Courses content of the third semester at Aalto

Course title: Lignocellulose chemistry

Key words	lignin, cellulose, hemicellulose, structure, conversion, delignification
Aims	The course provides understanding on the structure of the main components of lignocellulose and their reactions under conditions that are relevant for chemical fractionation and conversion of biomass in industrial scales.
Content	Lectures on acid-base catalysed degradation and oxidation reactions of cellulose, hemicelluloses and lignin during the most relevant chemical fractionation processes of plant biomass. Relationships between the chemical structure and reactivity. Description of reaction rates based on the reaction mechanisms. Laboratory works that deepen the understanding on selected reactions and exemplify the use of analytical techniques in monitoring the reactions.
ECTS	**5**
Skills	Knowledge and understanding For a passing grade the student must • understand chemical reaction mechanisms • be able to derive reaction rate equations • know the main chemical components of lignocellulose • understand the impacts of chemical reactions • know the main methods for structural analysis of lignocellulose Competences and skills For a passing grade the student must • carry out laboratory works • write laboratory reports • reflect own learning by writing • demonstrate own learning orally Judgement and approach For a passing grade the student must • keep and present a learning diary • have a learning reflection discussion with the professor • submit reports on the laboratory works
Module Coordinator(s)	Tapani Vuorinen, professor
Teaching staff	Tapani Vuorinen, Iina Solala, course assistants
Language of instruction	English
Nb hours of lectures	24

Nb hours of practical work	30
Nb hours of tutorials	5
Nb hours of personal work	65
Nb hours of other	11 (group work)
Length of the internship in weeks	
Bibliography recommended	
Prerequisites	Plant Biomass recommended
Teaching period (when)	II (November-December)
Place of teaching (where)	Aalto University
Assessment	Learning diary, learning reflection discussion, working in laboratory, laboratory work reports

Course title : Plant biomass

Key words	lignocellulose, composition, structure, fractionation, products
Aims	The course provides a broad view on the significance of global biomass resources, chemical composition and anatomical structure of plants, fractionation of biomass into its main components and their conversion into various products.
Content	Lectures on living functions, chemical composition and anatomical structure of plants, chemical, biochemical and thermochemical fractionation methods of plant biomass, material and chemical products from plant biomass. Case presentations from bioproduct industry. Literature reviews on specific biomass crops and their use, including sustainability aspects. Laboratory works on chemical analyses and microscopy of plants.
ECTS	**5**
Skills	Knowledge and understanding For a passing grade the student must • understand the importance of plant biomass • know the main fractionation methods of plant biomass • recognize the main products from plant biomass • know the analytical methods for analysing the chemical composition of plant biomass • know microscopic methods for structural analysis of plant tissues Competences and skills For a passing grade the student must • carry out laboratory works • carry out scientific literature search • write a scientific report • provide a seminar presentation

	Judgement and approach For a passing grade the student must • submit a literature report on a given topic • give a seminar presentation on the same topic • submit a report on the laboratory works
Module Coordinator(s)	Tapani Vuorinen, professor
Teaching staff	Tapani Vuorinen, Iina Solala, course assistants
Language of instruction	English
Nb hours of lectures	20
Nb hours of practical work	30
Nb hours of tutorials	5
Nb hours of personal work	65
Nb hours of other	15 (seminar, group work)
Length of the internship in weeks	
Bibliography recommended	
Prerequisites	No prerequisites
Teaching period (when)	I (September-October)
Place of teaching (where)	Aalto University
Assessment	Written report on literature assignment, seminar presentation, working in laboratory, laboratory work report

Course title: Fiber and Fiber Products Course

Key words	Natural fibers, cell wall, fiber networks
Aims	The aim of this course is to give students an undertsanding of the production, structure, characterization and use of cellulosic fibers.
Content	The emphasis is on natural fibers derived from wood and their use in paper and board products. However, regenerated fibers, carbon fibers and emerging applications are covered to some extent. Laboratory exercises concentrate on fiber characterization and identification. topics include: fiber isolation from wood, fiber morphology, fiber/water interactions, fiber reactivity, paper physics, regenerated fiber production and use, emerging fiber applications.
ECTS	**5**
Skills	Knowledge and understanding For a passing grade the student must • Understand the basics of pulp fiber morphology • Be able to characterize natural fibers • Understand how pulp fibers interact with water • Understand basics of fiber networks • Understand technical differences between different types of pulp fibers

	Competences and skills For a passing grade the student must • Be able to capable to carry out laboratory measurements • Be able to analize lab data and draw conclusions • Make a written and oral presentation Judgement and approach For a passing grade the student must • Show a systematic approach to analysing and classifying fibers
Complementary skills	Presentation skills
Module Coordinator	Thad Maloney
Teaching staff	Eero Hiltunen
Language of instruction	English
Nb hours of lectures	24
Nb hours of practical work	60
Nb hours of tutorials	
Nb hours of personal work	50
Nb hours of other	
Length of the internship in weeks	N/A
Bibliography recommended	N/A
Prerequisites	N/A
Teaching period (when)	I
Place of teaching (where)	School of Chemical Engineering, Aalto University
Assessment	40% exercises, 60% exam

Course title: Cellulose-based fibres (including Green Line project 3rd stage)

Key words	fibre cell wall, cellulose microfibril, nanocellulose, lignin, hemicellulose, functional materials, regenerated fibres
Aims	Acquaint the student with plant-based fibres and nanofibres: structure, physical and chemical behavior as well as applications
Content	Isolation of wood and non-wood fibres from the plant material; cell wall structure of lignocellulosic fibres; chemical structure and most common chemical reactions of cell wall components; structure-property relationships of lignocellulosic fibres; sorption behaviour and effect on properties; fibre mechanics and modelling; defects in fibres and their effect on properties; dissolution of cellulose and manufacture of regenerated cellulose; structure and properties of regenerated cellulose; nanocellulose – isolation, characteristics and applications
ECTS	**5**

Skills	Knowledge and understanding For a passing grade the student must • Be able to tell the physical and chemical distinctions between natural fibres, regenerated fibres, and nanofibres • Be able to describe the basic structures, properties and functions of common hemicelluloses and lignins • Master the morphology of the native cellulose microfibril and acknowledge how it affects nanocellulose preparation and properties • Be able to detect the major obstacles and difficulties in cellulose dissolution and regeneration through basic laws of physical chemistry • Be able to explain the main pathways to chemical modification of cellulose, including nanocellulose • Be able to apply basic structure-property relationship to cellulose-based fibres and understand their implications in most common modern applications Judgement and approach For a passing grade the student must • Be able to distinguish the special nature of plant-based fibres and assess how the properties affect their applicability • Be able to point out the main bottlenecks in modern applications of cellulose-based fibres, and fibre components • Be able to choose correct analytical methods for assessing certain properties of cellulose-based fibres and their applications
Module Coordinator(s)	Prof. Eero Kontturi
Teaching staff	Prof. Eero Kontturi, Prof. Michael Hummel, hand-picked PhD students and postdocs supervising over laboratory works
Language of instruction	English
Nb hours of lectures	24
Nb hours of practical work	70
Nb hours of tutorials	
Nb hours of personal work	40
Nb hours of other	
Length of the internship in weeks	N/A
Bibliography recommended	N/A
Prerequisites	N/A
Teaching period (when)	I + II (autumn)
Place of teaching (where)	School of Chemical Engineering, Aalto University
Assessment	Oral examination (50%) Report on the laboratory work (50%) Grading from 0-5

Course title: An Introduction to Wood Properties and Wood products

Module's title	An Introduction to Wood Properties and Wood products
Key words	Wood; wood products; wood properties
Aims	The aim of this course it to introduce students to the structure of wood and its material properties as well as some of the important wood-based products and how they are manufactured. There is emphasis on the properties and products of wood relevant to applications in the built environment. After the course the student: • understands the basics of wood properties and behaviour, especially with respect to use in the built environment, and how this can be managed • knows about the range of wood products commercially available, or that are under development • appreciates how the most common wood products are manufactured and how they can be used
Content	Tree growth and ecology; wood species; wood anatomy; wood ultrastructure; moisture and wood; short-term and long-term mechanical properties; wood degradation; acoustic and thermal behaviour; wood products; wood product manufacturing.
ECTS	**5**
Skills	Knowledge and understanding For a passing grade the student must • be familiar with tree growth and the ecological factors that affect it • knows the key anatomical features of wood be familiar with the main chemical constituents of wood, their properties and how they make up the structure of the wood cell wall • know about the anisotropic nature of wood and appreciate how the anatomical structure of wood affects its physical and mechanical properties • be familiar with the relationship between mass and volume in wood • know the states of water in wood and be familiar with the thermal, electrical and acoustic properties of wood and appreciate its behaviour in fire • be familiar with the key physical and biological agents responsible for the degradation of wood • know about the short-term and long-term mechanical behaviour of wood under static and cyclical loading and appreciate how environmental factors affect this • appreciates how wood might be utilised in energy and resource efficient constructions • be able to describe the key steps in the manufacture of solid wood and wood-based composite products Competences and skills For a passing grade the student must

	• be able to differentiate important softwood and hardwood species from their microstructures • be familiar with how water affects the mechanical and physical properties of wood, as well as how it affects its durability Judgement and approach For a passing grade the student must • ……
Module Coordinator(s)	Mark Hughes
Teaching staff	Mark Hughes, Hannu Viitanen
Language of instruction	English
Nb hours of lectures	0-30 h
Nb hours of practical work	0-40 h
Nb hours of tutorials	0
Nb hours of personal work	0-50 h
Nb hours of other	0-30 h
Length of the internship in weeks	13
Bibliography recommended	J.M. Dinwoodie (2000), "Timber: Its nature and behaviour", CRC Press; 2 edition.
Prerequisites	None
Teaching period (when)	Periods 1 & 2 (autumn)
Place of teaching (where)	Department of Bioproducts and Biosystems
Assessment	Examination; reports

Course title: Polymer Blends and Composites

Key words	Polymers; Composites; Mechanics; Properties; Manufacture
Aims	The aim of this module is for students to be able to: • Appreciate the potential of polymers in composite technology • Understand the role of reinforcement, matrix and interface • Appreciate reinforcement processes in short- and long-fibre reinforced composites • Understand the influence of fibre architecture on composite properties • Know how micromechanical models can be used to predict selected composite properties • Evaluate the compatibility between polymer and reinforcement/filler systems and is familiar with the main methods of controlling compatibility • Know how thermosetting and thermoplastic polymer composites can be processed into various products • Able to conducts a literature study and present the study orally
Content	Fibre reinforced polymer matrix composites (FRP); reinforcement, matrix and interface; principles of load sharing; stress transfer mechanisms; fibre

	(reinforcement architecture); thermoset and thermoplastic polymer composites processing; polymers blends; interfaces; applications for FRPs.
ECTS	**5**
Skills	Knowledge and understanding For a passing grade the student must • be familiar with the potential of synthetic polymers in composite technology • know about the role of reinforcement, matrix and interface in a composite system • know about the principles of load sharing and reinforcement processes in short and long fibre reinforced composites and the influence of fibre architecture on composite properties • know about the methods to process thermosetting and thermoplastic polymer composites into various products Competences and skills For a passing grade the student must • be able to use simple micromechanical models to predict selected composite properties • be able to evaluate the compatibility between polymer and reinforcement/filler systems and be familiar with the main methods of controlling compatibility • be able to complete a literature study and present his/her study orally Judgement and approach For a passing grade the student must • .....
Module Coordinator(s)	**Mark Hughes**
Teaching staff	**Mark Hughes; Sedigheh Borandeh; Sami Lipponen**
Language of instruction	**English**
Nb hours of lectures	**14**
Nb hours of practical work	**-**
Nb hours of tutorials	**-**
Nb hours of personal work	**81 (Project work and presentation)**
Nb hours of other	**40 (Self-study for exam)**
Length of the internship in weeks	**N/A**
Bibliography recommended	• **D. Hull and T. W. Clyne. "An Introduction to Composite Materials" (Cambridge Solid State Science Series)** • **M.R. Piggott. "Load bearing fibre composites" (Pergamon)**
Prerequisites	**None**
Teaching period (when)	**Period I**
Place of teaching (where)	**Department of Bioproducts and Biosystems**
Assessment	**Examination; project work; presentation**