RENEWABLE MATERIALS FOR HEALTHY BUILT ENVIRONMENTS, doctoral study programme, third Bologna cycle

Compulsory and elective course descriptions

COMPULSORY COURSES

Course name: **SCIENTIFIC WRITING AND PRESENTATION**
Number of ECTS credits: **5**

Content:
The student will review and practice key skills in scientific writing and presentation:
- Reporting scientific results
- Structuring scientific writing
- Oral presentations of scientific results
- Presenting science to non-scientific audiences
- Argument and persuasive writing
- Proposal writing
- Poster presentation
- Role of graphics and visualisation

Course name: **DESIGN AND ANALYSIS OF PLANNED EXPERIMENTS**
Number of ECTS credits: **5**

Content:
The student will become familiar with the following topics in experimental design and analysis, with an emphasis on experiments related to engineering and material science:
- Identifying and expressing hypotheses
- Sampling, experimental units, replication
- Factors and levels
- Relationship between sample size, predictive power, and planned analysis
- Randomisation
- One-way layouts
- Matched pairs
- Fixed effects, random effects, mixed effects
- Factorial arrangement
- Blocking, latin squares, split plots, nesting
- Analysis and reporting in R
- Other topics in analytics

Course name: **RENEWABLE MATERIALS FOR HEALTHY BUILT ENVIRONMENTS**
Number of ECTS credits: **20**

Content:
The student will become familiar with the following topics with an emphasis on applications in the built environment:
A. Renewable material science

- Design, development, production, and use of lignocellulosic based construction materials are the focus of this section. Structural (load-bearing) and non load-bearing interior and exterior applications will be discussed. Engineered composite theory will also be explored along with advantages and disadvantages with using each type of material in context to the build environment. Adhesives and additives necessary for producing renewable composites will be addressed in terms of LCA and VOC emitting properties. Specific renewable materials in the course include: wood, hemp, flax, straw, and other potential agricultural fibres.

B. Structural timber building systems

- Basics of timber properties (mechanical properties with the emphasis on anisotropy) and how they influence the building structural design.
- Basic structural classifications of residential timber building systems (log house, light frame, post and beam, moment resisting frame, cross laminated timber).
- Hybrid structural systems (timber-concrete, timber-steel, timber-masonry, timber-glass).
- Construction details in timber buildings (carpentry connections, contemporary fasteners).

C. Design of sustainable and restorative environments

- Sustainability with respect to building materials (environmental impacts, service life), sustainable buildings (environmental impacts, green building certification systems), and restorative environmental and ergonomic design (biophilic design, restorative environmental design).
- The links between material selection, design choices, ICT tools, etc. will be made to impacts on occupant health especially related to stress, air quality, cognition, ergonomics/activity, and ageing

D. Information and Computer Technologies

- A comprehensive overview on the basics of information processing in relationship with renewable materials research and manufacturing processing. Analysis of the research and industrial problems with respect to information processing methodologies and technologies: practice of specification and modelling. Basic understanding of key methodologies and technologies: IoT, data management and data analytics. Use cases: information engineering in renewable materials research, data-driven industrial processes, building information modelling.

E. Advanced manufacturing

- An overview of key technologies for renewable materials processing and manufacturing will be presented with a specific focus on the whole value chain analysis. Model streams, including agricultural residues, forest/timber products, recycled wood and biorefinery will be introduced as representative examples of the state-of-the-art industrial solutions. An effect of the managing manufacturing technologies on the environmental impact, service life performance, emissions and recyclability will be discussed.

Course name: **PREPARATION OF DOCTORAL DISPOSITION - SEMINAR**
Number of ECTS credits: **15**

Content:

In this course the students will be through seminars and lectures of visiting scientists from Slovenia and abroad get familiar with different topics on Data science. The topics are going to be focusing on the specific research lecturers/mentors of the study program.
Students in this course will also prepare a paper that will cover one of the areas of student interest in linking to one (or more) of the presented themes in the lectures.
The seminars will be directly linked to projects that are carried out at the university.
Within the course students will need to prepare doctoral disposition under the supervision of selected mentor in line with university regulations for disposition. The wide array of presented topics will encourage more innovative and creative thinking of students enabling them, with the help of their mentors, to be more interdisciplinary and integratory in their research work.

ELECTIVE COURSES

Course name: **SELECTED TOPICS IN WOOD SCIENCE AND TECHNOLOGY**
Number of ECTS credits: **10**

Content:
Advanced identification of wood anatomy
- Microscopic and macroscopic identification of wood, using software wood atlases
- Structure of wood from gross to molecular from X-Ray CT, NMR
- Relationship of anatomy, behaviour, and physical properties (physics, mechanics, etc)

Wood technology
- Wood, water, and their relationship
    - Types of water in wood, moisture content, equilibrium moisture content, shrinkage, swelling, specific gravity, density, influence of water on fundamental wood properties
- Mechanical properties of wood
    - Destructive and nondestructive testing of wood
    - Viscoelastic properties of wood
    - Anisotropy
    - Physical/optical testing methods

Innovative uses of Wood
Wood composites
- Types of composites (particle/fiber, laminate, matrix reinforcement)
    - Manufacturing, properties, use
    - Analysis using composite mechanics models
- Adhesive bonding of wood
    - Wettability, surface tension, adhesive penetration
    - Advanced bonding quality determination
    - Wood composites based on solid wood - types, manufacturing processes and their use

Course name: **SELECTED TOPICS IN WOOD MODIFICATION AND FUNCTIONALIZATION OF RENEWABLE MATERIALS**
Number of ECTS credits: **10**

Content:
Selective topics in:
- bulk modification/functionalization: acetylation, furfurylation, thermal treatment, impregnation, densification
- surface modification: coatings, finishing, machining
- novel approaches for alternative modification process design (e.g. biomimicry)
- Industrial scale modification processes and product quality control methods
- Characterization of modified materials: mechanical, physical, chemical
- Effect of materials modification/functionalization on human health in the context of build environment
- Time depended response of modified materials
- Service life of modified renewable materials
- End of life solution for modified renewable materials with the emphasis for cascade use
- Environmental impact of the different modification methods

Course name: **SELECTED TOPICS IN ADVANCED MANUFACTURING/ PROCESS CONTROL OF ENGINEERED REWABLE MATERIALS FOR USE IN SUSTAINABLE BUILDINGS**
Number of ECTS credits: **10**

Content:
Selective topics in:
Advanced manufacturing technologies
- CAD/CAM assisted production of buildings
- Primary and secundary production (e.g. Cross-laminated timber, glulam and big dimension members, chip/fiberboards)
- Hybrid composite biomaterials
- Innovative surface and bulk treatments of renewabble materials

Quantitative Decision Making
- Linear Programming
- Queuing Methodology
- Project Management and PERT/CPM
- Simulation
- ERP/MES/APS systems

Process Control
- Sensor Technology (thermal, mechanical, and optical)
- Discontinuous, Continuous, Cascade, and Composite Control Systems
- Multivariate process control

Course name: **SELECTED TOPICS IN RENEWABLE MATERIAL ENGINEERING AND SUSTAINABLE CONSTRUCTION**
Number of ECTS credits: **10**

Content:
Selected topics in:
- Utilization of renewable materials in green buildings.
- Fundamentals of Sustainable Construction with Renewable Materials.
- Construction engineering principles:
  - Advanced light-frame and heavy frame construction
  - Engineered renewable products; glulam, CLT, LVL, composites (hemp, bamboo, fibreboards) and hybrid elements
  - Connections in sustainable structures with an emphasis in their deformation capability
  - Design principles according to Eurocode standards; vertical loading, horizontal loading (wind, seismic), fire
  - Design principles beyond building codes (displacement based design, dynamic analyses, openings in elements)
  - Strengthening and retrofitting of existing structures and elements
  - Mathematical modelling of structures
  - Detail designing of structures for structural and building physic demands (thermal, sound, moisture, fire)

Course name: **SELECTED TOPICS IN THE CHARACTERISATION OF RENEWABLE MATERIALS**
Number of ECTS credits: **10**

Content:
Selective topics in:
- aesthetic characterization (color, gloss, texture)
- durability and service life performance (biotic and abiotic resistance)
- mechanical characterization (stiffness, elasticity, tensile, compression, shearing, bending strength, hardness)
- acoustic characterization (vibrational methods)

- thermal characterization (thermal conductivity, active and passive thermovision)
- optical characterization (microscopy)
- human health and safety aspects characterization
- different approaches for data evaluation
- methods applicable for in-situ measurements

Course name: **SELECTED TOPICS IN THE REGENERATIVE SUSTAINABILITY**
Number of ECTS credits: **10**

Content:
This course introduces the topic of restorative and regenerative sustainability with a focus on the role of buildings and building design. Restorative and regenerative design include aspects of ecological, economic, social sustainability as well as human wellbeing impacts. Framing topics include building aspects such as material selection, design decisions, target use and users as well as building rating and design systems.
Selected topics in:

- Sustainability, restoration, regeneration
- Dimensions of sustainability
- Role of buildings
- Environmental, economic, human, and social impacts of buildings
- Urbanisations, well being
- Building assessment systems
- Policy and regulatory situation
- Renewable materials in regenerative sustainability
- Forest sector activities in sustainability
- Intersectionality in sustainability

Course name: **SELECTED TOPICS IN HUMAN HEALTH IN THE BUILT ENVIRONMENT**
Number of ECTS credits: **10**

Content:
This course will introduce the student to a wide variety of building impacts on human health. Selected topics in:

- Indoor Air Quality
- Stress
- Cognition and performance
- Acoustics
- Lighting
- Thermal comfort
- Ergonomic/kinesiological factors
- Role of Material selection
- Community design
- Ambient assisted living / active healthy ageing
- Other topics

Course name: **SELECTED TOPICS IN IoT AND THE BUILT ENVIRONMENT**
Number of ECTS credits: **10**

Content:
Selected topics with an emphasis on applications in the built environment:

- Principles of building informatics and information processing
- Basics of sensors, sensor networks and IoT tools
- Data processing and data management in sensor networks
- Cloud computing, Big data and data engineering

- IoT platforms and their integrated applications
- Principles of information systems
- Building Information Modelling in design and sustainable building management
- Optimisation in sustainable building design and construction
- Augmented and virtual reality in building design and construction
- Principles of building management systems

Course name: **SELECTED TOPICS IN MODELING**
Number of ECTS credits: **10**

Content:
Selected topic in:
- Physical modelling using finite elements
- Finite element (FE) method
  - Basic types of finite elements (linear, planar, volume)
  - Material models used in FE modelling (elasto-plastic models of renewable materials incl. plant tissues such as wood, bamboo and hemp, man-made materials)
  - Geometry preparation for FE simulations (deterministic and from images of biomaterials)
- Structural analyses (static, modal, harmonic, transient)
- Thermal analyses (steady-state and transient)
- Modelling of composite materials (fibre and layered man-made and bio-composites)
- Modelling of buckling

Course name: **HOLISTIC DESIGN OF CONTEMPORARY TIMBER BUILDINGS**
Number of ECTS credits: **10**

Content:
Design of contemporary timber buildings.
- Static design load cases
- Wind design
- Seismic design
- Acoustic details
- Fire design
- Connection design
- Holistic design principles, interaction of different load cases, identification of collisions. Combination with human wellbeing issues.

Course name: **THE BUILT ENVIRONMENTS AND ROLE OF ENGINEERS**
Number of ECTS credits: **10**

Content:
Provides the students a wide asset of competences and knowledge necessary for comprehension of the built environment, roles and specific tasks of the established engineering fields and their interactions.
- Built environment throughout history
- Construction fields (structural engineering, civil engineering, engineering structures, infrastructure)
- Heating, ventilation and plumbing, electrical installations
- Materials for construction
- Construction design (static, dynamic, fire)
- Building physics (temperature, humidity)
- Influence of construction on the environment, LCA and LCC, sustainability certifying
- Building retrofit
- Human health in the built environment

- Smart buildings
- Building performance along the service life
- Building legislation