video materials, additional readings. Methods: lectures.	

1.4. Circular Economy in Wooden Construction

Wood is the renewable construction material which can significantly contribute to a more circular construction sector. The topic provides understanding of circular economy principles in a wooden building life cycle: starting from growth, extraction and production of materials, continuing with design, construction, building maintenance, and ending with its reuse, disassembly and recycling.

1. LEARNING OBJECTIVES	
The student understands and is able to apply circular economy principles in the life-cycle stages of wooden building.	
2. ASSESSMENT CRITERIA	
Assessment Methods	Test (online), Project presentation
Fail	The student failed to meet the minimum requirements
Satisfactory	The student has a basic understanding of how to apply circular economy principles in wooden building life cycle stages
Good	The student has a good understanding of how to apply circular economy principles in wooden building life cycle stages, provides reasonable solutions
Excellent	The student has an advanced understanding of how to apply circular economy principles in wooden building life cycle stages, provides reasonable, original solutions
3. THE QUALIFICATION CRITERIA CONCERNING THE GOALS OF THE CURRICULUM	
Emphasis on circular economy principles in wooden building life cycle stages	
4. PEDAGOGICAL METHODS AND THE RATIONALE FOR THEM	
The pedagogical methods implemented in the lecture will be phenomenon based learning and project-based learning. Circular economy is understood as a phenomenon. Students will be given a task to provide circular economy based solutions for the regeneration of particular timber buildings.	
5. TEACHING MATERIALS AND GUIDANCE METHODS	
Teaching materials: lecture notes, interactive presentation, video materials, additional readings. Methods: lectures, project work.	

1.5. Social leadership

At the first part students are presented the nature of trust and mistrust. They reflect qualities of trustworthy leader/ team members and structures that might create mistrust. In the second part students are presented the elements of dialogue. They reflect their dialogical abilities regarding to these elements. At the third part students learn of values and decision making. Through a case they practice their ethical decision-making skills.

1. LEARNING OBJECTIVES
The student understands the dynamical nature of trust and mistrust The student knows elements of dialogue and effect of these in leadership work The student understands importance of ethical decision making

2. ASSESSMENT CRITERIA	
Assessment Methods	Qualitative self-assessment, Online test of leadership skills (Online).Participation and reflection
Satisfactory	Pass / Fail
Good	
Excellent	

3. THE QUALIFICATION CRITERIA CONCERNING THE GOALS OF THE CURRICULUM
The management task introduces circular economy concepts and differences to the linear economy.

4. PEDAGOGICAL METHODS AND THE RATIONALE FOR THEM
The pedagogical choices follow the principles of the methodological framework as follows

Solution in ”trust balancer”	Pedagogical approaches
	Phenomenon based learning
Dialogue and trust are “ways of being” rather than specific techniques. These learned leadership skills exist in the management/ technical mastery exercises as well	Same phenomenon in different subjects

Trust and dialogue are holistic phenomena. Management exercises are consisted so, that their solution requires ability to apply and analyse information from many sources	Holistic phenomena
To use experience is particularly important in leadership skills of dialogue and trust. Example cases where trust is damaged and how dialogue can improve the work community are written in form of narratives, which helps to connect feeling and experience to group work	Authenticity and contextuality
Technical mastery/ management tasks are written in forms of problems to be resolved	Problem based
Training has two meetings and individual tasks between these	Process based
All activities are done in groups in order to share peer experience	Workshop as a tool
	Research based learning
Technical mastery/ management tasks require accurate research processes	Research methods in use
Technical mastery/ management tasks require accurate resources	Critical attitude towards knowledge
	Blended learning

All materials and tasks are on virtual platform. Students study part of the theoretical content independently, whereas the face-to-face time is reserved for reflection in groups	Mixture of classroom and online activities

5. TEACHING MATERIALS AND GUIDANCE METHODS

Practical exercises outdoors. We are navigating in small groups from point to point, which consists of different tasks concerning trust, interaction, and technologically sustainable solutions in the form of selective demolition (HAMK).

The groups present their circular economy innovation in the Learning Cafe.

In the on-line version these are applied.

2. Forestry and Wood Manufacturing

2.1. Forest resource management and sustainable forestry planning

Forestry is large topic, therefore in this lecture only some aspects are discussed. Overview of forestry and sustainable forestry methods with aspects of an industrial wood as material plantation needs are provided: wood growth, material in a tree, tree as ecosystem element, tools, machinery and methods, natural forest protection and sustainable forestry methods with certification.

1. LEARNING OBJECTIVES	
Students will learn about sustainable forestry, methods, tools, planning.	
2. ASSESSMENT CRITERIA	
Assessment Methods	Test
Fail	The student failed to meet the minimum requirements.
Satisfactory	The student recognizes methods to assess Timber Types/materials and use >40% Test
Good	The student understands resource production (*Timber) assessment methods and the impact on different forestry approaches >70% Test
Excellent	The student can elaborate and assess Long term impact on the environment, identifying critical points for decision
3. THE QUALIFICATION CRITERIA CONCERNING THE GOALS OF THE CURRICULUM	
Resource management, Product planning, Technical properties of wood as a renewable material.	
4. PEDAGOGICAL METHODS AND THE RATIONALE FOR THEM	
Lecture, Video material (use case - within time limits methods of communication)	
5. TEACHING MATERIALS AND GUIDANCE METHODS	
Lecture, Forest products, Timer production, Wooden materials, Use Case	

2.2. Wood as a building material. From forest to construction material

Natural wood for construction has limited availability as solid wood, both due being organic material and by wood structure itself. The lecture analyses wood as a material and types of engineered wood.

1. LEARNING OBJECTIVES	
Knowledge about forestry and wood manufacturing, awareness of environmental protection and ecological diversity. Understanding the climate and geographical conditions as specifics to decision making.	
2. ASSESSMENT CRITERIA	
Assessment Methods	Test
Fail	The student failed to meet the minimum requirements. Has no basic understanding how as forest as sources of renewable resource,
Satisfactory	The student has a basic understanding of how the forest is a source of a renewable resource, Recognizing methods to assess Timber Types/materials and, use
Good	The student understands the important decision points about the forest and wooden material selection.
Excellent	The student can elaborate and provide an explanation for the decision, considers long term perspective in planning
3. THE QUALIFICATION CRITERIA CONCERNING THE GOALS OF THE CURRICULUM	
a) Wood and timber as a renewable material b) Decision criteria and Biodiversity aspects *(Monocultures)	
4. PEDAGOGICAL METHODS AND THE RATIONALE FOR THEM	
Lectures, research based learning, blended learning.	
5. TEACHING MATERIALS AND GUIDANCE METHODS	
Lecture, Video material (Time Lapse), Use Case	

3. Design of Timber Buildings

3.1. The general design of timber buildings

Historic timber buildings represent an essential part of common European cultural heritage and are often being considered as irreplaceable. The actual methods of timber construction differ from country to country, but there are also many similarities, because of the specific properties of wood, and by the movement from country to country of skilled carpenters and techniques over the centuries. The course focuses on the typical style of timber architecture in the North European climate environment.

1. LEARNING OBJECTIVES	
The student recognizes the distinctive style of timber architecture in the North European climate environment.	
2. ASSESSMENT CRITERIA	
Assessment Methods	Application of topic in project assignment/work
Satisfactory	Pass / Fail
Good	
Excellent	
3. THE QUALIFICATION CRITERIA CONCERNING THE GOALS OF THE CURRICULUM	
Aspects of circular economy in structural timber systems are addressed in the lecture.	
4. PEDAGOGICAL METHODS AND THE RATIONALE FOR THEM	
The pedagogical method implemented in the lecture will be the project based learning, by implementing the acquired knowledge to the given task.	
5. TEACHING MATERIALS AND GUIDANCE METHODS	
Lecture, group work, individual/group assignment during lectures or online.	

3.2. Structural systems of timber buildings

Wood products are suited to almost all new-build and renovation construction. Wood structures can be used in different applications in buildings, be they tall tower blocks, large halls or bridges. In addition to structures, common uses for wood products are windows and doors, interior decoration and furniture. The course introduces the basic principles of the most common structural systems of timber buildings.

1. LEARNING OBJECTIVES	
The student can identify the most commonly used structural systems in timber construction.	
2. ASSESSMENT CRITERIA	
Assessment Methods	Application of topic in project assignment/work
Satisfactory	Pass / Fail
Good	
Excellent	
3. THE QUALIFICATION CRITERIA CONCERNING THE GOALS OF THE CURRICULUM	
The aspects of circular economy in structural timber systems are addressed in the lecture.	
4. PEDAGOGICAL METHODS AND THE RATIONALE FOR THEM	
The pedagogical method implemented in the lecture will be the project based learning, by implementing the acquired knowledge to the given task.	
5. TEACHING MATERIALS AND GUIDANCE METHODS	
Lecture, group work, individual/group assignment during lectures or online	

3.3. Timber connections

Mass timber connections are not only crucial to a project's structural design, they also impact everything from aesthetics to code compliance—and finding the optimal solution requires careful planning. The lecture introduces various types of timber connections.

1. LEARNING OBJECTIVES	
The student can make a concept design of load-bearing timber connections.	
2. ASSESSMENT CRITERIA	
Assessment Methods	Open questions, Project presentation
Fail	The student failed to meet the minimum requirements.
Satisfactory	The student can identify the main differences between pinned and rigid connections
Good	The student can identify the appropriate type of connection for main elements
Excellent	The student can compose the whole structural system with rigid connections for modern timber construction
3. THE QUALIFICATION CRITERIA CONCERNING THE GOALS OF THE CURRICULUM	
Reuse of structures, demountable connections	
4. PEDAGOGICAL METHODS AND THE RATIONALE FOR THEM	
Project based learning – students solve practical tasks for selection of timber connections.	
5. TEACHING MATERIALS AND GUIDANCE METHODS	
Lectures, Project work.	

3.4. Structural design of timber elements EC5

In the Eurocode series of European standards (EN) related to construction, ***Eurocode 5: Design of timber structures*** (abbreviated **EN 1995** or, informally, **EC 5**) describes how to design buildings and civil engineering works in timber, using the limit state design philosophy. The lecture will give a general overview about the Ultimate limit state design (ULS) and Serviceability limit state (SLS).

1. LEARNING OBJECTIVES	
The students are familiar with the basic approaches of EC5 for designing timber structures.	
2. ASSESSMENT CRITERIA	
Assessment Methods	Applying the EC5, ULS, and SLS methods to the Study case. Identifying the load-bearing elements in the study case
Satisfactory	Pass / Fail
Good	
Excellent	
3. THE QUALIFICATION CRITERIA CONCERNING THE GOALS OF THE CURRICULUM	
The student improved the knowledge of the sustainable design of timber building by finding the suitable design for safe, sustainable structures in accordance with EC5	
4. PEDAGOGICAL METHODS AND THE RATIONALE FOR THEM	
The pedagogical method implemented in the lecture will be the phenomenon based learning and research-based learning. The lecture will start with a request for dialog. The students will be asked to share their opinion on how the design of timber elements will affect the life of the building. Is there any way they can design taking into account the idea of a circular economy? Real-life examples of successful and failed design will sustain the students' motivation and connection to reality.	
5. TEACHING MATERIALS AND GUIDANCE METHODS	
Lecture, videos handouts.	

3.5. Fire safety design of sustainable timber structure

Circular building design can help to reduce the consumption of nonrenewable raw materials, which can lead to depletion of material stocks, toxic emissions, and waste. There is a contradiction between circular- and fire safety design. Circular design focuses on reducing the impact of material use, and fire safety design focuses on reducing the fire risk. The key aspect for including the fire safety design in a circular build environment is the understanding of the influence of the fire safety design on the balance between material use and fire risk in mass timber buildings.

1. LEARNING OBJECTIVES	
The student can identify ways to protect timber structures from fire.	
2. ASSESSMENT CRITERIA	
Assessment Methods	Project based: choosing the right fire protection method for the timber elements (coatings, hidden connections, etc.)
Satisfactory	Pass / Fail
Good	
Excellent	
3. THE QUALIFICATION CRITERIA CONCERNING THE GOALS OF THE CURRICULUM	
The fire protection should be chosen concerning the possibility of reusing the timber.	
4. PEDAGOGICAL METHODS AND THE RATIONALE FOR THEM	
The pedagogical method implemented in the lecture will be the phenomenon based learning, having the theme of fire risk versus material use.	
5. TEACHING MATERIALS AND GUIDANCE METHODS	
Lecture, videos, handouts	

4. Construction of Timber Buildings

4.1. Project management and construction management

Project management as a method for implementing construction objects. Lecture covers overview of construction object lifecycle and relevant aspects for phases with focus on Project management, project execution as construction phase and specifics for construction.

1. LEARNING OBJECTIVES	
Introduction of ● Project Lifecycle with Building Lifecycle ● Project planning principles ● Project execution ● Frameworks	
2. ASSESSMENT CRITERIA	
Assessment Methods	Tests
Satisfactory	<40%
Good	70%
Excellent	90%+
3. THE QUALIFICATION CRITERIA CONCERNING THE GOALS OF THE CURRICULUM	
RQM PM/ Scheduling principles/ Risk management Controls Lifecycle	
4. PEDAGOGICAL METHODS AND THE RATIONALE FOR THEM	
Lecture / Practical Cases	
5. TEACHING MATERIALS AND GUIDANCE METHODS	
Lecture, Use cases	

4.2. Moisture management in the construction of timber buildings

Timber is hydroscopic, meaning that it absorbs water. Some preservatives can increase timber's ability to attract and absorb moisture. When moisture is poorly managed, these combined properties of core wood can cause bow, crook, cut and twist in a piece of timber, none of which are desirable on a building project. Adding to this, moisture influences all the timber's mechanical properties as well. For this reason, keeping timber dry at every stage of the project is critical.

1. LEARNING OBJECTIVES	
The student should be aware of the influence moisture can have on timber structures and the measures that can be taken to protect these from moisture damage.	
2. ASSESSMENT CRITERIA	
Assessment Methods	The assessment is based on the implementation of knowledge in the final project / how moisture affects the old structures and how to identify the reusable construction elements.
Satisfactory	Pass / Fail
Good	
Excellent	
3. THE QUALIFICATION CRITERIA CONCERNING THE GOALS OF THE CURRICULUM	
Recycle and reuse of materials	
4. PEDAGOGICAL METHODS AND THE RATIONALE FOR THEM	
Project based learning and research based learning– the students will have to apply their knowledge about moisture management in the given task, as well as acquire extra knowledge by individual study.	
5. TEACHING MATERIALS AND GUIDANCE METHODS	
Lecture, videos, handouts	

5. Life Cycle Assessment

5.1. Energy Life Cycle Performance of buildings

The lecture introduces the LCA procedure, focusing on the application of the four steps of goal and scope definition, life cycle inventory, life cycle impacts, interpretation. Some examples will be illustrated to show the advantages and limits of the methodology.

1. LEARNING OBJECTIVES	
To clarify what has been illustrated above, students will be shown some case studies and how information on products can be collected through the use of technical data sheets of material, environmental certifications and labels	
2. ASSESSMENT CRITERIA	
Assessment Methods	Test (online)
Fail	The student failed to meet the minimum requirements.
Satisfactory	The student has a basic understanding of applying LCA procedures in wooden building life cycle stages.
Good	The student has a good understanding of how to apply LCA procedures in wooden building, makes reasonable decisions
Excellent	The student has an advanced understanding of how to apply LCA procedures in wooden building, makes reasonable, original decisions
3. THE QUALIFICATION CRITERIA CONCERNING THE GOALS OF THE CURRICULUM	
LCA procedures, knowledge about technical data sheets of material, environmental certifications and labels.	
4. PEDAGOGICAL METHODS AND THE RATIONALE FOR THEM	
Project-based learning – solution of LCA assessment tasks	
5. TEACHING MATERIALS AND GUIDANCE METHODS	
Lecture, slide, videos.	

5.2. Building Thermal Balance

At the basis of the application of the LCA to a building is the knowledge of the performance of a building. In this module the Balance of the building system will be described, specifying which input parameters are fundamental and which are the output parameters to pay attention to.

1. LEARNING OBJECTIVES	
Buildings must be classified on the basis of a global energy performance index, the module will illustrate the main balance equations that allow you to evaluate the energy needs for the air conditioning of indoor environments that guarantee the comfort conditions for users.	
2. ASSESSMENT CRITERIA	
Assessment Methods	Test (online)
Fail	The student failed to meet the minimum requirements.
Satisfactory	The student has a basic understanding of applying Building thermal balance.
Good	The student has a good understanding of how to apply Building thermal balance
Excellent	The student has an advanced understanding of how to apply Building thermal balance, makes reasonable, original decisions
3. THE QUALIFICATION CRITERIA CONCERNING THE GOALS OF THE CURRICULUM	
Emphasis on Building balance, balance equations, input and output parameters	
4. PEDAGOGICAL METHODS AND THE RATIONALE FOR THEM	
Project-based learning – solution of LCA assessment tasks	
5. TEACHING MATERIALS AND GUIDANCE METHODS	
Lecture, slide, videos	

5.3. LCA application in building

In this module students will acquire notions on how to analyze the performance of a building and which are the fundamental parameters to be collected for the development of a model with a reliable output.

1. LEARNING OBJECTIVES	
Application of LCA on Base Case and renovation case	
2. ASSESSMENT CRITERIA	
Assessment Methods	Test (online), Project presentation
Fail	The student failed to meet the minimum requirements.
Satisfactory	The student has a basic understanding of applying LCA procedure.
Good	The student has a good understanding of how to apply LCA procedure.
Excellent	The student has an advanced understanding of how to apply LCA procedure., makes reasonable, original decisions
3. THE QUALIFICATION CRITERIA CONCERNING THE GOALS OF THE CURRICULUM	
LCA application	
4. PEDAGOGICAL METHODS AND THE RATIONALE FOR THEM	
Project-based learning – solution of LCA assessment tasks	
5. TEACHING MATERIALS AND GUIDANCE METHODS	
Lecture, slide, videos	

6. Building Occupancy & Maintenance

6.1. Maintenance of timber buildings

Maintenance phase is crucial phase in building life cycle as its timespan is supposed to be the greatest among the phases of building life cycle. Maintenance includes activities to retain and restore the functionality of buildings including the ones designed and built with timber. Lecture outlines fundamentals of building use and maintenance, tackles use of digital technologies in real estate management and reveals main maintenance tasks of different building elements.

1. LEARNING OBJECTIVES	
Students gain understanding about maintenance phase in building life cycle and its importance. Student learns about fundamentals of building use and maintenance, use of digital technologies in real estate management and about main maintenance tasks of different building elements. Student is able to apply knowledge about building maintenance to timber buildings.	
2. ASSESSMENT CRITERIA	
Assessment Methods	Test, Group discussion, Presentation
Fail	The student failed to meet the minimum requirements.
Satisfactory	Student has basic understanding of timber building maintenance (40% in Test)
Good	Student has good understanding of timber building maintenance (70% in Test)
Excellent	Student has advanced understanding of timber building maintenance. Student is able to apply general building maintenance principles to timber buildings (90%+ in Test)
3. THE QUALIFICATION CRITERIA CONCERNING THE GOALS OF THE CURRICULUM	
This lecture outlines the importance of maintenance phase in building life cycle.	
4. PEDAGOGICAL METHODS AND THE RATIONALE FOR THEM	
The pedagogical methods implemented in the lecture will be phenomenon-based learning, blended learning and research-based learning. Students will practically apply knowledge about building maintenance to timber buildings.	
5. TEACHING MATERIALS AND GUIDANCE METHODS	
Lectures, video materials, readings, case studies.	

7. Building Disposal, Reuse and Recycling

7.1. Waste management

Construction is one of largest waste "producers" as and industry, thus improving waste management would yield significant reduction of total waste. While solid waste is already recognized and assessed, there are other types of waste. Lecture would cover aspect of current approach of waste management and indicate By-Product as material source (Currect wase -> Material) production.

1. LEARNING OBJECTIVES	
The student is aware of waste management decisions in all stages of the building life cycle. Material, and process view aspect. Indication of the waste management aspects in different regulatory environments. Indication of by-product as potential for innovations in processes to increase profitability with reduction of waste and "by-product" instead of waste	
2. ASSESSMENT CRITERIA	
Assessment Methods	Test (online), Project presentation
Fail	The student failed to meet the minimum requirements.
Satisfactory	The student has a basic understanding of waste management in some stages of the building life cycle.
Good	The student can make waste management decisions in all stages of building life cycle
Excellent	The students can make rational, advanced waste management decisions in all stages of building life cycle
3. THE QUALIFICATION CRITERIA CONCERNING THE GOALS OF THE CURRICULUM	
Emphasis on circular economy principles in waste management	
4. PEDAGOGICAL METHODS AND THE RATIONALE FOR THEM	
Lectures, project-based learning, site visits.	
5. TEACHING MATERIALS AND GUIDANCE METHODS	
Lectures, project work	

7.2. Secondary use of timber

The construction industry creates significant volumes of waste timber. The use of recycled or reclaimed wood has attracted attention in recent years. The aim of the lecture is to introduce the students with alternative solutions for the secondary use of timber in construction, including reclaiming, recycling, production of recycled timber elements.

1. LEARNING OBJECTIVES	
Students will gain knowledge and understanding about the alternative solutions for the secondary use of timber in construction, will be able to analyze and select the most appropriate solutions for the practical cases.	
2. ASSESSMENT CRITERIA	
Assessment Methods	Test, assessment of project work
Fail	The student failed to meet the minimum requirements.
Satisfactory	The student understands the key solutions for the secondary use of timber in construction in a simple context.
Good	The student demonstrates a good understanding of solutions for the secondary use of timber in construction and is able to compare them and to apply in practice.
Excellent	The student demonstrates an in-depth understanding of the solutions for the secondary use of timber in construction and is able to compare them and to apply in complex contexts.
3. THE QUALIFICATION CRITERIA CONCERNING THE GOALS OF THE CURRICULUM	
Application of circular economy principles at the end of timber building life cycle, secondary use of timber	
4. PEDAGOGICAL METHODS AND THE RATIONALE FOR THEM	
The pedagogical methods implemented in the lecture will be case study and project-based learning. Students will be given a case to provide solutions for the secondary use of timber in construction.	
5. TEACHING MATERIALS AND GUIDANCE METHODS	
Teaching materials: interactive presentation, video materials, additional readings. Methods: lectures, project work	

CASE STUDIES

CASE STUDY - EXAMPLE - Part 1

Holiday village (Padasjoki, Finland)

The project aims to develop a multi-professional description of a holiday village that consists of ecologically and socially sustainable processes.

The objective for the student teams is to develop a description of "a village" that serves the needs of travellers and residents. This description consists of both technological solutions and the usability of the premises. The students start the project by examining their attitudes towards social connotations of leadership, such as their relationship to human leadership. Then, they move on to describe the outcome of a village, based on user data.

1. LCA - before the demolition/ retrofitting
2. Become familiar with the basic concepts of social leadership to promote human leadership and teamwork skills,
3. Examine the needs possible users have for the project target Mainiemi Mill area (Padasjoki, Finland),
4. Develop a plan describing the activities and functions of the real estate following circular economy principles (Leisure living facilities and everyday life services),
5. Structural system

The students plan how the existing wood real estate should be renovated following the circular economy principles.

CASE STUDY - EXAMPLE - Part 2

In order to make the students an active part of the project, it will be shown how to apply a simple LCA procedure to an exemplary case study. In particular, the development of a case study of a wooden house will be proposed, whose performance will be analyzed in two different climatic contexts, one extremely rigid (Northern Europe) and one Mediterranean (Southern Europe). The LCA procedure will be applied for each "Base Case" model. The results obtained will allow to evaluate which renovation and / or recycling actions can be applied in order to reduce the impacts and extend the useful life of the building.

The development of this action involves the following phases:

a) creation of an energy model of a case study.

b) simplified application of the LCA to the case study, impact assessment and useful life.

d) choice and implementation of restructuring and recycling actions.

During the course, students will be shown how to implement a case study on a simulation tool. In particular, it will illustrate what are the fundamental data to be collected and known on the construction materials of buildings, the geometry and exposure, the type of systems and consumption, latitude and boundary conditions.

These data will be used to develop a "base case" model that will be simulated simultaneously in different climatic contexts. To compare the behavior of a wooden house at different latitudes, students will be divided into two groups, in which each of them will analyze the performance of the building in two different and extreme climatic contexts: a case study in Northern Europe and a case study study in Southern Europe.

In order to identify the best renovation actions to be applied, the output data relating to the performance of the buildings will be analyzed and selected. This information will be used to implement a simple LCA procedure and evaluate the overall impact that a wooden building has at different latitudes.

The redevelopment interventions identified will then be used to evaluate how they positively affect the reduction of impacts and the useful life of the buildings. Some recycling/reuse actions will be evaluated, taking into account the avoided impact due to the use of secondary raw materials and second-life of components.

COURSE MATERIALS

All course materials are available at the E-learning platform: https://kursai.vilniustech.lt/course/view.php?id=47.