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Sustainable, High-Performance Building Solutions in Wood (HiBiWood)

2020-1-LV01-KA203-077513

COURSE CURRICULA

BSc/BA trans-disciplinary elective module

“Sustainable, high-performance building solutions in wood“

BSc/BA elective module prepared by FH Campus Wien, Austria

June 2023

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MODULE SPECIFICATION

Originating Institution, Department	Module Co-ordinator(s)
Riga Building College	Linda Krage
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Cracow University of Technology	Łukasz Wesołowski
Häme Ammattikorkeakoulu Oy	Cristina Tirteu

TITLE OF THE MODULE

Title of the module
Sustainable, High-Performance Building Solutions in Wood

PROGRAMME(S) IN WHICH TO BE OFFERED

Institution	Programmes
Riga Building College	Architectural Technology
Klaipedos Valstybine Kolegija	Civil Engineering
FH-Campus Wien	Architecture - Green Building
Cracow University of Technology	Architecture / Architecture and urbanism
Häme Ammattikorkeakoulu Oy	Construction Engineering / Site Management

LEVEL OF STUDIES[1]

First cycle (BSc/BA) ☒	Second cycle (MSc/MA) ☐	Third cycle (PhD) ☐

[1] According to the Framework of Qualifications for the European Higher Education Area, Annex 8: http://www.aic.lv/ace/ace_disk/Bologna/Bergen_conf/Reports/EQFreport.pdf

CREDITS AND LEARNING HOURS

ECTS Value[2]	Academic learning hours[3]	Length (in Semesters)	Years in which to be offered
9	240	1, 2 or 3 (selectable)	2023/2024

DISTRIBUTION OF LEARNING HOURS

Lectures (25%)	Individual studies (13%)	Project-based learning (62%)	Total
60	30	150	240

one ECTS credit point equals between 25-30 working hours

INTRODUCTION

The 9 ECTS trans-disciplinary innovative module *"Sustainable, high-performance wooden building solutions in wood"* is addressed to BSc/BA 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 planning aspects needed to construct multi-storey timber buildings. 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 project-based learning approach will provide a holistic view and an actual know-how about the planning of multi-storey timber buildings.

AIM OF THE MODULE

The aim of the 9 ECTS trans-disciplinary innovative module *"Sustainable, high-performance wooden building solutions in wood"* is to fill the gaps regarding the construction of multi-storey timber buildings in higher education programmes. The students will acquire deeper professional knowledge, skills and competences that meet the demands of the employment market.

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 multi-storey timber constructions.

[2] European Credit Transfer System, 1 ECTS = 25-30 academic learning hours. Please refer to ECTS Users' Guide: https://ec.europa.eu/education/ects/users-guide/docs/ects-users-guide_en.pdf

[3] 1 academic learning hour is equal to 45 minutes

LEARNING AND TEACHING STRATEGIES

The module *"Sustainable, high-performance wooden building solutions in wood"* is a course of 9 ECTS with a learning strategy based on project-based-learning (PBL) and learning-by-doing approach.

The students from different planning disciplines (architecture, civil engineering and building site management) will work together and develop a project of a residential building in timber (3-4 storey), going through all real-life phases (from preliminary design to detailed planning and building site management).

The module will provide a deeper and holistic knowledge about the key planning aspects of timber buildings (architectural design, structural systems, timber technology, building physics (sound, moisture, heat, fire protection), cost estimation, montage and logistics), that will be applied directly on the project. The development of the assignment will mirror the real-life phases of constructing a building with emphasis on different disciplines: 1) architectural design and timber technology; 2) engineering and detailed constructive execution of the project; 3) building site management.

The timber-specific knowledge needed for the elaboration of the assignment will be acquired through a methodology mix:

- Self-study using the provided teaching materials and technical literature
- Face-to-face lectures
- Analysis of case studies: development of a technical report that includes the aspects: architectural concept, statics/ structural grid, building construction, building physics and sustainability
- Elaboration of timber-specific questions with focus on construction systems, building physics and site management
- Excursions to timber production halls and construction sites in order to gain practical experience

During the elaboration of the assignment the teachers will give continuous guidance/ supervision to the students and will guarantee the practical, real-life learning experience through excursions, visits and conferences with architects and constructors.

The students will work in groups and will deliver the two small assignments in form of reports (analysis of a case study and elaboration of a timber-specific topic) in the beginning of the semester as a knowledge fixation/preparation for the project work.

As a final result, students will prepare a presentation of the project and defend it in front of a jury. Grades are given by the jury using the ECTS scale, based on achieved learning outcomes.

LEARNING OUTCOMES AND ASSESSMENT

Learning Outcomes of the module[4]	***Methods of study***	***Assessment Criteria***	***Assessment methods of student achievements***	***Achievement level indicators***
LO1. Design a multi-storey timber building with architecture quality; Apply different timber constructions (load bearing systems)	PBL Lectures Literature analysis Case studies Independent study	Demonstration of knowledge about timber construction systems and load bearing properties and critical application during the creative process/arch. decisions; highlighting the weaknesses and strengths of each system.	☒ Problem solving questions ☐ E-tests ☐ Regular tests ☒ Problem solving tasks ☒ Projects ☒ Peer evaluation ☐ Automated feedback ☒ Final evaluation ☐ Other:	***Threshold:*** Evidence of basic understanding of timber construction systems and poor application according to the design requirements.
				Typical: Evidence of good understanding of timber systems and application according to the design requirements.
				Excellent: Evidence of excellent understanding of timber constructions systems, their load bearing properties and influence on the design requirements; creative incorporation of this analysis into the design process.
LO2. Develop details of building elements (superstructure catalogue) considering physical-technical properties of timber	PBL Lectures Literature analysis Case studies Independent study	Demonstration of knowledge about the physical-technical properties of timber and its critical application by the development of the	☒ Problem solving questions ☐ E-tests ☐ Regular tests ☒ Problem solving tasks ☒ Projects ☒ Peer evaluation ☐ Automated feedback ☒ Final evaluation ☐ Other:	***Threshold:*** Evidence of general understanding of the physical-technical properties of timber and poor application by the development of the superstructure catalogue
				Typical: Evidence of good understanding of the physical-technical properties of timber and

[4] Learning outcomes are specified in three categories – as **knowledge, skills and competence**. This signals that qualifications – in different combinations – capture a broad scope of learning outcomes, including theoretical knowledge, practical and technical skills, and social competences where the ability to work with others will be crucial. Please refer to Cedefop (2017). Defining, writing and applying learning outcomes: a European handbook. Luxembourg: Publications Office of the European Union. https://www.cedefop.europa.eu/files/4156_en.pdf.

		superstructure catalogue		application by the development of the superstructure catalogue
				Excellent: Evidence of excellent understanding of the physical-technical properties of timber; creation of successful sound/heat/fire/moisture protection concepts that are incorporated successfully in the superstructure catalogue
LO3. Develop building site management concept for a multi-storey building	PBL Lectures Literature analysis Independent study	Demonstration of ability to plan and organise the erection of timber projects: dimensions, cost estimation, transport, montage, logistics; effects of selected variants, advantages/ disadvantages; Critical application on a project	☒ Problem solving questions ☐ E-tests ☐ Regular tests ☒ Problem solving tasks ☒ Projects ☒ Peer evaluation ☐ Automated feedback ☒ Final evaluation ☐ Other:	***Threshold:*** Evidence of general understanding of planning and organising timber construction projects
				Typical: Evidence of good understanding of planning and organising timber construction projects
				Excellent: Evidence of excellent understanding of planning and organising timber construction projects; Successful development of a building site management concept

LECTURE TOPICS

The individual lectures of the module are organized into 4 courses, each with 15 SWS (academic attendance hours), corelating to 1 ECTs. In this way, the lectures can also be held separately as theoretical courses, independent from the practical project-based exercises.
The knowledge transfer of the lectures is supported by small tasks, which are described in more detail in the Assignment Book of the project and were tested as preparatory tasks during the three intensive courses C2, C4 and C6.

Lectures	Duration
1. Architectural Design in Timber – Introduction	**15h / 1 ECTs**

Introduction – Global Environmental Issues. Why timber?	1h
Architecture – How to think/design in timber?	1,5h
History of (multi-storey) timber construction	1,5h
Forestry and Sustainable Aspects (Grey Energy, Efficiency, Economy, Economic Aspects, Regional Value Creation)	2h
Best practice: details, construction, architecture	1,5h
Building materials from tree to slab to "by-products"	1,5h
Static requirements – Introduction	2h
Introduction in Building physics – Heat / Sound / Moisture management	1h
Introduction in Building physics – Fire protection	1h
Building Construction: Plan generation and structural drawing	1h
Museum in Marszewo – first CLT public building in Poland - case study	1h
2. Advanced Architectural Design in Timber	**15h / 1 ECTs**
Production, interfaces, quality assurance, craft, prefabrication, details	1h
Tendering, structural systems, elements	1h
Timber technology, construction, connections, structural systems	1,5h
Timber technology, construction, connections, structural systems (company presentation)	1h
Timber BIM modelling. IFC and Operation and Maintenance	1,5h
CLT Production, Planning, Design	1,5h
Facade finishing types (construction/materials)	1h
Wooden facades, plaster systems	1h
Flat roof solutions (construction, materials)	1h
Interior finishing (walls, ceilings, floors)	1h
Balcony design and construction	1h
Openings (window and door fixing)	1h
Building installations - prefabrication wet rooms (onsite/partly prefab/prefab)	1,5h
3. Timber Engineering	**15h / 1 ECTs**
Architecture for timber engineers	1,5h
Introduction to engineered timber systems and components	1,5h
Structural systems / Building mechanics	2h

Introduction to Eurocodes / Eurocodes / EC5	2h
Advanced: Building physics - Heat / Sound / Moisture management	1,5h
Detailing for timber buildings	2h
Structural Systems – Elements	2h
Timber BIM modelling	1,5h
Design coordination (local regulations, fire protection)	1h
4. Building Site Management and Building Process with Timber	**15h / 1 ECTs**
Mapping the timber construction process	1,5h
Correlation of building construction parameters	1,5h
Structural systems and Building mechanic – installation chronology of load-bearing construction elements on the building site	1,5h
Moisture management on a building site	1,5h
Cost estimation for building life cycle assessment	1,5h
Cost estimation: Dimensions, transport, montage, and logistics	1,5h
BCF workflow and digital processes (coordination, construction, maintenance)	1,5h
Logistics – transportation, montage, timeline, coordination of companies*	1,5h
Best-practice examples of large-scale international projects in timber (company presentation)	1,5h
Sustainability concept – recyclability and dismantling strategies with timber*	1,5h
TOTAL	**60h / 4 ECTs**

1. Architectural Design in Timber – Introduction

Timber construction has gained significant attention as a sustainable and versatile building material. This course provides a comprehensive understanding of global environmental issues related to timber construction, explores the architectural aspects of designing with timber, examines the historical context of multi-storey timber construction, and delves into forestry and sustainable practices. Participants will learn about best practices, construction techniques, building materials, static requirements, building physics, and case studies of notable timber structures. The course aims to equip students with the knowledge and skills to effectively utilize timber in modern architectural design while considering environmental and sustainability factors.

1. LEARNING OBJECTIVES

By the end of the course, the students will be able to:

- Understand the global environmental issues associated with construction materials and why timber is a preferred choice in sustainable building practices.
- Acquire architectural thinking and design principles specifically tailored to timber construction projects.
- Explore the historical development and evolution of multi-storey timber construction methods.
- Comprehend the static and building physics requirements necessary for timber structures and their design implications.
- Trace the journey of timber from its raw form to the production of slabs and other by-products used in construction.
- Explore best practices for timber construction, including details, construction techniques, and architectural considerations.

2. CONTENT / INDIVIDUAL LECTURES

1.1. Introduction – Global Environmental Issues. Why timber?
1.2. Architecture – How to think/design in timber?
1.3. History of (multi-storey) timber construction
1.4. Forestry and Sustainable Aspects (Grey Energy, Efficiency, Economy, Economic Aspects, Regional Value Creation)
1.5. Best practice: details, construction, architecture
1.6. Building materials from tree to slab to "by-products"
1.7. Static requirements – Introduction
1.8. Introduction in Building physics – Heat / Sound / Moisture management
1.9. Introduction in Building physics – Fire protection
1.10. Building Construction: Plan generation and structural drawing
1.11. Museum in Marszewo – first CLT public building in Poland – Case study

3. ECTS	4. ACADEMIC HOURS
1 ECTs	15 SWS

5. ASSESSMENT CRITERIA

Assessment Methods	Test, group discussion, presentations of best practices
Fail	The student failed to meet the minimum requirements.
Satisfactory	Student has basic understanding of the topics (40% in Test)
Good	Student has good understanding of the topics (60% in Test)
Very good	Student has good understanding of the topics (80% in Test)
Excellent	Student has advanced understanding of the topics (90%+ in Test)

6.	**SIGNIFICANCE FOR THE GOALS OF THE CURRICULUM**
	The course offers a general overview of the important aspects of timber constructions and thus serves as an introduction to the topic. It provides the basic knowledge needed to design a timber building.
7.	**DIDACTIC METHODS**
	The didactic methods implemented in the course are blended-learning and research-based learning – review of technical literature and video materials; analysis of best practices [Assignment Book]
8.	**TEACHING MATERIALS**
	Lectures, video materials, technical literature, case studies of timber buildings [O4 Best Practices]

2. Advanced Architectural Design in Timber

This course deals with advanced topics related to timber construction, focusing on production processes, quality assurance, prefabrication techniques, and construction systems. Participants will explore timber technology, construction methods, connections, and structural systems. The course also covers timber BIM modelling, CLT (Cross-Laminated Timber) production and design, facade finishing types, wooden facades and plaster systems, flat roof solutions, interior finishing, balcony design, openings for windows and doors, and building installations with a focus on prefabricated wet rooms.

1.	**LEARNING OBJECTIVES**
	By the end of the course, the students will be able to: - Acquire comprehensive understanding of advanced timber construction techniques. - Gain the knowledge necessary for developing details for timber buildings. - Gain insights into timber technology, construction practices, connections, and structural systems
2.	**CONTENT / INDIVIDUAL LECTURES**
	2.1. Production, interfaces, quality assurance, craft, prefabrication, details 2.2. Tendering, structural systems, elements 2.3. Timber technology, construction, connections, structural systems. 2.4. Timber technology, construction, connections, structural systems (company presentation) 2.5. Timber BIM modelling. IFC and Operation and Maintenance 2.6. CLT Production, Planning, Design 2.7. Facade finishing types (construction/materials) 2.8. Wooden facades, plaster systems

2.9. Flat roof solutions (construction, materials) 2.10. Interior finishing (walls, ceilings, floors) 2.11. Balcony design and construction 2.12. Openings (window and door fixing) 2.13. Building installations - prefabrication wet rooms (onsite/partly prefab/prefab)	
3. ECTS	**4. ACADEMIC HOURS**
1 ECTs	15 SWS
5. ASSESSMENT CRITERIA	
Assessment Methods	Test, group discussion, presentations of elaborated timber-specific topics
Fail	The student failed to meet the minimum requirements.
Satisfactory	Student has basic understanding of the topics (40% in Test)
Good	Student has good understanding of the topics (60% in Test)
Very good	Student has good understanding of the topics (80% in Test)
Excellent	Student has advanced understanding of the topics (90%+ in Test)
6. SIGNIFICANCE FOR THE GOALS OF THE CURRICULUM	
The course offers advanced knowledge of the important aspects of timber buildings needed for the design process.	
7. DIDACTIC METHODS	
The didactic methods implemented in the course are blended-learning and research-based learning – review of technical literature and video materials, elaboration of timber-specific topics [Assignment Book]	
8. TEACHING MATERIALS	
Lectures, video materials, technical literature, case studies of timber buildings [O4 Best Practices], [Fact sheets]	

3. Timber Engineering

This course provides timber engineers and architects with a comprehensive understanding of engineered timber systems, structural mechanics, Eurocodes, building physics and their influence on the design process. Participants will gain knowledge and skills essential for effective collaboration between architects and engineers in timber construction projects. Through theoretical lectures, elaboration of timber-specific topics and case studies, participants will

develop a strong foundation in timber engineering principles, enabling them to contribute to the successful design and execution of timber buildings.

1. LEARNING OBJECTIVES

By the end of the course, the students will be able to:

- Comprehend the structural systems and building mechanics relevant to timber construction, enabling the design of efficient timber structures.
- Develop an advanced understanding of building physics principles related to heat, sound, and moisture management in timber buildings.
- Deepen the knowledge about developing details for timber buildings.
- Utilize timber BIM modelling to enhance the design and coordination process, improving communication and collaboration between different trades

2. CONTENT / INDIVIDUAL LECTURES

3.1. Architecture for timber engineers
3.2. Introduction to engineered timber systems and components
3.3. Structural systems / Building mechanics
3.4. Introduction to Eurocodes / Eurocodes / EC5
3.5. Advanced: Building physics - Heat / Sound / Moisture management
3.6. Detailing for timber buildings
3.7. Structural Systems – Elements
3.8. Timber BIM modelling.
3.9. Design coordination (local regulations, fire protection)

3. ECTS	4. ACADEMIC HOURS
1 ECTs	15 SWS

5. ASSESSMENT CRITERIA

Assessment Methods	Test, group discussion, presentations of elaborated timber-specific topics
Fail	The student failed to meet the minimum requirements.
Satisfactory	Student has basic understanding of the topics (40% in Test)
Good	Student has good understanding of the topics (60% in Test)
Very good	Student has good understanding of the topics (80% in Test)
Excellent	Student has advanced understanding of the topics (90%+ in Test)

6. SIGNIFICANCE FOR THE GOALS OF THE CURRICULUM

The course offers comprehensive knowledge on timber engineering principles

7. DIDACTIC METHODS
The didactic methods implemented in the course are blended-learning and research-based learning – review of technical literature and video materials, elaboration of timber-specific topics [Assignment Book]
8. TEACHING MATERIALS
Lectures, video materials, technical literature, case studies of timber buildings [O4 Best Practices], [Fact sheets]

4. Building Site Management and Building Process with Timber

This course focuses on the management aspects of timber construction projects, covering the entire construction process from mapping and correlation of parameters to logistics, cost estimation, digital processes, and sustainability considerations. Participants will learn about the installation chronology of load-bearing construction elements on the building site, moisture management, cost estimation for building life cycle assessment, BCF (Building Information Modeling, Construction, Facility Management) workflows, logistics, and best-practice examples of large-scale international timber projects. The course also emphasizes the importance of sustainability concepts, including recyclability and dismantling strategies with timber.

1. LEARNING OBJECTIVES

By the end of the course, the students will be able to:

- Map the timber construction process, understand its stages, and identify the key parameters that impact the project's success.
- Understand the installation chronology of load-bearing construction elements on the building site and ensure proper sequencing for a smooth construction workflow.
- Estimate costs for building life cycle assessment, considering dimensions, transport, montage, logistics, and the overall economic viability of timber construction projects.
- Understand sustainability concepts related to timber construction, including recyclability and dismantling strategies, and integrate them into project planning and execution.
- Understand the management of timber construction projects, while considering environmental, economic, and logistical factors.

2. CONTENT / INDIVIDUAL LECTURES

4.1. Mapping the timber construction process
4.2. Correlation of building construction parameters
4.3. Structural systems and Building mechanic – installation chronology of load-bearing construction elements on the building site
4.4. Moisture management on a building site
4.5. Cost estimation for building life cycle assessment

4.6. Cost estimation: Dimensions, transport, montage, and logistics
4.7. BCF workflow and digital processes (coordination, construction, maintenance)
4.8. Logistics – transportation, montage, timeline, coordination of companies*
4.9. Best-practice examples of large-scale international projects in timber (company presentation)
4.10. Sustainability concept – recyclability and dismantling strategies with timber*

3. ECTS	4. ACADEMIC HOURS
1 ECTs	15 SWS

5. ASSESSMENT CRITERIA	
Assessment Methods	Test, group discussion, presentations of elaborated timber-specific topics
Fail	The student failed to meet the minimum requirements.
Satisfactory	Student has basic understanding of the topics (40% in Test)
Good	Student has good understanding of the topics (60% in Test)
Very good	Student has good understanding of the topics (80% in Test)
Excellent	Student has advanced understanding of the topics (90%+ in Test)

6. SIGNIFICANCE FOR THE GOALS OF THE CURRICULUM

The course offers comprehensive knowledge on building site management and construction process of timber buildings

7. DIDACTIC METHODS

The didactic methods implemented in the course are blended-learning and research-based learning – review of technical literature and video materials

8. TEACHING MATERIALS

Lectures, video materials, technical literature, case studies of timber buildings [O4 Best Practices], [Fact sheets]

TASKS FOR PROJECT-BASED LEARNING

In addition to the theoretical knowledge transfer through the described courses, the achievement of the Learning Outcomes LO1, LO2, LO3 is accomplished through hands-on, project-based assignments that mirror the actual phases of timber building projects.

These exercises are extensively outlined in the project's Assignment Book and can be completed individually, similar to the theoretical courses. This approach allows universities and students to tailor the module curriculum based on their specific requirements and the students' prior knowledge.

No	Tasks	Number of hours
1.	LO1: Design of residential timber building (3-4 floors)	50
2.	LO2: Construction solutions for a timber building	50
3.	LO3: Elaboration of building site management concept & building a physical model	50
	TOTAL:	**150**

ASSESSMENT OF THE PROJECT-BASED TASKS:

Assessment components (in chronological order of submission/examination date)				
Type of assessment	Weighting, %	Duration *(if exam)*	Word count *(if essay or similar):*	Component pass required
Design of residential timber building	35%			Yes ☒ No ☐
Construction solutions for a timber building	35%			Yes ☒ No ☐
Building site management concept	20%			Yes ☒ No ☐
Building a physical model	10%			Yes ☒ No ☐
Total:	100%			

LEARNING MATERIALS

Core materials:

- Kapfinger, Otto; Kaufmann, Hermann. Wood Works, Springer Verlag, Wien-New York, 2011

- Kaufmann, Hermann; Krötsch, Stefan; Winter, Stefan: Manual of Multistorey Timber Construction. Detail Business Information: München, 2017

Supplementary materials:

- Pech, Anton: Holz im Hochbau. Theorie und Praxis, Birkhäuser: Basel, 2016
- Jeska, Simone; Pascha, Khaled Saleh: Neue Holzbautechnologien, Birkhäuser Verlag GmbH, Basel, 2015
- Lennartz, M. W., & Jacob-Freitag, S.: New Architecture in Wood. Birkhäuser: Basel, 2016
- Götz; Hoor; Möhler; Natterer: Holzbau Atlas, Institut für internationale Architektur-Dokumentation GmbH, München, 1980

Online resources:

- https://www.thinkwood.com/mass-timber [23.03.2022]
- www.proholz.at [06.06.2003]
- www.dataholz.eu [06.06.2003]
- https://efectis.com/en/external-thermal-insulation-composite-systems-etics/
- www.steico.com

Other materials:

REQUIRED IT RESOURCES

No.	Software, manufacturer
1.	CAD software: Revit/ArchiCad/AutoCad
2.	3D design software: Rhinoceros 3D/SketchUp/ Cinema 4D/ 3D Max
3.	Graphics and image editing: InDesign, Illustrator, Photoshop
4.	Statics & Building physics calculations: Physibel

COURSE MATERIALS

E-learning platform: https://learn.hamk.fi/course/view.php?id=10006
Fact Sheets – Booklet
Assignment Book
Best practices (Case studies)