University of Zagreb

Faculty of Forestry and Wood Technology

Course Catalogue for Incoming Students

Zagreb, February 15, 2019

Updated: March 05, 2024

Study at Faculty of Forestry and Wood Technology

The Faculty of Forestry and Wood Technology is an internationally recognized institution which offers a high level of education for careers in forestry, wood processing and furniture manufacture. The Faculty is a place for permanent education and for the development of an intellectual with a broad spectrum of knowledge, whose work is recognized not only in the professional field but also in the social life of Croatia. The Faculty draws on the celebrated past and activities of its forerunners. We are a renowned profession which has its written rules and values, but also unwritten rules which you will learn in practice. We are well known for our close collaboration and solidarity.

Incoming Students

Exchange students are students participating in a formal exchange programme between their home university and the University of Zagreb (i.e. Erasmus+, CEEPUS, Bilateral agreements etc.)

Incoming students can choose courses from the list „Courses in English Available to Incoming Students in Academic Year 2022./2023." in this catalogue, published on Faculty's website. Courses in catalogue are divided according to study level (undergraduate or graduate) and according to Faculty departments (Forestry, Wood Technology). All courses are awarded with credits using the ECTS system.

At the moment, Faculty of Forestry and Wood Technology does not offer full degree study programs (undergraduate or graduate) in English language.

Study Programmes

Faculty of Forestry and Wood Technology offers 3 Undergraduate Study Programmes, 5 Graduate Study Programmes, 8 Specialist Postgraduate Study Programmes and one Postgraduate Doctoral Study Programme.

Undergraduate Study Programmes (BSc)
Forestry
Urban Forestry, Nature Conservation and Environmental Protection
Wood Technology
Graduate Study Programmes (MSc)
Forestry - Silviculture and Management Planning with Wildlife Management
Forestry - Techniques, Technologies and Forestry Management
Urban Forestry, Nature Conservation and Environmental Protection
Close to Nature Forestry (Programme in English)
Design of Wood Products
Wood Technology Processes
Specialist Postgraduate Study Programmes (8)
Postgraduate Doctoral Study Programme (1)

The undergraduate study programmes have duration of 3 years (6 semesters; 180 ECTS credits).
The graduate study programmes have duration of 2 years (4 semesters; 120 ECTS credits).
Upon graduation there is a possibility to continue the studies at the doctoral level in duration of 3 years (180 ECTS) or at specialist level in duration of 2 years (120 ECTS).
At all programme levels, students participate in classes in newly equipped classrooms and laboratories, and at the training and research forest centres.
Field classes enable students to acquire practical knowledge, and are held at the Faculty's 5 forest centres. These are distributed among all the important climatic zone forest communities in Croatia, of which the Faculty is particularly proud.

Learning outcomes at program level

Undergraduate Study Programmes (BSc)

Forestry

Upon completion of the undergraduate studies, the student receives a certificate stating the completion of studies and the acquisition of a title according to the course of studies: University degree of Bachelor (baccalaureus/baccalaurea) in Forest Engineering

Forestry is a profession, science and art of managing and preserving forest ecosystems for the permanent welfare of society, environment and economy. Accordingly, the students of undergraduate and graduate studies are instructed to manage forest ecosystems from the biological, ecological, technical and economic point of view.

Programme of Undergraduate Studies in Forestry is designed in a way that it leads the student in a logical sequence from the fundamental biological and technical disciplines, over the introductory disciplines to the components of the forest ecosystems and forest management techniques, to those disciplines that complete the knowledge about forest and forest land management.

The skills acquired by completing these programme studies: full proficiency as forest district manager, expert associates in forestry professions, duties in forest inventory, participating in the implementation of the forest management program, all professional field works on establishing, tending and regeneration of forest stands, knowledge of mechanical means, techniques and standard technologies applicable in forestry - first of all in forest harvesting from natural forests, forest cultures and plantations. Furthermore, a bachelor of forestry is qualified for expert works on melioration and landscaping of forest areas in the Mediterranean area, protection of forests from abiotic and biotic factors, especially from fires, management of professional activities related to the implementation of hunting management plans and programmes, organization of hunting grounds, collaboration in the preparation of the environmental studies and zoning plans, technique and technology of forest road construction, sales of wood assortments, organization of production in forestry, safety in forestry work. He/she has been trained for individual works in sectors of private enterprise and forest district management system, as well as for the teamwork in all other activities related to the professions in forestry, nature and environment protection.

With a Bachelor's degree of Forestry students are prepared for their professional development by participating in various seminars and workshops during their practical experience, and during their regular studies they get completely qualified to continue their studies at the Faculty of Forestry and Wood Technology in graduate studies with the programmes in Silviculture and Management Planning with Wildlife Management, and in Technique, Technologies and Management in Forestry.

Urban Forestry, Nature Conservation and Environmental Protection

Upon completion of the undergraduate studies, the student receives a certificate stating the completion of studies and the acquisition of a title according to the course of studies: Bachelor/(baccalaureus/baccalaurea) Engineer of Urban Forestry, Nature Conservation and Environmental Protection

The Undergraduate Studies of Urban Forestry, Nature Conservation and Environmental Protection are studies based on a reform of similar studies in Europe and it partially derives from the Studies existing at the Department of Forestry so far.

A Bachelor of Urban Forestry, Nature Conservation and Environmental Protection is qualified for professional forestry jobs of an expert associate carried out in urban areas (biological and technical works on landscaping of parks and greening,

protection of plants in urban areas, arboriculture, nursery, seed growing, etc), as well as for the jobs related to nature and environment protection (professional jobs in natural protected areas, collaboration in the development of environmental studies and space planning, integrated environmental management and legislation, environmental monitoring, etc.)

With a Bachelor's degree in Urban Forestry, Nature Conservation and Environmental Protection students are prepared for their professional development by participating in various seminars and workshops during their practical experience, and during their regular studies they get completely qualified to continue their studies at the Faculty of Forestry and Wood Technology in the graduate studies with the programmes in Urban Forestry, Nature Conservation and Environmental Protection. He/She is also qualified for an individual or team-work, he/she has been introduced to the trends in urban forestry, nature conservation and environmental protection in the country and in the world.

Wood Technology

Upon completion of the undergraduate studies, the student receives a certificate stating the completion of studies and the acquisition of a title according to the course of studies: Bachelor's degree (baccalaureus/baccalaurea) in Wood Technology.

The Undergraduate Studies of Wood Technology provide basic knowledge from a wide range of technical and natural sciences, as well as the professional knowledge and skills required by the modern development of the wood industry companies: knowledge of wood structure and wood technical properties, basic knowledge of wood protection, basic technical knowledge for monitoring and control of machine operations and transport equipment, competences for monitoring wood technology processes and implementing certain technological operations. Participating in the supply of materials and other equipment, monitoring the product and work performance quality, expert, operational knowledge of the management of wood technology processes.

With a Bachelor's degree in Wood Technology students are prepared for their professional development by participating in various seminars and workshops during their practical experience, and during their regular studies they get completely qualified to continue their studies at the Faculty of Forestry and Wood Technology in graduate studies with the programmes in Wood Technology Processes and Design of Woof Products.

A Bachelor of Wood Technology is qualified for professional jobs in all forms of enterprises dealing with wood treatment and wood processing, he/she can work as an associate in trade business and distribution of wood products and carry out duties and tasks in wood-processing enterprise. A Bachelor of Wood Technology is also qualified for supervising the processes of wood drying and of wood materials, for monitoring the implementation of technological processes in sawmills, in the field of the production of veneer, plywood panels and chipped wood panels, furniture, builders joinery and of other wood products.

The students at the undergraduate studies of wood technology will be able to participate in horizontal mobility within the areas of the Biotechnical Sciences and European Universities, the University of Zagreb or the Faculty of Forestry and Wood Technology has signed the Cooperation Agreement with. A special programme will enable the undergraduate students of related faculties who want and are entitled to follow individual courses or to further continue with graduate studies at the Faculty of Forestry and Wood Technology.

Graduate Study Programmes (MSc)

Forestry - Silviculture and Management Planning with Wildlife Management

Upon completion of graduate studies and final thesis defence, the student receives a university diploma stating the completion of studies and the acquisition of an academic title according to the programme of studies: Master's degree in Forest Engineering - Silviculture and Forest Management with Wildlife Management

The skills acquired by completing these programme studies: the knowledge of the position and trends of forestry profession in the country and in the world, full proficiency in forest ecosystems management in every sense, implementation of the forest management plans, establishment and growth of forests, melioration and landscaping of

forest areas in the Mediterranean area, protection of forests from abiotic and biotic factors, especially from fires, management of professional activities related to the implementation of hunting management plans and programmes, organization of hunting grounds, the preparation of the environmental studies, development of forest zoning plans, the activities of an expert manager and supervisor in nature and environment protection, wood assortment placement, safety in the forestry workplace, organization of production in forestry, coordination of all activities in forestry, he/she is prepared for his/her professional and scientific development and postgraduate studies through various educational forms.

Master of Forest Engineering - Silviculture and Forest Management with Wildlife Managementis fully prepared for an individual and teamwork in the fields of forest growing and tending, forest and hunting planning, and has additional applied knowledge in the fields of techniques, technologies and management in forestry.

Job competences and qualifications: most complex jobs in all forms of forestry organizations from forest district to complex trade company, county and state inspectors, forestry and hunting advisory service, a professional associate in research institutions in the field of forestry and hunting, directors, expert manager and supervisor in protected natural facilities, manager and associate in forestry products trade and traffic affairs, jobs and tasks in forestry entrepreneurship, teacher in vocational secondary and related schools, publicist writing and media jobs and tasks related to forestry profession.

Forestry - Techniques, Technologies and Forestry Management

Upon completion of graduate studies and final thesis defence, the student receives a university diploma stating the completion of studies and the acquisition of an academic title according to the programme of studies: Master's degree in Forest Engineering - Techniques, Technologies and Management in Forestry

The skills acquired by completing these programme studies: the knowledge of mechanical means, techniques and standard high quality technologies applied in forestry, primarily in forest harvesting from natural, even-aged and uneven-aged forest stands, cultures, plantations and energy woods, the knowledge of main and secondary wood products and their movement from their point of production to the market by means of the off-road transportation and through the network of forest and public roads, the knowledge of the preparing and planning methods for technical works in forestry, methods, techniques and technology of forest opening, ie the design and construction of a forest road network, the choice of mechanical means and technologies based on cost analysis and other criteria, the knowledge of the forest, human and technical potential management, marketing knowledge related to forest wood products and secondary forest products. The candidate additionally masters the applied knowledge of ecology, forest protection and forest management.

The Studies develop student's competence and ability to manage and make independent and team-oriented expert (business) decisions, and the ability to involve in doctoral studies and in scientific expert courses.

Job competences and qualifications: forestry jobs of a greater complexity from the Forest Office to Forest District as vertically the lowest structural forest units, forestry jobs under the competency of county and republic institutions, inspections services, duties and tasks related to forestry entrepreneurship, jobs and duties in development, scientific and educational institutions, the traffic of forest products on domestic and foreign markets, the traffic of equipment, the duties of a professional publicist writing and media related to the profession.

Urban Forestry, Nature Conservation and Environmental Protection

Upon completion of graduate studies and final thesis defence, the student receives a university diploma stating the completion of studies and the acquisition of an academic title according to the programme of studies: Master of Engineering in Urban Forestry, Nature Conservation and Environmental Protection

The Skills acquired by completing these studies: the knowledge about urban forestry, nature conservation and environmental protection in the country and in the world, proficiency in the development of environmental studies, management and planning in forest ecosystems of the natural protected areas, space analysis and evaluation, integrated protection in natural protected areas, ecological monitoring, management and protection of soil and water, restoration of degraded habitats, management of animal species, proficiency in development of environmental studies, management in specific urban forest ecosystems, analysis and evaluation as well as design of park areas, horticultural Dendrology, production of ornamental plants, integrated protection of tree species in urban areas, planning and management of

professional forestry jobs in urban areas, development of programmes and management bases in natural protected areas and urban forest ecosystems, preparation for the professional and scientific development through various educational forms and postgraduate studies.

By acquiring knowledge and skills through graduate studies, a Master of Engineering in Urban Forestry, Nature Conservation and Environmental Protection is fully prepared for an individual and team-work in the field of urban forestry, nature conservation and environmental protection.

Job Qualifications: the most complex jobs in all types of organizations of the protected natural areas (strictly protected reserves, national parks, special reserves, nature parks, nature monuments, significant landscapes, forest parks and monuments of park architecture), in public/state administration, county and municipal administration, including advisory services and inspections, proficiency in horticultural jobs and jobs in utility companies, expert associate and coordinator jobs in research and scientific institutions in the field of urban forestry, nature conservation and environmental protection, expert manager and supervisor in nature conservation and environmental protection, teaching and education jobs in vocational high-schools and other related schools, duties and tasks in publicist writing and media related to urban forestry, nature conservation and environmental protection.

Close to Nature Forestry (study program in English)

The duration of study program is four semesters (2 years, 120 ECTS-credits). It is a graduate university study program (single major). This program is fully accredited and meets the requirements of the European Bologna system. Successful graduates receive the title " mag. ing. nat. silv." (Master of Close to Nature Forestry).

The study program is conducted by lecturers with many years of experience in teaching and with a personal approach to each student. Classes are held in the modern and fully equipped classrooms and laboratories. Study program includes practical work in the field, in Faculty's own forests, that is, Training and Forest Research Centres, which are located throughout Croatia, from lowland and floodplain areas to mountainous and coastal regions; and also in forests managed by our partners (national parks, state-owned forests, etc.).

Skills achieved upon the completion of the study program:
Masters of Close to Nature Forestry are equipped for activities in the fields of forestry, ecology and nature conservation. They are competent for the management and conservation of forest ecosystems at the global level, based on the sustainable management and use of natural resources. They are qualified for an integral approach to forest management, taking into account many services that forests provide (such as climate, biological diversity, circular economy built on biological foundations, social and cultural services) and for quickly resolving numerous challenges.

They are also trained and equipped to:

- develop and implement forest ecosystem management plans and programmes,
- develop, organize and implement strategic plans and more complex tasks in forestry,
- manage and make independent business decisions in the areas of silviculture, forest protection, forest management and exploitation, and wildlife management
- organize and implement professional field tasks to establish, cleaning, thinning and regeneration of forest stands
- organize and implement works in forest inventory and pruning
- organize and implement works to protect forests from abiotic and biotic factors
- draft ecological studies and implement ecological forest monitoring
- apply knowledge of mechanical means, techniques, and technologies in performing forestry works
- apply knowledge of techniques and technologies to open forests and build forest roads
- apply knowledge on the main and secondary forestry products and ecosystem services
- apply methods to prepare, plan and organize works in forestry

- manage forestry, human and technical resources in conducting forestry works
- improve the existing technology and introduce new technologies
- plan, organize and implement production organization tasks in forestry
- plan and calculate production, calculate the basic business success indicators, draft basic financial reports, recognize types of costs, define and analyse costs
- manage the most complex tasks in all forms of forestry organizations
- perform the duties of a scientific and professional associate in scientific research institutions in the field of forestry

Job competencies and qualifications:
Upon completion of the graduate university study programme Close to Nature Forestry, the Master of Close to Nature Forestry is trained for work in private companies, public and private sector in the profession. They are equipped to perform the most complex tasks in all forms of forestry organisms, from districts to complex companies, county and national inspectorates, forestry and hunting advisory services, as expert associates in research institutions in the field of forestry and hunting, directors, managers and supervisors in protected natural areas, managers and associates in the trade of forest products, tasks in forestry business, teachers in professional secondary and similar schools, tasks in publishing and the media associated with the forestry profession.

Wood Technology Processes

Upon completion of graduate studies and final thesis defence, the student receives a university diploma stating the completion of studies and the acquisition of an academic title according to the programme of studies: Master of Wood Technology - Wood Technology Processes

Skills acquired by completing these studies: the knowledge of position and trends in the wood processing sector in the home country and abroad, scientific knowledge about wood as a renewable material, full proficiency in management of wood technology processes, planning and calculation of production, coordination of all the activities in wood industry, preparation for the professional and scientific development through various educational forms and postgraduate studies. A Master in Engineering is completely prepared for an individual and team work in the fields of sawing and hydrothermal treatment of wood, wood protection, in the field of veneer production technology, of plywood panels and chipped wood panels, in the production technology of the final wood products, in particular the coordination of wood and wood products surface treatment processes. A Master's in engineering is involved in design of technology, developing and improving production, optimizing production and has additional applied knowledge in the fields of engineering and management in the wood industry. He/She writes his/her final thesis of an experimental, professional or scientific character.

Master of Engineering is qualified for the most complex jobs in all forms of enterprises dealing with the treatment, processing of wood and wood trade and in consulting and design companies, he/she can work as expert associate in research institutions in the field of wood and wood technologies, as a manager and associate in trade and traffic of wood products, he/she can carry out duties and tasks in wood technology enterprises, work as a teacher in vocational high schools and other related schools and carry out duties and tasks in publicist writing and media related to professions in wood industry.

Wood Product Design

Upon completion of graduate studies and final thesis defence, the student receives a university diploma stating the completion of studies and the acquisition of an academic title according to the programme of studies: Master of Woof Technology - Design of Wood Products

Given the specificity of the Studies in Design of Wood Products, whose program is mainly addressed to the sector of wood industry, it is expected that the cooperation with the economic and public sector will be of a wide and mutual advantage. The objective of the students' education is to establish an interdisciplinary collaboration of this profile of students with economic entities, and finds support in the practical use of their solutions through communication and cooperation with the industry and trade, either from the state or private sector. The project tasks that a student solves in collaboration with

production companies, lead him/her systematically through the knowledge, problem analysis, conceptual solutions and proposals for solving the default problem in all directions - of design, structural, technical, technological - in the very process of production, programming and of market research, promotional activities and distribution of wood products, to bring the solution to the creation of a model or a prototype while mastering communication skills with associates of different profiles.

Master of Woof Technology - Design of Wood Productsis qualified to carry out professional duties in bigger and smaller companies (from the company's plant to the saloon) dealing with the production or distribution of furniture or other wood products. He/She is also ready to take part in solving the interdisciplinary problems related not only to a part of designing or constructing products and their presentation, but also to a decision about the choice of materials, reproductive materials, treatment technology and the quality assurance of the final product. Thanks to the knowledge of the methodology of design of final wood products, the graduate students are qualified to carry out a series of functions, from the product development, quality improvement, product design and construction, equipment of facilities, all the way to the presentation and sale of products on the fairs.

Academic Calendar 2023/2024

WINTER SEMESTER

Teaching period	October 2, 2023 to January 26, 2023
Winter holidays (no classes)	December 25, 2023 to January 7, 2024
Winter examination period (no classes)	January 29, 2024 to February 23, 2024

SUMMER SEMESTER

Teaching period	February 26, 2024 to June 7, 2024
Summer examination period (no classes)	June 10, 2024 to July 12, 2024

NATIONAL HOLIDAYS	
January 1	New Year's Day
January 6	Epiphany
March 31 and April 1	Easter and Easter Monday
May 1	Labor Day
May 30	Statehood Day
May 30	Corpus Christi
June 22	Anti-Fascist Struggle Day
August 5	Victory and Homeland Thanksgiving Day
August 15	Assumption of Mary
November 1	All Saint's Day
November 18	Remembrance Day
December 25	Christmas
December 26	St. Stephen's Day

Student Support

Faculty of Forestry and Wood Technology

International Relations Office

- room 146 (yellow building)
- International Relations Coordinator
  Katarina Korov Faj mag. ing. silv.
  Phone: +385 99 263 3048
  E-mail: kkorov@sumfak.unizg.hr (contact for students)
- ECTS Coordinator
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Department of Forestry Courses - Undergraduate Study Programmes (BSc)

BASES OF HUNTING MANAGEMENT (code: 33863)

Original course title	Osnove lovnog gospodarenja	Status	compulsory
Semester	winter	Course teacher	Prof. Marijan Grubešić, PhDProf. Krešimir Krapinec, PhD; Assist. Prof. Kristijan Tomljanović, PhD
ECTS	6	Study level and programme	BSc Forestry

Course content

Lectures:
1. Introduction. Content. Historical overview of hunting development
2. Hunting management as a sports, recreational and economic activity
3. Game zoology. Game classification (scientific, hunting and legal)
4. Morphology, biology and ecology of large furry game
5. Morphology, biology and ecology of small hairy game
6. Morphology, biology and ecology of game birds (Part I)
7. Morphology, biology and ecology of game birds (Part II)
8. Diseases and protection of wildlife
9. Hunting ground, division of hunting grounds, types of hunting grounds, acquisition of hunting rights
10. Management of open hunting grounds
11. Game breeding and protection. Damage to and from wildlife
12. Ways of hunting game
13. Hunting weapons and ammunition
14. Hunting cynology
15. Legislation in the field of hunting (Regulations)

Exercises:
1. Systematics and classification of game
2. Determining age and sex - large game
3. Determining age and sex - small game
4. Errors of horns, antlers and tusks - I
5. Errors of horns, antlers and tusks - II

6. Beginning of breeding shooting
7. Preparation and processing of hunting trophies - horns and antlers
8. Preparation and processing of hunting trophies - fur and skulls
9. Game counting - large and small game
10. Counting other animal species
11. Hunting management basis - forms
12. Implementation of the hunting management basis
13. Basics of cynology
14. Weapons and Ballistics - I
15. Weapons and ballistics - II

Learning outcomes

- ✓ Describe the role and importance of hunting management through history, legal regulations in hunting (hunting and hunting development, the role of hunting management)
- ✓ Explain hunting zoology (game species, morphological and biological characteristics, protected animal species, bugs and horns, determining age and sex, assessing hunting trophies).
- ✓ Interpret game disease (symptoms, pests, hygiene hunting ground, and treatment of patients game mortality).
- ✓ Describe the hunting ground (division and arrangement of the hunting ground, hunting productive area, bonitating hunting ground for large and small game)
- ✓ Interpret catching wild animals, hunting weapons and ammunition (the proper operation and maintenance of weapons, ammunition, hunting ballistics).
- ✓ Explain hunting kinology (division of hunting dogs, working characteristics and methods of dog education and training).

Language

All teaching activities will be held in Croatian. However, foreign students will have the opportunity to attend additional office hours with the lecturer in English. Additionally, the lecturer will refer foreign students to the corresponding literature in English, as well as give them the possibility of taking the associated exams in English.

Literature

1. Andrašić, D., 1984: Zoologija divljači i lovna tehnologija. Skripta, Sveučilište u Zagrebu Šumarski fakultet, Zagreb, 294 str.
2. Mustapić, Z., i suradnici., 2004: LOVSTVO priručnik. Hrvatski lovački savez Zagreb, 597 str.
3. Tucak, Z., Florijančić, T., Grubešić, M., Topić,
4. J., Brna, J., Dragičević, P., Tušek, T., Vukušić, K., 2002: Lovstvo. Drugo prošireno izdanje. Uđbenik, Sveučilište Josipa Jurja Strossmayera u Osijeku, Poljoprivredni fakultet Osijek, 405 str
5. Grupa autora: 1967: Lovački priručnik, Lovačka knjiga Zagreb, 704 str.

Forms of teaching

Lectures (30 h), exercises (30 h), field work

Assessment methods

Written exam. Term papers and student oral presentation

BASICS OF FOREST ECONOMICS (code: 33866)

Original course title	Osnove ekonomike u šumarstvu	Status	compulsory
Semester	winter	Course teacher	Assoc. Prof. Stjepan Posavec, Ph.D; Assist. Prof. Karlo Beljan, Ph.D
ECTS	4	Study level and programme	BSc Forestry

Course content

Exercises:
1. Introduction to the economics of natural resources
2. Definition and subject of forestry economics
3. Historical development of the economy
4. Basics of natural resource economics
5. Basics of environmental economics
6. Sustainable development and renewable energy sources
7. The concept and definition of forest rent and forest tax
8. Determining forest values
9. The meaning of the forest as capital
10. Depreciation
11. Economic role and importance of forestry
12. Basics of marketing in forestry
13. Basics of economic analysis
14. Planning in forestry
15. The role of forestry in the bioeconomy

Lectures:
1. Simple and compount interest rate calculation
2. Interest rate and discounting in forestry
3. Economic characteristics of the development of even-age stands
4. Determining the value of a even-age stand
5. Economic characteristics of uneven-age stand development
6. Determining the value of the uneven-age stand
7. Present cutting value method, forest tax
8. Modern methods of determining the value of forests
9. Land rent in forestry
10. Calculation of depreciation of assets in forestry
11. Examples of supply and demand in forestry
12. Elasticity of supply and demand
13. Cost-effectiveness and profitability in forestry
14. Basics of cost planning in forestry
15. Basics of investing in forestry

Learning outcomes

- ✓ To explain economics of natural resources and sustainable development (specificity of production in forestry, biological-technical characteristics and economic characteristics).
- ✓ Interpret forest rent and forest tax.
- ✓ Interpret the determination of forests value (methods of evaluation in forestry, problems of total economic value of natural resources)
- ✓ To explain the meaning of forest as capital (fixed assets and capital in forestry, categories of capital goods in forestry).
- ✓ To analyze marketing in forestry (market laws, formation of forest resource prices, supply and demand laws).

- ✓ Present economic analysis and planning in forestry (business indicators, forestry production, outline investment plan and business plan).

Language

All teaching activities will be held in Croatian. Foreign students will have the opportunity to attend additional office hours with the lecturers and be provided with teaching materials and literature in English.

Literature

1. Figurić, M.: Uvod u ekonomiku šumskih resursa, Šumarski fakultet, Zagreb, 1998.
2. Sabadi, R.: Ekonomika šumarstva, Školska knjiga Zagreb, 1992.
3. Posavec, S.: Jurjević, P., Prpić, B., Vuletić, D., Jakovac, H., Posavec, S., 2011.: Procjena vrijednosti općekorisnih funkcija sredozemnih šuma primjenom šumarskih ekoloških i klasičnih ekonomskih načela, Šume hrvatskoga Sredozemlja, Matić, S. (ur.), Zagreb, Akademija šumarskih znanosti, 2011. Str. 516-523. ISBN 978-953-985715-6
4. Posavec, Stjepan; Pezdevšek Malovrh, Špela, 2020: Market Value and Timber Assortment Sale Models - Comparative Study, Management Aspects in Forest Based Industries / Jelačić, Denis (ur.). Zagreb: WoodEMA i.a., 2020. str. 17-37, ISBN:978- 953-57822-7-8
5. Posavec, S., Beljan, K. 2013. Forest products production and sale trends in Croatia, Markets for wood and wooden products, ur. Jelačić, D., Zagreb, 2013., str 95-105, ISBN978-953-57822-0-9
6. Klemperer, W.D.: Forest resource economics and finance, McGraw-Hill Book Comp., New York, 1996.

Forms of teaching

Lectures (30), exercises (15)

Assesment methods

Written and oral exam

FOREST MENSURATION (code: 33861)

Original course title	Dendrometrija	**Status**	compulsory
Semester	winter	**Course teacher**	Prof. Mario Božić, Ph.D Assoc. Prof. Ernest Goršić, Ph.D; Assoc. Prof. Mislav Vedriš, Ph.D
ECTS	7	**Study level and programme**	BSc Forestry

Course content

CLASSES
1. Introduction. Measures and measurement systems. Measurement errors. Presentation of measured data. Measurement planing.
2. Measurement of tree diameter and circumference: procedure, instruments, errors.
3. Height measurement.Working principle of hypsometer.. Errors in tree height measurement. Height measurement with hypsometers working on geometrical principle.
4. Height measurement with Blume-Leiss and Vertex hypsometers.
5. Height measurement with standard and CP scale Bitterlich relascope. Measurement of unattainable diameters with Bitterlich relascope.
6. The volume of trees and its parts.
7. Double-entry volume tables.
8. Forest inventory. Stand quality.
9. Sample. Sample size.
10. Sample plots: Types and form; setup and measurement.
11. Diameter distribution of even and uneven aged stands.

12. Height curves – even aged stands: sample, construction, height curve shift. Height curves – uneven aged stands: sample, construction.
13. Single-entry volume tables – tariffs: construction, implementation.
14. Growth and yield tables.
15. Former surveys. Sample for definition of tree increment.

PRACTICE (field work, computer)
1. Introduction. Familiarising with instruments for diameter and circumference measurement. Caliper rectification.
2. Tree diameter and circumference measurement procedures.
3. Familiarising with hypsometer Haga, Blume-Leiss, Vertex, Christen-Eić.
4. Familiarising with Bitterlich relascope hypsometer with standard and CP scale.
5. Measurement of tree diameter: with caliper, relascope and measuring tape (circumference).
6. Analysis of differences in diameters measured with different instruments.
7. Calculation of tree volume with sectioning method.
8. Measurement of tree diameter and height for volume calculation with doubleentry volume tables.
9. Calculation of tree volume with double-entry volume tables.
10. Familiarising with different types of measurement plots (circle, square, line, nested circle).
11. Preparation for field practice, drawing dot grid on the map and azimuth definition.
12. Calculation of field practice data: Distribution of trees per diameter classes and construction of height curves.
13. Calculation of field practice data: Construction of volume tariff and volume calculation.
14. Calculation of field practice data: Variabilitiy of measured data, filling the forms.
15. Student presentation of field practice results.

Field practice
Calculation of particular stand volume is the main goal of field practice in subject Forest mensuration. For that pourpose students will in class (within class practice) set up a grid of sample plots on the map which will be used in the filed for measurement. The measurement itself will be carried out for each group of students during two days on Faculty research facility - Management unit Doršćina.
1. DAY
Upon arrival un the Faculty research facility students will be instructed to find their stands for measurement using the map and known points in the field. On the first day students measure stand variability based on breast height basal area variability which will be measured with Bitterlich relascope. The measurement will be preformed on 10-15 standpoints. After that they will measure heights and dedicated diameters of 50-100 trees of dominant species in the stand. On the basis of the heights measured the students will (within class practice) construct stand height curve.
2. DAY
On the sample of 10-15 plots (depending on the size of certain stand) in the same stands as on previous day measurement of number of trees per diameter class will be performed. The measurement will be carried out on circular plots with radius defined in advence. Before the measurement itself, students will be warned about most common mistakes made during the measurement process so they could avoid them.

Learning outcomes

- ✓ List measured variables, precision and accuracy in measurement, and means of data presentation.
- ✓ Interpret measurement of tree diameter, perimeter and height (instruments, errors).
- ✓ Explain data collection on sample plot, stand and management unit (sample and sample size, types and sizes of sample plots, measurement on sample plots.
- ✓ Interpret a diameter distribution in even-aged and selection stands (change of diameter distribution due to harvest, importance of diameter distribution by tree species and diameter classes).
- ✓ Describe construction of height curves (height curve of even-aged and selection stands, shift of height curve in even-aged stands, methods of curve construction).
- ✓ Interpret determination and calculation of volume (volume of felled and standing trees, sectional method, single-entry and double-entry volume tables, applicability of single-, double- and tripleentry volume tables for single trees and forest stands).
- ✓ Describe design of a sample and data collection methods for diameter increment.

Language

All teaching activities will be held in Croatian. Foreign students will have the opportunity to attend additional office hours with the lecturers and be provided with teaching materials and literature in English.

Literature

1. Božić, M., Goršić, E., Vedriš, M.: Forest mensuration, Teaching materials from lectures ansd exercises
2. Bitterlich, W., 1984: The Relascope Idea. CAB, pp.242, London
3. Loetsch, F., Zöhrer, F., Haller, K.E., 1973: Forest Inventory. pp.467, BLV München.
4. West, P.W., 2004: Tree and Forest Masurement. Springer V, pp.167, Berlin.

Forms of teaching

Lectures (45), exercises (30), field work (2 days)

Assesment methods

Evaluation of exercise assignments, partial exams, written and oral final exam.

ANATOMICAL STRUCTURE OF WOOD (code: 226037)

Original course title	Anatomska građa drva	Status	compulsory
Semester	winter	Course teacher	Prof. Jelena Trajković, PhD; Assoc. Prof. Bogoslav Šefc, PhD; Assist. Prof. Iva Ištok, PhD
ECTS	3	Study level Study level and programme	BSc Forestry

Course content

Lecutres
1. Introduction: The aims of wood anatomy. The origin of wood in plant kingdom. Commercial utilisation.
2. Methods in wood anatomy: Optical microscopy,
3. Macroscopic wood characteristics. Main sections and directions in wood. Texture, grain, growth rings, wood pores, sapwood and hardwood
4. Wood formation in tree, cambium. Structure of vascular plants. Cambium. Ontogenesis of wood tissue.
5. Cells. Cambium formation. Cambium: organisation of cells, dimensions of cells, cell divisions, periods of activity, postcambial growth of cells. Ontogenesis of wood tissue.
6. Secondary phloem and rhytidome. Periderm, structure, origin, position, duration. Bark, inner, outer, rhytidome, cork.
7. Wood cell walls: Layers, submicroscopic structure, pits and other sculptures of the wood cell walls
8. Wood elements. Morphology of wood cells, their dimensions and function.
9. Histology of conifer wood. Pattern and shape of cells and tissues in conifer wood, useful features for conifer wood identification, comparative wood anatomy of commercial conifer wood
10. Histology of hardwood. Pattern and shape of cells and tissues in hardwood, useful features for hardwood identification, comparative wood anatomy of commercial hardwood
11. Wood identification. Dichotomous and polytomous keys for microscopic and macroscopic identification of commercial wood species
12. Variations in wood structure. Wood variations within the tree on different positions: within growth ring, between growth rings, along the radius of transversal section, tree height, between roots, trunk and branch.
13. Causes of wood structure variability within species and within tree. History, position and properties of juvenile and adult wood in trees. Growth ring width: the percentage of late wood in growth ring.
14. Irregularities of wood structure. Reaction wood, compression failures, brittle heart, spiral grain, knots, false and incontinuous rings.
15. Influence of wood structure on technical properties of wood and its use. Wood anatomy and moisture content. Moisture content and technical properties of wood. Wood shrinkage and swelling. Wood anatomy and wood density. Wood density and technical properties of wood.

Laboratory exercises
1. Microscopy with a biological school microscope
2. Microscopic structure of coniferous wood cells

3. Microscopic structure of deciduous wood cells
4. Characteristics of coniferous wood structure important for wood identification
5. Characteristics of coniferous wood structure important for wood identification
6. Characteristics of coniferous wood structure important for wood identification
7. Microscopic characteristics of deciduous wood
8. Microscopic characteristics of deciduous wood
9. Microscopic characteristics of deciduous wood
10. Macroscopic characteristics of coniferous wood
11. Macroscopic characteristics of coniferous wood

Learning outcomes

- ✓ Describe and recognize (sketch) position and role of wood cells, wood tissues and phloem cells and tissues in living tree (botanical conection)
- ✓ Describe and recognize the role of wood anatomy in fundamental wood properties (technical conection)
- ✓ Determine (recognize) domestic commercial types of wood using determination key(s)

Language

All teaching activities will be held in Croatian. However, foreign students in mixed groups will have the opportunity to attend additional office hours with the lecturer and teaching assistants in English to help master the course materials. Additionally, the lecturer will refer foreign students to the corresponding literature in English, as well as give them the possibility of taking the associated exams in English

Literature

1. Panshin, A. J.; Zeew, C. de, 1980: Textbook of wood technology, McGraw-Hill, Inc. 722 str.
2. Schweingruber, F.H., 1990: Anatomy of European woods, Paul Haupt Berne and Stuttgart Publishers, 800 str.

Forms of teaching

Lectures (30), exercises (15)

Methods of grading

Exercises, microscopic wood identification colloquia, macroscopic wood identification colloquia, exam.

APPLIED PHYTOPATHOLOGY (code: 226127)

Original course title	Primjenjena fitopatologija	**Status**	compulsory
Semester	summer	**Course teacher**	prof. dr. sc. Danko Diminić; doc. dr. sc. Jelena Kranjec Orlović
ECTS	6	**Study level and programme**	BSc Urban Forestry, Nature Conservation and Environmental Protection

Course content

Lectures:

1. Definition of disease; deviations from normal plant functions; types of diseases. Disease symptoms; onset of disease; anatomical and physiological changes in diseased plants.
2. Causes of plant diseases: non-infectious or non-parasitic diseases; infectious or parasitic diseases. Fungi as the most numerous and most common causes of diseases of trees and shrubs; fungal morphology; fungal reproduction; classification (systematics) of fungi.

3. Division of fungi according to lifestyle. Obligatory or true parasites, facultative parasites; optional saprotrophs; necrophytes. Reproduction of fungi; mushroom nutrition; environmental impact on fungal growth and development. Mushroom specialization.
4. The onset and course of the disease. Infection; infectious potential; pathogen strength; types of infection; sources of infection; infection process. Incubation. Fructification.
5. Definition of resistance. Preinfective or passive resistance. Post-infection or active resistance; plant reaction to a pathogenic organism; congenital relationship; noncongenital relationship: necrotic defense reactions, histological reactions, phytoalexins. Apparent resistance.
6. Diseases of needles and leaves of urban and forest trees (in general). The most common (and new) diseases in Croatia and this part of Europe - the causes.
7. Diseases of the bark of urban and forest trees and shrubs (in general). The most common (and new) diseases of the cortex and conductive elements in Croatia and this part of Europe.
8. The concept and origin of rot; brown and white type of rot. Species of tree rot fungi (in general). The most common rot fungi on urban trees in Croatia and this part of Europe.
9. The most common damage of anthropogenic and abiotic cause on urban (and forest) trees and conditions for their occurrence.
10. Semi-parasitic flowering plants (in general). The most common semi-parasitic flowering plants on urban trees and trees of protected forest ecosystems in Croatia and this part of Europe.

Exercises in the microscopic partikum:
1. Basic structure of fungi: hyphae, mycelium.
2. Examples of needle and leaf disease, appearance and anatomical structure of the fruiting body / body and spores.
3. Examples of diseases of the bark of shoots, branches and trunks, appearance and anatomical structure of fruiting bodies and spores.
4. Examples of forest tree rot, appearance and anatomical structure of fruiting bodies and spores.

Field work:
1. Examples of infected trees explain the occurrence of infection, disease development and the impact (harmfulness) of recorded pathogens on the health of urban trees, and in protected forest ecosystems on individual trees and the ecosystem as a whole.
2. Examples of infected trees explain the occurrence of infection, disease development and the impact (harmfulness) of recorded pathogens on the health of urban trees, and in protected forest ecosystems on individual trees and the ecosystem as a whole.
3. Examples of infected trees explain the occurrence of infection, the development of rot and the impact (harmfulness) of recorded pathogens on the health of urban trees and mechanical stability of infected trees in urban areas and the occurrence of damage from broken branches or bumps / trunks.
4. Examples of infected trees explain the origin of the infection and the impact of pathogens on the health of trees.

Learning outcomes

- ✓ Analyze the causes of plant diseases (non-infectious or non-parasitic and infectious or parasitic diseases and fungi as the most numerous and most common causes of diseases of trees and shrubs).
- ✓ Interpret the biology and physiology of fungi (division according to lifestyle – with aprotrophs, parasites and necrophytes, reproduction and specialization of fungi).
- ✓ Present the pathogenesis (origin and course of the disease, infection, incubation, fructification) and resistance of plants to pathogens (passive, active and apparent resistance).
- ✓ Describe diseases of needles and leaves of urban and forest trees (symptoms of the disease, biology and harmfulness of pathogens).
- ✓ Explain diseases of the bark of shoots, branches and trunks and conductive elements of trees and shrubs (symptoms of the disease, biology and harmfulness of pathogens).
- ✓ Interpret the most common rot of urban trees and the characteristics and types of rot (disease symptoms, biology and harmfulness of pathogens).
- ✓ Interpret the most common anthropogenic and abiotic damage to urban (and forest) trees (mechanical damage to the bark, damage from pesticide application, lightning, winter hardiness, damage due to lack of nutrients).
- ✓ Describe harmful semi-parasitic flowering plants on urban trees and trees of protected forest ecosystems (disease symptoms, biology and harmfulness of semi-parasites).

Language

All teaching activities will be held in Croatian. However, foreign students in mixed groups will have the opportunity to attend additional office hours with the lecturer and teaching assistants in English to help master the course materials. Additionally, the lecturer will refer foreign students to the corresponding literature in English, as well as give them the possibility of taking the associated exams in English

Literature

- Glavaš, M., 1996: Osnove šumarske fitopatologije. Sveučilište u Zagrebu, Šumarski fakultet, 140 str.
- Glavaš, M., 1999: Gljivične bolesti šumskoga drveća. Sveučilište u Zagrebu, Šumarski fakultet, 281 str.
- Tomiczek, C., D. Diminić, T. Cech, B. Hrašovec, H. Krehan, M. Pernek & B. Perny, 2007: Bolesti i štetnici urbanog drveća. Šumarski institut, Jastrebarsko, Sveučilište u Zagrebu, Šumarski fakultet, 384 str. Diminić, D., 2013-2020: opća fitopatologija te važne i aktualne (nove) bolesti drveća i grmlja (PDF).
- Butin, H., 1995: Tree Diseases and Disorders. Oxford University Press, Oxford, 252 str. 2. Strouts, R.G. & Winter, T.G., 1994: Diagnosis of ill-health in trees. HMSO, London, 307 str.
- Glavaš, M. & D. Diminić, 2001: Mikološki kompleks obične jele. U: Prpić, B. (ed.) 2001: Obična jela (*Abies alba* Mill.) u Hrvatskoj. Akademija šumarskih znanosti, Zagreb, 606–625.
- Diminić, D., 2003: Gljivične bolesti obične bukve. U: Matić, S. (ed.) 2003: Obična bukva (*Fagus sylvatica* L.) u Hrvatskoj. Akademija šumarskih znanosti, Zagreb, 549–560.
- Diminić, D., 2005: Mikoze kore i lišća topola i vrba. U: Vukelić, J. (ed.) 2005: Poplavne šume u Hrvatskoj. Akademija šumarskih znanosti, Zagreb, 390–397.
- Glavaš, M. & D. Diminić, 2011: Bolesti šumskoga drveća. U: Matić, S. (ed.): Šume hrvatskoga sredozemlja. Akademija šumarskih znanosti, Zagreb, 533-555.
- Diminić, D., D. Kajba, M. Milotić, I. Andrić, J. Kranjec Orlović, 2017: Suceptibility of *Fraxinus angustifolia* clones to *Hymenoscyphus fraxineus* in lowland CroatiaBaltic Forestry 23(1): 233-243.
- Cech, T., D. Diminić, K. Heungens, 2010: *Cylindrocladium buxicola* causes common box blight in Croatia. Plant pathology, 59 (2010), 6; https://bsppjournals.onlinelibrary.wiley.com/doi/full/10.1111/j.1365-3059.2010.02361.x
- 9. D. Diminić, J. Kranjec Orlović, I. Lukić, M. Ježić, M. Ćurković Perica, M. Pernek, 2019: First Report of Charcoal Disease of Oak (*Biscogniauxia mediterranea*) on Quercus spp. in Croatia. Plant disease 2019 v.103 no.10 https://apsjournals.apsnet.org/doi/10.1094/PDIS- 03-19-0458-PDN

Forms of teaching

Lectures (30), exercises (15), field work (16)

Methods of grading

midterm exam on basis of phytopathology, final exam: written + oral

ARBORICULTURE (code: 33828)

Original course title	Arborikultura	Status	compulsory
Semester	summer	Course teacher	Assist. Prof. Vinko Paulić, Ph.D; Assoc. Prof. Damir Drvodelić, Ph.D
ECTS	5	Study level and programme	BSc Urban Forestry, Nature Conservation and Environmental Protection

Course content

Through this subject student get acquainted with selection of trees for urban areas, planting and care for trees and other woody vegetation in non-forest context.

List of lectures:
1. Introduction into arboriculture and urban forestry
2. Selection of trees for urban areas
3. Planting of trees

4. Transplanting large trees
5. Tree pruning
6. Pruning of other woody vegetation in urban areas (hedges, shrubs, vines)
7. Methods of tree health state assessment
8. Visual tree assessment
9. Modification of urban soil for planting of trees
10. Mulch
11. Application and management of nutrition in arboriculture
12. Tree irrigation in arboriculture
13. Special tree management situations
14. Management and inventarization of urban tree plantings

List of exercises:
1. Planting trees
2. Pruning trees
3. Formative pruning of young trees
4. Symptoms and effects on trees
5. Visual tree assessment
6. Use of tree climbers and climbing technique in arboricultural works
7. Root pavements conflict damage
8. Arboricultural instruments
9. Application of resistance drilling instrument in arboriculture
10. Acoustic tomography

List of field work classes:
1. Visual tree assessment
2. Management of urban trees.

Learning outcomes

- ✓ Interpret basic principles of arboriculture (arboriculture and urban forestry, selection of tree species and influence on tree care operations, analysis of desirable tree characteristics from arboriculture point of view, selection of quality plants for planting, basic types of planting material)
- ✓ Explain planting of trees and shrubs (basic types of planting techniques for trees and shrubs in urban areas, planting of seedlings, trees, shrubs and transplanting large trees in urban surroundings) and mulching of plants (use of mulch, mulch materials selection, advantages and disadvantages of certain mulch materials, mulch application and decontamination)
- ✓ Interpret pruning of trees and shrubs (reasons for pruning, pruning effects and reaction of plants, formative pruning of young trees, pruning of old trees, shrubs, hedges, etc.)
- ✓ Explain fertilization and irrigation of urban trees (types, way and time of tree fertilization, use of antitranspirants, difference in irrigation systems for urban greenery)
- ✓ Interpret root system of urban trees (trees in pavement, soil and other factors that influence growth of trees in urban areas, influence of root growth on infrastructure, remedial treatment for root-pavement conflicts)
- ✓ Explain hazardous trees in urban areas (hazard form tree failure, biomechanics in arboriculture, optimization of tree form, tree defects and symptoms, tree static, tree vitality, arboricultural instruments for hazardous tree assessment)
- ✓ Interpret management and inventory of urban greenery (care and management schedule of urban trees, tree sanitation plan, methods for tree inventory and tree cadastre)

Language

All teaching activities will be held in Croatian. Foreign students will have the opportunity to attend additional office hours with the lecturers and be provided with teaching materials and literature in English.

Literature

- Oršanić, M. Drvodelić, D., 2005: Arborikultura (interna skripta)
- HUA, 2015: Rječnik arborikulturnih pojmova, Glossary of arboricultural terms. Hrvatska udruga za arborikulturu, Zagreb

- HUA, 2013: Europski priručnik o orezivanju, Hrvatska udruga za arborikulturu, Zagreb
- Mattheck, C., 2004: Stablo i okoliš, Zrinko tumači život urbanog stabla, Zrinjevac, Zagreb
- Costello , L. R., K. S. Jones, 2003: Reducing Infrastructure Damage by Tree Roots: A Compendium of Strategies, ISA, Champaign, IL, SAD
- Ferrini, F., Konijnendijk van den Bosch, C. C., Fini, A., 2017: Routledge Handbook of Urban Forestry, Routledge; 1st edition, Kanada
- Gilman, E., F., 2002 : An illustrated guide to pruning, 2nd ed., Delmar, NY, SAD
- Harris, R. W., J.R. Clark, N.P. Matheny, 2003: Arboriculture: Integrated Management of Landscape Trees, Shrubs, and Vines, Prentice Hall, New Jersey, SAD
- Miller, R. W., 2015: Urban Forestry: Planning and Managing Urban Greenspaces, Third Edition 3rd Edition, Waveland Press, Kanada
- Roloff, A., 2016: Urban Tree Management: For the Sustainable Development of Green Cities, Wiley-Blackwell; 1st edition, V. Britanija
- Shigo, A. 1998: A New Tree Biology and Dictionary, Shigo and Trees, Associates, Snohomish, WA, SAD
- Shigo, A. 1991: Modern Arboriculture, Shigo and Trees, Associates, Snohomish, WA, SAD

Forms of teaching

Lectures (30), exercises (30), field work (2 days)

Methods of grading

Written and oral examination-passing of written part conditional for oral exam entry. Preconditions: course attendance, finished exercise and field work

BIOMETRICS (code: 33857)

Original course title	Biometrika	**Status**	compulsory
Semester	summer	**Course teacher**	Prof. Anamarija Jazbec, PhD; Assoc. Prof. Mislav Vedriš, PhD; Assoc. Prof Ernest Goršić, PhD
ECTS	5	**Study level and programme**	BSc Forestry

Course content

LECTURES:
1. Basic biometric terms (observations, data, population). Types of variables. Graphical tools.
2. Frequency table. Realtive frequencies. Cumulative frequencies
3. Measures of central tendency. Arithmetic mean, geometric mean, harmonic mean
4. Measures of position. Median. Quartiles, percentiles. Mode.
5. Measures of variation, asymmetry and skewness. Range. Variance, Standard deviation. Coefficient of variation
6. Empirical distribution.
7. Basics of probability. Expected value.
8. Continuous random variable. Normal distribution.
9. Discrete random variable. Binomial distribution. Normal approximation to a binomial distribution.
10. Sampling methods. Sampling distribution. Central limit theorem. Estimators. Standard error.
11. Confidence interval. Interval estimation of the mean and proportion. Tdistribution.
12. Hypothesis testing and inference. Testing expected value of mean. Testing proportion.
13. Testing two population variances. F distribution. Testing two population means.
14. Testing two population proportions. Paired t-test.
15. ・2 distribution. Chi-square test.

EXERCISES:
1. Basic biometric terms (observations, data, population). Types of variables. Graphical tools.

2. Frequency table. Relative frequencies. Cumulative frequencies
3. Measures of central tendency. Arithmetic mean, geometric mean, harmonic mean
4. Measures of position. Median. Quartiles, percentiles. Mode
5. Measures of variation, asymmetry and skewness. Range. Variance, Standard deviation. Coefficient of variation
6. Empirical distribution.
7. Basics of probability. Expected value
8. Continuous random variable. Normal distribution.
9. Discrete random variable. Binomial distribution. Normal approximation to a binomial distribution.
10. Sampling methods. Sampling distribution. Central limit theorem. Estimators. Standard error.
11. Confidence interval. Interval estimation of the mean and proportion. Tdistribution.
12. Hypothesis testing and inference. Testing expected value of mean. Testing proportion.
13. Testing two population variances. F distribution. Testing two population means.
14. Testing two population proportions. Paired t-test.
15. · 2 distribution. Chi-square test.

Learning outcomes

- ✓ Explain types of variables: numeric (continuous and discrete) and categorical (dichotomous, ordinal i nominal); graphical presentation and frequency tables, classification of graphs according to data types: bar chart, histogram, frequency polygon, line chart, pie chart, scatterplot, stemand- leaf plot, Box-Whisker plot; relative frequencies, cumulative absolute and cumulative relative frequencies, calculation and analysis.
- ✓ Describe measures of central tendency and measures of position (arithmetic mean, geometric mean, harmonic mean, quadratic mean, minimum, maximum, median, lower and upper quartile, mode)
- ✓ Explain measures of variation (data range, interquartile range, standard deviation, variance, coefficient of variation)
- ✓ Interpret theoretical distributions or models of population distributions (normal Gaussian distribution, Student's tdistribution, binomial distribution, chi-square distribution, F-distribution, definition of density function and distribution function, calculating probability (area) under the density function for normal and t-distribution, calculating probability for binomial distribution, normal approximation to the binomial distribution)
- ✓ Explain point estimates of arithmetic mean, variance and proportion (central limit theorem, sampling distribution, standard error) Distinguish population parameters from their sample estimates; estimate population arithmetic mean (expected value), variance and proportion based onthe sample
- ✓ Present hypothesis testing of arithmetic mean and proportion (rules and procedure of testing, type I (α) and type II (β) errors, power of the test (1- β), testing (assumed constant) arithmetic mean and proportion of population
- ✓ Present interval estimates of expected value and proportion, testing of proportion, variances (F-test) and arithmetic mean (Student t-test) from two independent samples and testing difference of arithmetic means from two dependent samples (paired t-test)
- ✓ Present analysis of observed and expected frequencies for categorical variable using chi-square test

Language

All teaching activities will be held in Croatian. Foreign students will have the opportunity to attend additional office hours with the lecturers and be provided with teaching materials and literature in English.

Literature

1. Jazbec, A (2009) BASIC STATISTICS, 2nd ed. Faculty of Forestry, Zagreb. (University textbook)
2. Teaching materials for the whole subject (script)
1. Pranjić A. (1986): Šumarska biometrika. ŠF, Zagreb. 204 pp.
2. Kozak A., Kozak R., Staudhammer C., Watts S. (2008): Introductory Probability and Statistics: Applications for Forestry and Natural Sciences. CABI Publishing, Wallingford, UK. 408 pp.
3. Prodan M. (1968): Forest Biometrics. Pergamon press, Oxford. 432 pp.
4. Quinn, G.P., Keough, M.J., (2002): Experimental Design and Data Analysis for Biologists. UP, Cambridge. 537 pp.
5. Sokal RR, Rohlf FJ. (1995) Biometry. Freeman and Company. New York. 899 pp.
6. Zar J.H.(1999) Biostatistical analysis. Prentice Hall. 663 pp.

Forms of teaching

Lectures (30), exercises (30)

Methods of grading

Evaluation of exercise assignments, partial exams, written and oral final exam

FOREST PHYTOPATHOLOGY (code: 33880)

Original course title	Šumarska fitopatologija	Status	compulsory
Semester	summer	Course teacher	Prof. Danko Diminić, Ph.D; Jelena Kranjec Orlović, Ph.D
ECTS	5	Study level and programme	BSc Forestry

Course content

Lectures:
1. Explain the causes of plant diseases (non-infectious or non-parasitic diseases, infectious or parasitic diseases, morphology, reproduction and classification (systematics) of fungi).
2. Interpret the biology and physiology of fungi (division according to lifestyle, reproduction, diet, specialization, mutual ecological relations among fungi).
3. Explain the pathogenesis and resistance of plants to pathogens (types and sources and process of infection, fungal penetration into the plant, incubation of fructifications, factors of resistance to pathogen penetration, plant reaction to the pathogen).
4. Explain diseases of fruits and seeds and drooping (symptoms of the disease, plant hosts, harmful pathogens, consequences on the health of fruits and seeds and young plants).
5. Analyze diseases of needles and leaves, bark, shoots, branches and trunks of forest trees (disease symptoms, biology and harmfulness of pathogens).
6. Analyze forest tree rot (species of forest tree rot fungi, the most common rot fungi in Croatia, symptoms of disease, biology and harmfulness of pathogens, consequences on the health status of infected trees and their economic value)
7. Interpret damage of anthropogenic and abiotic cause (mechanical damage to the bark during felling and extraction, cracks from frost (winter hardiness), damage from drought, sun wounds).
8. Interpret harmful semi-parasitic plants (most often semi-parasitic flowering plants onforest trees).

Exercises in the microscopic partikum:
1. Basic structure of fungi: hyphae, mycelium, stroma, sclerotia.
2. Examples of diseases of seeds and young plants.
3. Examples of needle and leaf diseases, appearance and anatomical structure of fruiting bodies and spores.
4. Examples of diseases of the bark of shoots, branches and trunks, appearance and anatomical structure of fruiting bodies and spores.
5. Examples of forest tree rot, appearance and anatomical structure of fruiting bodies and spores.

Field work:
1. Examples of infected trees explain the origin of the infection, the development of the disease and the impact (harmfulness) of the recorded pathogens on the health of trees and the forest ecosystems.
2. The examples of infected trees explain the origin of the infection, the development of the disease and the impact (harmfulness) of the recorded pathogens on the health of trees and the forest ecosystems.
3. Examples of infected trees explain the occurrence of infection, the development of rot and the impact (harmfulness) of recorded pathogens on the health of trees and the forest ecosystems.
4. Examples of infected trees explain the origin of the infection and the impact of pathogens on the health of trees and the forest ecosystems.

Learning outcomes

1. Explain the causes of plant diseases (non-infectious or non-parasitic diseases, infectious or parasitic diseases, morphology, reproduction and classification (systematics) of fungi).
2. Interpret the biology and physiology of fungi (division according to lifestyle, reproduction, diet, specialization, mutual ecological relations among fungi).
3. Explain the pathogenesis and resistance of plants to pathogens (types and sources and process of infection, fungal penetration into the plant, incubation of fructifications, factors of resistance to pathogen penetration, plant reaction to the pathogen).
4. Explain diseases of fruits and seeds and drooping (symptoms of the disease, plant hosts, harmful pathogens, consequences on the health of fruits and seeds and young plants).
5. Analyze diseases of needles and leaves, bark, shoots, branches and trunks of forest trees (disease symptoms, biology and harmfulness of pathogens).
6. Analyze forest tree rot (species of forest tree rot fungi, the most common rot fungi in Croatia, symptoms of disease, biology and harmfulness of pathogens, consequences on the health status of infected trees and their economic value)
7. Interpret damage of anthropogenic and abiotic cause (mechanical damage to the bark during felling and extraction, cracks from frost (winter hardiness), damage from drought, sun wounds).
8. Interpret harmful semi-parasitic plants (most often semi-parasitic flowering plants on forest trees).

Language

All teaching activities will be held in Croatian. However, foreign students will have the opportunity to attend additional office hours with the lecturer and teaching assistants in English to help master the course materials. Additionally, the lecturer will refer foreign students to the corresponding literature in English, as well as give them the possibility of taking the associated exams in English.

Literature

- Glavaš, M., 1996: Osnove šumarske fitopatologije. Sveučilište u Zagrebu, Šumarski fakultet, 140 pp.
- Glavaš, M., 1999: Gljivične bolesti šumskoga drveća. Sveučilište u Zagrebu, Šumarski fakultet, 281 pp.
- Diminić, D., 2013-2020: Introduction to the phytopathology, fundamental principles in mycology on and important and current (new) diseases of trees and shrubs (presentations of all lectures in PDF format).
- Butin, H., 1995: Tree Diseases and Disorders. Oxford University Press, Oxford, 252 pp.
- Strouts, R.G. & Winter, T.G., 1994: Diagnosis of ill-health in trees. HMSO, London, 307 pp.
- Glavaš, M. & D. Diminić, 2001: Mikološki kompleks obične jele. U: Prpić, B. (ed.) 2001: Obična jela (Abies alba Mill.) u Hrvatskoj. Akademija šumarskih znanosti, Zagreb, 606–625.
- Diminić, D., 2003: Gljivične bolesti obične bukve. U: Matić, S. (ed.) 2003: Obična bukva (Fagus sylvatica L.) u Hrvatskoj. Akademija šumarskih znanosti, Zagreb, 549–560.
- Diminić, D., 2005: Mikoze kore i lišća topola i vrba. U: Vukelić, J. (ed.) 2005: Poplavne šume u Hrvatskoj. Akademija šumarskih znanosti, Zagreb, 390–397.
- Glavaš, M. & D. Diminić, 2011: Bolesti šumskoga drveća. U: Matić, S. (ed.): Šume hrvatskoga sredozemlja. Akademija šumarskih znanosti, Zagreb, 533-555.
- Diminić, D., D. Kajba, M. Milotić, I. Andrić, J. Kranjec Orlović, 2017: Suceptibility of Fraxinus angustifolia clones to Hymenoscyphus fraxineus in lowland Croatia. Baltic Forestry 23(1): 233-243.
- D. Diminić, J. Kranjec Orlović, I. Lukić, M. Ježić, M. Ćurković Perica, M. Pernek, 2019: First Report of Charcoal Disease of Oak (Biscogniauxia mediterranea) on Quercus spp. in Croatia. Plant disease 2019 v

Forms of teaching

Lectures (30), exercises (30), field classes (16)

Methods of grading

midterm exam on basis of phytopathology, final exam: written + oral

WILDLIFE MANAGEMENT (code: 226139)

Original course title	Gospodarenje životinjskim vrstama	Status	compulsory
Semester	winter	Course teacher	Prof. Krešimir Krapinec, Ph.D; Prof. Marijan Grubešić, Ph.D; Assoc. prof. Kristijan Tomljanović, Ph.D
ECTS	4	Study level and programme	BSc Urban Forestry, Environmental Protection and Nature Conservation

Course content

LECTURES:
1. Grounds for managing of animals, general and antropological overview of human-wild animals interactions around the World. – 2 hours
2. Niche, competition, guilds, habitat assessment. – 3 hours
3. Feeding behaviour and feeding strategies – 3 hours
4. Animal behaviour, home range, territoriality with emphasizes to reproductive behaviour and reproductive strategies – 3 hours
5. Population ecology and capacities – 3 hours
6. Human-animal interaction, spotting and forecasting potetntial problems and problematical species. – 3 hours
7. Population control, techniques for preventing damages. – 3 hours
8. Endangered species and recovery plans (agrocenosis, woody habitats). – 4 hours
9. Legislative, management plans. – 3 hours
10. Hunting legislative and organisation of hunting in Croatia – 3 hours

EXERCISES:
1. Criterions for animal classification – 1 hour
2. Taxonomy of birds and mammals – 2 hours
3. Sexing and aging big game – 3 hours
4. Sexing and aging small game – 2 hours
5. Census techniques – 3 hours
6. Census techniques, practical work – 2 hours
7. Hunting museum visiting – 2 hours

Learning outcomes

- ✓ Define criterion for wild animal classification (conservation and use of wild animals)
- ✓ 2.Feeding strategy (niche, habitat and ecosystem, competition, ecophysiological adaptations of ruminants and carnivores, splitting according to feeding strategy
- ✓ To explain wild animals behaviour and habitat-animal interactions (displaying of behaviour, reproductive behaviour, communication, home range and territory, migrations and migratory species, habitat selection, dispersion patterns and dispersal).
- ✓ Assessment of population dynamic, capacity (limiting factors and the law of tolerance, population structure, sustainable use)
- ✓ Find out types of animal population management on the local and global point of view (population control, causes of extinction or endangerment of populations, introduction, reintroduction, translocation, recovery plans, management plans and legislative).

Language

All teaching activities will be held in Croatian. However, foreign students will have the opportunity to attend additional office hours with the lecturer and teaching assistants in English to help master the course materials. Additionally, the

lecturer will refer foreign students to the corresponding literature in English, as well as give them the possibility of taking the associated exams in English.

Literature

Obligatory literature

Scalet, C.G., Flake, L.D., Willis, D.W., 1996: Introduction to Wildlife and Fisheries: An Integrated Approach; W.H. Freeman and Company; New York; 512 pp.
Bolton, M., 1997: Conservation and the use of wildlife resources. Chapman & Hall; London; 278 pp
DeGraaf, R.; Miller, R.I., 1996: Conservation of Faunal Diversity in Forested Landscapes. Chapman & Hall; 633 pp.
Sutherland, W.J., 2006: Ecological Census Techniques – a handbook, second edition. Cambridge University Press, The Edinburgh Building, Cambridge, 432 pp.

Recommended literature

1. Williams, B. K.; Nichols, J. D.; Conroy, M. J. 2001: Analysis and Management of Animal Population .– modeling, estimating and decision making. Acadmic Press. 817 pp.
2. Schwartz, M.W., 1997: Conservation in higly fragmented landscapes; Chapman & Hall; New York; 436 pp.
3. Wagenknecht E., 1971: Bewirtschaftung unserer Schalenwildbestande. VEB Deutscher Landwirtschaftsverlag, Berlin 386 pp.
4. Garms, H., Borm,L., 1981: Fauna Europe; Mladinska knjiga, Ljubljana, 550 pp.

Forms of teaching

Lectures (30), exercises (15)

Methods of grading

oral exam

Department of Forestry Courses - Graduate Study Programmes (MSc)

COMPUTER MODELING OF LANDSCAPE ARHITECTURE (code: 98209)

Original course title	Računalno oblikovanje parkovnih prostora	Status	compulsory
Semester	winter	Course teacher	Assoc. Prof. Hrvoje Nevečerel, PhD Assist. Prof. Kruno Lepoglavec, PhD
ECTS	6	Study level and programme	MSc Urban Forestry, Environmental Protection and Nature Coservation

Course content

Lectures:
1. Post-industrial society, modern urban development, the impact of ICT technologies on urban development, the development of digital technologies, the impact on human development, the projection of social change due to technological development (1 hour).
2. Development of information technologies, definitions, explanation of modern concepts, systematization of software tools on operating systems, development tools, service and application programs, development of expectations and application of IT equipment, influence on the design of the built environment (2 hours).
3. Systematization of concepts, CAD, BIM, development of 2D and 3D models, 4D and 5D modeling, data exchange, organization of professional work, Geographic Information Systems, data collection and management. Field data collection (4 hours).
4. Development of human perception, computer visualization, scene elements, shading algorithms, photo-realistic display algorithms, animation, QTVR, real-time animation, augmented reality virtual reality, display mode selection criteria, landscape visualization (2 hours).
5. Review of the development of computer graphics in the field of art, science and technology, technology (raster, vector, video, interactive, animation, games), simulations, creation of virtual worlds, development of new artistic sensibility, scientific visualization (2 hours).
6. Computer model and digital production; Development of digital production technologies; Substrate and additive production technologies; Development of personal production (desktop 3D printing); 3D printing materials (2 hours).
7. Development of the idea of a computer as a consultant, review of technologies, definition of terms, interactive multimedia, WWW, development of the Internet, social networks, Big Data, basic concepts, review of data, state of development of BD, artificial intelligence, development and basic concepts, knowledge bases, problems systematization of knowledge (range in problem solving approach, heuristic procedure, mechanisms of rules and constraints), technologies (expert systems and neural networks), deep learning examples, further development, impact on urban design (smart and sustainable cities) (2 hours).

Exercises:
1. Spatial data and application of software tools for their processing (work with GIS tools) (2 hours).
2. Preparation of input data. Working with landscape modeling tools in the landscape. Working with tools for modeling vegetation in the landscape. Development of a computer model of the subject location (work with GIS tools) (2 hours).
3. Modern technologies and their possibilities of application in the design of park spaces in urban units (2 hours).
4. Computer mapping and documentation (working with GIS tools) (2 hours).

5. Field data processing with raster data conversion and vice versa (vectorization and rasterization) (work with GIS tools) (2 hours).
6. Application of space design software tools (work with Lansdscape tools) (2 hours).
7. Data processing and work with 2D computer graphics (2D raster and vector graphics) (work with GIS and CAD tools) (6 hours).
8. 2D basics of CAD tools for the needs of technical drawing on a computer (work with CAD tools) (2 hours).
9. 3D creation of a conceptual solution on the example of a landscape project (work with Lansdscape tools) (6 hours).
10. Basics of landscape visualization and computer representations. Landscape visualization tools. Visualization of landscape components (terrain and water surfaces, cover and vegetation). Making computer displays (visualizations) of the subject location (working with Lansdscape tools) (4 hours).

Field work:
1 day (8 hours) - Consideration of spatial factors. Use of recording and mapping devices in the field. Checking the computer model of landscape components in the field.

Learning outcomes

1. Analyze information technologies and tools for Urban design (systematization of IT and software technologies, expectations of application development and IT equipment, impact on the design of the built environment, data exchange, organization of professional work, geographic information systems, data collection and management).

2. Present the development of computer graphics for computer landscape modeling and visualization of the environment (computer visualization, scene elements, criteria for selecting display modes, landscape visualization, simulations, creation of virtual worlds, scientific visualization).

3. Formulate digital production (subjective and additive production technologies, application of technologies).

4. Present a responsible environment (development of the idea of a computer as a consultant, review of technologies, collection and processing of information from the environment).

Language

English

Literature

Required
1. Lectures in Computer modeling of landscape architecture in .pptx and .pdf format
2. Brian Davis, Jamie Vanucchi, 2014: Urban Forests as Landscape Artifacts. SCENARIO 04: Building the Urban Forest
3. Urban Forests and Trees 2005: selected chapters in the book.

Optional
1. Rebecca M., 2018: How to Bring Great Landscaping to Your Home. https://groomandstyle.com/how-to-bring-great-landscaping-home/
2. 3D Nature: „Visual Nature Studio/World Creation Set", korisničke upute, 3D Nature, 2003/2004
3. Brail, K.R.:"Planning Support Systems: Integrating Geographic Information Systems, Models, and Visualization Tools", ESRI, 2001, ISBN 1-58948-011-2
4. Desimini J., 2014: To Multiply or Subdivide: Futures of a Modern Urban Woodland. SCENARIO 04: Building the Urban Forest
5. Vdović, R., 2000: „Digitalni krajolik – elementi vizualizacije", magistarski rad, Arhitektonski fakultet

Forms of teaching

Lectures (15h)

Exercises (30h)

Field work (1 day)

Methods of grading

partial exams, lab assignments, presentation

GENERAL AND LANDSCAPE ECOLOGY (code: 33886)

Original course title	General and Landscape Ecology	Status	compulsory
Semester	winter	Course teacher	Prof. Ivica Tikvić, PhD; Assoc. Prof. Damir Ugarković, PhD
ECTS	6	Study level and programme	MSc Forestry: Silviculture and Forest Management with Wildlife Management

Course content

Lectures
1. Introduction to General and Landscape Ecology. Fundamentals of general and landscape ecology. History of general and landscape ecology.
2. Organisms, environment and habitats in forest ecosystems
3. Life processes of organisms and the environment in forest ecosystems.
4. Ecological processes and functioning of forest ecosystems.
5. Relationships of organisms and light in forest ecosystems. Relationships of organisms and heat in forest ecosystems.
6. Relationships between organisms and water in forest ecosystems. Relationships between organisms and air in forest ecosystems.
7. Relationships of organisms and chemicals in forest ecosystems. Relationships of organisms and mechanical factors in forest ecosystems.
8. Relationships between organisms and climate in forest ecosystems. Relationships of organisms and relief in forest ecosystems.
9. Relationships between organisms and soil in forest ecosystems. Relationships of organisms and geological substrates in forest ecosystems.
10. Relationships of organisms in forest ecosystems - plants, animals, microorganisms and humans.
11. Ecological problems in forest ecosystems.
12. Protection of organisms and their habitats in forest ecosystems.
13. Improving the condition of forest habitats and forest organisms.
14. Forest ecosystem services
15. Monitoring the condition of forest ecosystems.

Exercises
1. Ecological projects in the field of forestry
2. Biological relations between organisms in the ecosystem - mycorrhiza
3. Monitoring, protection and improvement of forest habitats - National

Ecological Network
4. Assessment and improvement of public forest functions
5. Analysis of environmental impact studies
6. Determining the biodiversity index of forest ecosystems

Field work
1. Protection and conservation of forest habitats and species within NATURE 2000.
2. Improving the state of OKFŠ and forest ecosystem services

Learning outcomes

- ✓ Adopt basic principles for the protection of forests against abiotic and biotic factors and to apply the basic procedures and means for forest protection.
- ✓ Participate in the implementation of the forest management program.
- ✓ Perform professional field work on founding, care and restoration of foreststands.
- ✓ Perform professional work on melioration and landscaping of forest areas in the Mediterranean area.
- ✓ Cooperate on the development of ecological studies and spatial plans.

Language

All teaching activities will be held in English as well as all learning material in English will be provided to the students.

Literature

Required

- EKOLOŠKI LEKSIKON, Glavni urednik Oskar Springer, Zagreb: Barbat, Ministarstvo zaštite okoliša i prostornog uređenja Republike Hrvatske, 2001., 361 str.
- Vjekoslav Glavač, 1999. UVOD U GLOBALNU EKOLOGIJU, Državna uprava za zaštitu prirode i okoliša : Hrvatske šume. 207 str., Zagreb.
- Priroda Hrvatske Riznica za bolju budućnost, 2015., Državni zavod za zaštitu prirode, str. 52
- Pregled stanja biološke i krajobrazne raznolikosti RH, 1999., Ministarstvo zaštite okoliša i prirode.
- Tikvić, I., D. Ugarković, 2020: Opća i krajobrazna ekologija. Skripta, Šumarski fakultet Sveučilišta u Zagrebu
- Crveni popis ugroženih biljaka i životinja Hrvatske, 2004., Državni zavod za zaštitu prirode, str. 112.

Optional

- Daniel B. Botkin, Edward A. Keller; : ENVIRONMENTAL SCIENCE EARTH AS A LIVING PLANET (1-649 str.)
- Eugene P. Odum, 1971.: FUNDAMENTALS OF ECOLOGY (1-574 str.)
- Robert E. Ricklefs, 1990.: ECOLOGY (1-885 str.)
- BIOLOŠKA I KRAJOBRAZNA RAZNOLIKOST HRVATSKE, Državna uprava za zaštitu prirode i okoliša, Zagreb 1999, str. 151.
- Richard T.T. Forman, Michel Godron, 1986: LANDSCAPE ECOLOGY. John Wiley and Sons, Inc. New York, p. 1-620.
- BIODIVERSITY, E.O.Wilson, Editor, National Academy of Science, 1988, p. 521
- Mackenzie, A., A. S. Ball, S. R. Virdee, 2001: Ecology. BIOS Scientific Publishers Limited, UK, str. 339

Forms of teaching

Lectures (30h)

Exercises (15h)

Field work (2 days)

Methods of grading

Written tests, passive grades from exercises, passive grades from lectures, exercises, and field work attendance, oral exam

MECHANISATION OF TIMBER LOGGING (code: 225890)

Original course title	Mehanizacija pridobivanja drva	**Status**	compulsory
Semester	winter	**Course teacher**	Assist. Prof. Zdravko Pandur, PhD, ; Prof. Marijan Šušnjar, PhD
ECTS	5	**Study level and programme**	MSc Forestry: Techniques, Technologies and Management in Forestry

Course content

Lectures

1. Chainsaws 1. – history development, parts and components

2. Chainsaws 2. – safety at work
3. Harvesters – history development, types, performance
4. Harvesters heads– development, types, performance
5. Forwarders – development, types, performance
6. Tractors with semi-trailers – development, types, performance
7. Small sized forwarders for Thinnigs
8. Skidders – development, types, performance
9. Skidders – characteristics, kinematics
10. Winches
11. Cable yarders and wire systems
12. Cogeneration plants
13. Chippers
14. Forest trucks – types, characteristica
15. Energy in forestry – production, costs

Exercises
1. Preparation for the measurement exercise „Wheel – soil interaction - Wheel numeric"
2. Measurement exercise and data processing „Wheel – soil interaction - Wheel numeric"
3. Preparation for the measurement exercise „Morphological analysis of harvesters"
4. Measurement exercise and data processing „Morphological analysis of harvesters"
5. Preparation for the measurement exercise „Hidraulic tractor power lift"
6. Measuring exercise "Hydraulic tractor power lift"
7. Preparation for the measurement exercise „Tractive characteristics of skidders"
8. Measuring exercise „Tractive characteristics of skidders"
9. Preparation for the measurement exercise „Energy of forest machines and tools"
10. Measuring exercise „Energy consumption of forest machines and tools"
11. Calculation task – calculation of winch
12. Calculation task – calculation of forces during timber skidding
13. Calculation task – calculation of compressor system features
14. Calculation task – calculation of wheel numeric
15. Calculation task – calculation of engine speed characteristics of internal combustion engine

Field work
1. Machine felling and production by harvesters and wood extracting by cable yarders
2. Cogeneration power plants and production of energy wood

Learning outcomes

- ✓ Compare machines for tree felling and processing – motor chainsaws (history development, parts and elements, chainsaw use in Croatia, energy and environmental suitability of 2-stroke engines, chain (construction and maintenance), ergonomic features, guidelines of development, morphological analysis of chainsaw).
- ✓ Recommend machines for tree felling and processing – Harvesters (basic technical features, types, morphological, ergonomic, energy and environmental characteristics of harvester).
- ✓ Recommend forest vehicles for timber logging – Skidders, Forwarders (construction, types of skidders and forwarders, technical features, principle of Diesel engine, environmental suitability, morphological features).
- ✓ Present machines for timber transport – tractor assemblies (adapted farming tractor, adaptation for forest work, farming tractor equipped with forest winch, tractor with semi-trailer and crane).
- ✓ Present other machines of mechanised timber logging (forest trucks for timber transport, forest cableways, forest biomass chippers).

Language

All teaching activities will be held in Croatian. However, foreign students will have the opportunity to attend additional office hours with the lecturer and teaching assistants in English to help master the course materials. Additionally, the lecturer will refer foreign students to the corresponding literature in English, as well as give them the possibility of taking the associated exams in English.

Literature

Required
1. Šušnjar, M., Pandur, Z., - Presentations of lectures and exercises from the subject Mehanization of wood logging NO YES, Merlin
2. Längin, D., i dr.: South African Ground Based Harvesting Handbook. Forest Engineering Southern Africa and Institute for Commercial Forestry Research 2010, s. 45- 105. NO YES, web
3. Harvesting Systems and Equipment in British Columbia, FERIC, s. 49-89. NO YES, web
4. Best Practice Guidelines for Ground-based Logging, FITEC, New Zealand 2000, poglavlja: a) Types of extraction machines, s. 2-7., b) Personal protective equipment, s. 30., c) Wire rope, strops, and other accessories, s. 31-35., d) Forwarder extraction, s. 43. NO YES, web
5. Castro G.P., Malinovski J.R., Nutto L., Malinovski R.A. (2016) Machinery and Equipment in Harvesting. In: Pancel L., Köhl M. (eds) Tropical Forestry Handbook. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-54601- 3_183 NO YES, web
6. Wong, J.Y., Theory of ground vehicles. Fourth edition, John Wiley and sons, Inc. 2008, poglavlje: Performance characteristics of off-road vehicles, s. 319-362.

Optional
1. Šušnjar, M., Horvat, D., Kristić, A., Pandur, Z., 2008: Morphological analysis of forest tractor assemblies. Croatian journal of forest engineering, 29 (1): 41-51.
2. Tomašić, Ž.,Šušnjar, M.,Horvat, D.,Pandur, Z., 2009: Forces affecting timber skidding. Croatian journal of forest engineering, 30 (2): 127-139.
3. Šušnjar M., Horvat, D., Pandur, Z., Zorić, M., 2011: Određivanje osovinskih opterećenja kamionskoga i tegljačkoga skupa za prijevoz drva (Axle Load Determination of Truck with Trailer and Truck with Semitrailer for Wood Transportation). Croatian journal of forest engineering, 32 (1): 379-388.
4. Pandur, Z., Vusić, D., Papa, I., 2009: Dodatna oprema za povećanje proizvodnosti forvardera. Nova mehanizacija šumarstva, 30 (2009); 19 – 25.
5. Gužvinec, H. Zorić, M., Šušnjar, M., Horvat, D. Pandur, Z., 2012: Utjecaj načina sidrenja na vrijednosti horizontalne sastavnice vučne sile i faktor prianjanja prilikom privitlavanja drva skiderom i adaptiranim poljoprivrednim traktorom. Nova mehanizacija šumarstva. 33 (2012); 23-33.
6. Pandur, Z., Horvat, D., Šušnjar, M., Zorić, M., Benić, D., Bakarić, M., 2015: Applicability of hydraulic dynamometer for mesuring load mass on forwarders. BULLETIN OF THE FACULTY OF FORESTRY. supplement issue (2015); 101-110.
7. Pandur, Z., Šušnjar, M., Horvat, D., Zorić, M., Matajčić, M., 2015: Ispitivanje tehničkih značajki nove šumske poluprikolice »Lika«. Nova mehanizacija šumarstva. 36 (2015) ; 19-32.
8. Šušnjar, M., Bačić, M., Horvat, T., Pandur, Z., 2019: Analiza radnih obilježja šumskih kamionskih skupova za prijevoz drva. Nova mehanizacija šumarstva. 40 (2019), 1; 11-19. https://doi.org/10.5552/nms.2019.2
9. Pandur, Z., Horvat, D., Šušnjar, M., Zorić, M., Knežević, M., 2015: Load space utilization of forwarder Valmet 860.4. Forest engineering - Making a positive contribution. Formec Book of Abstracts and Proceedings 2015 / Kanzian, C.; Erber, G.; Kühmaier, M. (ur.). Beč: BOKU, 2015. 271-275.

Forms of teaching

Lectures (30 h), exercise 15 h), field work (2 days)

Assessment methods

Written exam, oral exam

TIMBER HARVESTING SYSTEMS (code: 225889)

Original course title	Sustavi pridobivanja drva	Status	compulsory
Semester	winter	Course teacher	Assist. Prof. Dinko Vusić PhD; Assist. Prof. Andreja Đuka, PhD; Branko Ursić, mag. ing. silv.
ECTS	6	Study level and programme	MSc Forestry: Techniques, Technologies and Management in Forestry

Course content

Lectures
1. Introduction. Concept of timber harvesting systems and timber harvesting methods.
2. Visualization of the timber harvesting system. Matrix, function diagram and simulation theory of production systems.
3. Productivity of the (sub) system of timber harvesting systems. Laws of mechanization of works in timber harvesting; interaction with stand and exploitation factors.
4. Standardization of work; experiential and technical standards in timber harvesting – a historical overview. Modern standardization systems for felling and processing and primary transport of wood.
5. Labor costs; cost classification; direct cost calculation methods.
6. Development of technique and technology in timber harvesting. Development of means and methods of work, theory of discontinuous evolution, synthesis at the level of modern wood extraction systems.
7. Partially mechanized systems of wood extraction by attraction. Team work. Integration of timber harvesting elements in time and space.
8. Partially mechanized skidding timber harvesting systems. Influencing factors; the picevolume law.
9. Mechanized forwarding timber harvesting. Influencing factors; unifirom product type law.
10. Mechanized skidding timber harvesting systems. Landing organization.
11. Skyline timber harvesting systems. Prerequisites for efficient operation.
12. Timber harvesting systems for small forest estates. Law of production volume.
13. Logistics in timber harvesting.
14. Timber long-distance transport. Integration with the timber harvesting system.
15. Energy wood harvesting systems. Supply chain optimization.

Exercises
1. Design of timber harvesting system. System components, component interaction and main influencing factors.
2. Calculation of the partially mechanized felling and processing productivity based on the influencing factors.
3. Calculation of the mechanized felling and processing productivity based on the influencing factors.
4. Calculation of the skidding productivity based on the influencing factors..
5. Calculation of the forwarding productivity based on the influencing factors.
6. Direct cost calculation at the (sub) system level.
7. Optimization of the skidding partially mechanized timber harvesting systems; productivity adjustment – standard time method; subsystem time overlap.
8. Optimization of the forwarding partially mechanized timber harvesting system; selection of a suitable means of primary transport - cost breakeven point.
9. Optimization of the forwarding mechanized timber harvesting systems; the impact of machine utilization on the unit cost of timber harvesting.
10. Optimization of the skidding mechanized timber harvesting systems; productivity adjustment - standard time method; subsystem time overlap.
11. Optimizing the skyline timber harvesting systems; selection of the means of work and the level of mechanization - cost analysis.
12. Cost analysis of the use of adapted agricultural machinery in timber harvesting on small forest estates.
13. Harvester information system data analysis; productivity monitoring and product records - logistics system adjustment.
14. Optimization of long-distance timber transport; selection of mode and appropriate means of long-distance transport - - cost breakeven point..

15. Optimization of wood chip supply system - choice of time, place and means of comminution.

Field work
1. One-day fieldwork with the aim of determining the main influencing factors and their influence on the selection of a suitable timber harvesting system. Analysis of the organization of work on a specific forest site, planned standards, documentation and methods of recording productivity and cost.

Learning outcomes

- ✓ Present the laws of timber harvesting efficiency (influential factors, ways of carrying out works in forestry, mechanization laws in timber harvesting, interaction with stand and exploitation factors, performance and labor productivity, standardization and labor costs, methods of direct cost calculation).
- ✓ Interpret the development of techniques and technologies in timber harvesting (development of equipment and methods of work, discontinuous evolution theory, system optimization, tree felling theory, tree bucking by the selected method).
- ✓ Present timber harvesting system (system elements and timber harvesting subsystems, component interaction, and visualization of the system).
- ✓ Valorize partially mechanized timber harvesting systems (buck-to-quality, tree-length, half-tree-length method, firewood production).
- ✓ Present mechanized timber harvesting systems (cut-to-length and full tree method, centralized timber yards and roundwood processing,).

Language

All teaching activities will be held in Croatian. However, foreign students will have the opportunity to attend additional office hours with the lecturer and teaching assistants in English to help master the course materials. Additionally, the lecturer will refer foreign students to the corresponding literature in English, as well as give them the possibility of taking the associated exams in English.

Literature

Required
1. Zečić, Ž., Vusić, D., 2018: Pridobivanje drva II - Predavanja i vježbe (interna skripta), Šumarski fakultet. Zagreb
2. Längin, D., Ackerman, P., Krieg, B., Immelmann, A., Potgieter, C., van Rooyen, J., Upfold, S., 2010: South African Ground Based Harvesting Handbook. Forest Engineering Southern Africa and Institute for Commercial Forestry Research, Scottsville, South Africa, 1–182. (Selected sections)

Optional
1. Sundberg, U., Silversides, C.R., 1988: Operational Efficiency in Forestry – Volume 1: Analysis. Kluwer Academic Publishers – Forest Sciences, Dodrechts/Boston/Lancaster, 1 – 219.
2. Silversides, C.R., Sundberg, U., 1989: Operational Efficiency in Forestry – Volume 2: Practice. Kluwer Academic Publishers – Forest Sciences, Dodrechts/Boston/Lancaster, 1 – 169.
3. MacDonald, AJ., 1999: Harvesting Systems and Equipment in British Columbia. FERIC, Handbook No., HB-12: 1–197.
4. Längin, D., Ackerman, P., Krieg, B., Immelmann, A., Potgieter, C., van Rooyen, J., Upfold,
S., 2010: South African Ground Based Harvesting Handbook. Forest Engineering Southern Africa and Institute for Commercial Forestry Research, Scottsville, South Africa, 1–182.
5. Taboršak, D., 1987: Studij rada. Tehnička knjiga Zagreb, 1 – 214.

Forms of teaching

Lectures (30), exercises (30h), field classes (8h)

Methods of grading

Written exam + oral exam

STATISTICAL METHODS AND MODELING IN FORESTRY (code: 33843)

Original course title	Statističke metode i modeliranje u šumarstvu	Status	compulsory
Semester	winter	Course teacher	Prof. Anamarija Jazbec, PhD; Assistant prof. Mislav Vedriš, PhD
ECTS	4	Study level and programme	MSc Urban Forestry, Nature Conversation and Environmental Protection

Course content

Comparing the equality of frequency distribution of two categorical variables-Chi2 test Correlation analysis (define the population correlation and the correlation coefficient, test the statistical significance of the estimated correlation coefficient on a random sample) Analysis of variance (comparison of more than two population means, parametric (ANOVA) and nonparametric (Kruskal - Wallis test), Post-hoc tests. Regression analysis (univariate and multivariate): define and classify regression analysis, bulinding methods of regression model, forward, backward and stepwise), testing the adequacy of the developed model (ANOVA, coefficient of determination, MSE). Testing the statistical significance of the estimated model parameters. Some nonlinear regression models. Growth models.

Learning outcomes

- ✓ Design survey questionnaire and determine the sample size (composing the questionnaire, creating and organizing database, sampling methods, determination of sample size for desired precision of estimate – mean and proportion, determination of sample size for binomial distribution)
- ✓ Explain comparison of two frequency distributions (chi-square test)
- ✓ Present correlation analysis (define correlation in population and estimate correlation coefficient; testing statistical significance of correlation coefficient based on random sample)
- ✓ Formulate analysis of variance: comparing more than two population means; parametric (ANOVA) and non-parametric test (Kruskal-Wallis), defining multiple comparison (post-hoc) test of difference between populations; graphical presentation using statistical software
- ✓ Present regression analysis: define and classify types of regression, model building methods, indicators and tests for model goodness of fit, testing statistical significance of estimated parameters, graphical presentation using statistical software

Language

All teaching activities will be held in Croatian. Foreign students will have the opportunity to attend additional office hours with the lecturers and be provided with teaching materials and literature in English.

Literature

Required

Jazbec A . (2005) PRIRUČNIK IZ STATISTIKE. Interna skripta.

Optional

1. Sokal R.R., Rohlf F.J. (1995) Biometry, Freeman and Company, New York
2. Zar J.H.(1999) Biostatistical analysis, Prentice Hall
3. Sparks T. (2000) Statistics in Ecotoxicology, Wiely & Sons, New York
4. Jongman R.H.G., Braak C.J.F., van Tongeren (2002) Data Analysis in Community and Landscape Ecology, Cambridge University Press

Forms of teaching

Lectures (15 h), exercises (30 h)

Methods of grading

Evaluation of exercise assignments, partial exams, written and oral final exam

APPLIED ZOOECOLOGY (code: 73827)

Original course title	Primijenjena zooekologija	Status	elective
Semester	winter	Course teacher	Assist. prof. Marko Vucelja, PhD
ECTS	2	Study level and programme	MSc Urban Forestry, Nature Conversation and Environmental Protection

Course content

Lectures:
1. What is zooecology? Definition and division of ecology. Who were the founders of ecology, or zooecology? Levels of biological systems by size and function
2. Environmental factors. Limiting factors. Ecological valence. Life form. Ecological niche. Abiotic and biotic factors. Homotypic and heterotypic relationships. The struggle for selfpreservation
3. Abiotic factors: light, temperature, water, air
4. Biotic factors: intraspecific and interspecific relationships. Neutralism, competition, amensalism, parasitism, predation, commensalism, mutualism
5. Trophic factors. Type of animal diet. The amount of food. Food quality. Autotrophic an heterotrophic organisms. Food chains and networks
6. Ecology of the population. Basic attributes of the population: density, spatial distribution, birth rate, mortality, age structure, growth potential, growth and maintenance flow
7. Population dynamics. Biotic potential and fluctuations in population density. Oscillations and fluctuations. Types of fluctuation curves. Pest groups according to fluctuation type. Phases of pest gradation. Spatial aspect of population dynamics
8. Population theories. Physical, biotic, trophic theory, gradocene theory, constitutional, synthetic theory
9. Biotic community or biocenosis. Composition and structure. Nutritional relationships. Ecotones and periodism
10. Ecological systems and biomes. Diversity and types of ecosystems. Matter and energy in the ecosystem. Successions. Producers, consumers, interpreters. Energy flow in the ecosystem
11. Evolutionary ecology. Evolution. Adaptation. Selection
12. Behavioral ecology. Territoriality. The search for food. Migration optimization. Group life
13. Biological diversity of Croatia: fauna: invertebrates
14. Biological diversity of Croatia: fauna: vertebrates
15. Biological diversity of Croatia: invasive species

Learning outcomes

- ✓ Describe the specifics of Croatian biodiversity, especially in the context of fauna (invertebrates, fish, amphibians, reptiles, birds, mammals)
- ✓ Name the IUCN categories of threatened species (from EX: extinct to DD: data deficient)
- ✓ Illustrate the differences between the organization levels of biological systems (individual, population, biocenosis, ecosystem, biome, biosphere).
- ✓ Discuss the importance and historical and current role of ecology, or zooecology, in understanding the complexity of the relationship between living and non-living things
- ✓ Distinguish numerous roles of abiotic and biotic factors in changing dynamics of animal populations, biocenoses and ecological systems
- ✓ Explain the matter cycling and energy flow through the ecosystem from primary producers, through primary to secondary, tertiary and other higher levels of consumers.
- ✓ Explain the importance of the relationship stability between production (autotrophic) and consumer (heterotrophic) components of different ecosystems

- ✓ Give examples of animal species (autochthonous, allochthonous, invasive) according to different habitat types in Croatia

Language

All teaching activities will be held in Croatian. Foreign students will have the opportunity to attend additional office hours with the lecturer and teaching assistants in English to help master the course materials. Foreign students will be provided to the corresponding literature in English, as well as give them the possibility of taking the associated exams in English.

Literature

Required

- Ecology: The Experimental Analysis of Distribution and Abundance, 6th edition, Charles J. Krebs, Pearson 2009., 569 pp.
- Elton, C, 1968: Animal Ecology, Methuen & Co. LTD and Science Paperbacks, London, 207 pp.
- Priroda Hrvatske: Riznica za bolju budućnost, DZZP, Zagreb 2015., 50. str.
- Biološka raznolikost Hrvatske, DDZP, 2009., Zagreb, 43. str.
- Androić, M., 1970: Osnovi zooekologije s osobitim osvrtom na entomofaunu, Izdavačko-tiskarsko poduzeće «A. G. Matoš», Samobor, 152 str.
- Šafarek, G., 2014: Životinje Hrvatske, Mozaik knjiga, Zagreb, 330. str.

Optional:

1. Uhlenbroek, C., 2009: Svijet životinja, Profil, 512. str.
2. Antolović, J., Frković, A., Grubešić, M., Holcer, D., Vuković, M., Flajšman, E., Grgurev, M., Hamidović, D., Pavlinić, I. i Tvrtković, N., 2006: Crvena knjiga sisavaca Hrvatske. Ministarstvo kulture, Državni zavod za zaštitu prirode, Zagreb, 128. str.
3. Tutiš, V., Kralj, J., Radović, D., Ćiković, D., Barišić, S. (ur.), 2013: Crvena knjiga ptica Hrvatske, Ministarstvo zaštite okoliša i prirode, Državni zavod za zaštitu prirode, Zagreb, 258 str.
4. Jelić, D., Kuljerić, M., Koren, T., Treer, D., Šalamon, D., Lončar, M., Podnar-Lešić, M., Janev Hutinec, B., Bogdanović, T., Mekinić, S. i Jelić, K., 2015: Crvena knjiga vodozemaca i gmazova Hrvatske. Državni zavod za zaštitu prirode, Zagreb, 232. str.
5. Mrakovčić, M., Brigić, A., Buj, I., Ćaleta, M., Mustafić, P. i Zanella, D., 2006: Crvena knjiga slatkovodnih riba Hrvatske. Ministarstvo kulture i Državni zavod za zaštitu prirode, Zagreb, 256. str.

Forms of teaching

Lectures (30 h)

Methods of grading

Written exam. Term papers and student oral presentations.

BEHAVIOURAL ECOLOGY (code: 73822)

Original course title	Behavioural ecology	Status	elective
Semester	winter	Course teacher	Assist. prof. Marko Vucelja, PhD
ECTS	2	Study level and programme	MSc Forestry: Silviculture and Forest Management with Wildlife Management

Course content

1. Introduction to behavioural ecology: history background with emphasis on work of Tinbergen, Lorenz and Darwin. Explanation of basic terms and definitions needed for understanding the behavioural and ecological studies.
2. Introducing different types of behaviour; different analysis and interpretations of behaviour.
3. Proximate and ultimate mechanisms of behaviour
4. Evolution of behaviour: Understanding behaviour through mechanisms of sexual and natural selection.

5. Intra- and inter- specific interactions
6. Foraging theory
7. Learning in animals: operant and classical conditioning, non-associative learning, imprinting
8. Selection types: balancing, directional, disruptive, stabilizing, r-strategy and k-strategy
9. Aggressive and territorial behaviour
10. Hormones and behaviour
11. Social behaviour in animals and humans
12. Conservation biology 1
13. Conservation biology 2
14. Importance of behavioural in comparison of different field of study (ecology, neurobiology, sociology and psychology)
15. Short summary of lectures 1-12; consultation for students with questions concerning the lectures

Learning outcomes

- ✓ Identify the main scientists and their research that set the foundations of ethological research.
- ✓ Identify the difference between the ultimate and proximal causes of animal behavior.
- ✓ List the types of innate and learned behaviors.
- ✓ Identify the mechanisms responsible for the innate and learned behavior.
- ✓ Identify examples of natural and sexual selection and the impact of both on the development and behavior of animal species.
- ✓ Identify in nature different types of behavior and appearance of animals due to natural and sexual selection.
- ✓ Classify different reproductive strategies of animals with an emphasis on monogamy and polygamy.
- ✓ Identify various mechanisms in females and males responsible for brood care.
- ✓ Identify sexual dimorphism and identify intrasexual and intersexual selection.

Language

All teaching activities will be held in Croatian. Foreign students will have the opportunity to attend additional office hours with the lecturers and be provided with teaching materials and literature in English.

Literature

Required
Alcock J. Animal Behavior: An Evolutionary Approach. Seventh Edition. Sunderland (MA): Sinauer Publishers, 2001.
Pavičić, Željko Opća etologija, Zagreb: Veterinarski fakultet Sveučilišta u Zagrebu, 2006., 62 str. Pavičić, Ž., Ostović, M., Aladrović, J., Opća etologija, poglavlje u knjizi Dobrobit životinja, Urednik/ci Pavičić, Željko ; Ostović, Mario 2019, raspon stranica 1-22.

Optional
1.Eibel-Eibesfeldt, I. Grundriss der vergleichenden Verhaltensforschung. München : Verlag Piper, 1969.
2. Pullin, A. S. Conservation Biology. Cambridge University Press, 2002.

Forms of teaching

Lectures (15 h)

Methods of grading

Written exam. Term papers and student oral presentations. Obligatory class attendan

ANIMAL BEHAVIOR (code: 225987)

Original course title	Ethology	Status	elective
Semester	winter	Course teacher	Assist. Prof. Marko Vucelja, PhD
ECTS	2	Study level and programme	MSc Urban Forestry, Nature Conversation and Environmental Protection

Course content

1. Introduction to animal behavior: the historical basis of ethological studies
2. Natural selection; Charles Darwin
3. Gender selection
4. Proximal and distal behavioral mechanisms
5. Evolution of the mating system
6. Evolution of feeding behavior, habitat selection
7. Learning in animals: operant and classical conditioning, non-associative learning, imprinting
8. Behavioral control: neural mechanisms
9. The role of aggressive and territorial behavior; intra- and inter-specific interactions
10. Behavioral organization: Neurons and hormones
11. Adaptation and behavior against predators
12. Conservation biology
13. Effects of habitat disturbances, species conservation
14. The importance of behavioral studies in science with emphasis on ecology, neurobiology, sociology, and psychology.
15. Short summary of lectures 1-12; consultations for students with lecture-related questions

Learning outcomes

- ✓ Identify the main scientists and their work that set the foundations of ethological research.
- ✓ Identify the difference between the ultimate and proximal causes of animal behaviour.
- ✓ Identify innate behaviours in animals.
- ✓ Identify different animal learning mechanisms.
- ✓ Identify examples of natural and sexual selection and the impact of both on the development and behaviour of animal species.
- ✓ Link the behaviour of animals in nature depending on their reproduction or survival.
- ✓ Classify different reproductive strategies of animals with emphasis on monogamy and polygamy.
- ✓ Identify sexual dimorphism and identify intrasexual and intersexual selection.
- ✓ Identify various mechanisms in females and males responsible for their own offspring.
- ✓ Recognize different types of animal behaviour in nature depending on their habitats.

Language

All teaching activities will be held in English as well as all learning material in English will be provided to the students.

Literature

Required

- Alcock J. Animal Behavior: An Evolutionary Approach. Seventh Edition. Sunderland (MA): Sinauer Publishers, 2001

Optional

- Bolton, M. Conservation and the Use of Wildlife Resources. Chapman & Hall, 1997. 3. Caro, T., ed. Behavioral ecology and conservation biology. Oxford University Press, New York, 1998.
- Pullin, A. S. Conservation Biology. Cambridge University Press, 2002.
- Matoničkin, I., Klobučar, G., Kučinić, M., 2010: Opća zoologija, Školska knjiga, Zagreb, 467. str.
- Uhlenbroek, C., 2009: Svijet životinja, Profil, 512. str.
- Pavičić, Ž., Ostović, M., 2019: Dobrobit životinja, Jastrebarsko, 2018. (2020), 456. str.
- Šolić, M., 2005: Ekologija ponašanja životinja, interna skripta, Sveučilište u Splitu, 80. str.

Forms of teaching

Lectures (30 h)

Methods of grading	Written exam. Term papers and student oral presentations. Obligatory class attendance.

FOREST BIOMASS FOR ENERGY (code: 225894)

Original course title	Šumska biomasa za energiju	Status	compulsory
Semester	winter	Course teacher	Assist. Prof. Dinko Vusić, PhD; Branko Ursić mag. ing. silv.
ECTS	2	Study level and programme	MSc Forestry: Techniques, Technologies and Management in Forestry

Course content

Lectures
1. Basic features of energy wood. Moisture content, ash content and calorific value.
2. Classification of energy wood. Normative system for solid biofuels.
3. Theoretical, technical and economic potential of forest biomass for energy.
4. Review of trends in the production and use of forest biomass.
5. Ecological advantage of using energy wood.
6. Forest biomass as a raw material for the production of pellets, briquettes and charcoal. Default and variable characteristics of the raw material - the impact on product quality.
7. Use of wood chips in power plants. Influence of energy quality on the efficiency of power plants.
8. Mechanized production of chopped firewood.
9. Production of wood chips. Raw material characteristics and comminution methods.
10. Transport of energy wood. Influence of shape and physical characteristics on transport efficiency.
11. Energy wood storage. Natural drying, dry matter loss and energy density.
12. Energy wood harvesting systems in early thinnings.
13. Energy wood harvesting systems in shelterwood fellings.
14. Energy wood harvesting systems in forest plantations.
15. Energy wood harvesting systems in SRC.

Exercises
1. Sampling of solid biofuels. Development of a sampling plan and preparation of a laboratory sample.
2. Determination of bulk density of wood chips.
3. Determination of the moisture content of wood chips.
4. Determination of the ash content of wood chips.
5. Paricle size distribution analysis of wood chips.
6. Presentation and recalculation of results. Conversion factors.
7. Preparing a product declaration.
8. Determining the basic quality parameters of chopped firewood.
9. Calculation of chipping productivity and costs. Selection of the optimal method and means of comminution.
10. Transport of wood chips. Selection of the optimal means of long-distance transport based on the cost breakeven point. Influence of moisture content on costs.
11. Determining the optimal storage time of wood chips - the point of maximum energy density.
12. Calculation of the productivity breakeven point when using accumulation cutting heads.
13. Optimization of a partially mechanized wood chips harvesting system.
14. Optimization of mechanized wood chips harvesting system.
15. Comparative analysis of energy wood harvesting systems in SRC.

Learning outcomes

Present production potential and forms of forest biomass for energy (sources and origin of biomass, energy forests, forms of biomass for use and trade, standards for solid biofuels from forestry, quality testing of wood chips).
Evaluate technologies and techniques of harvesting forest biomass as a solid biofuel (transport of compressed and comminuted biomass, storage, areas of application and use of forest biomass, structure of energy wood and brushwood by stand age and tree species, establishment and production of wood biomass in short rotation coppice).
Evaluate the environmental suitability, use and storage of forest biomass for energy (reduction of greenhouse gas effects by using biomass, legal acts, energy plants, heat, cogeneration and trigenation plants, forest wood biomass for pellet, briquette, charcoal production).

Language

All teaching activities will be held in Croatian. However, foreign students will have the opportunity to attend additional office hours with the lecturer and teaching assistants in English to help master the course materials. Additionally, the lecturer will refer foreign students to the corresponding literature in English, as well as give them the possibility of taking the associated exams in English.

Literature

Required

- Zečić, Ž., 2018: Šumska biomasa za energiju (interna skripta), Šumarski fakultet. Zagreb
- United Nations, Economic Commission for Europe, 2018: Wood Energy in the ECE Region: Data, trends and outlook in Europe, the Commonwealth of Independent States and North America. Aguilar, Francisco X. (ur.)., Geneva, 1–93.

Optional

1. Hakkila, P., 1989: Utilization of Residual Forest Biomass. Springer-Verlag, Berlin, 1–568.
2. Aguilar, F. X., 2014: Wood Energy in Developed Economies: Resource Management, Economics and Policy. Routledge, London and New York, 1–338.
3. Zečić, Ž., Vusić, D., 2020: Katalog drvnih šumskih proizvoda. Sveučilište u Zagrebu Šumarski fakultet, 1–217.

Forms of teaching

Lectures (15 h), exercises (15 h)

Assesment methods

Oral exam

INNOVATIONS IN FORESTRY (code: 33956)

Original course title	Inovacije u šumarstvu	Status	elective
Semester	winter	Course teacher	Prof. Mario Šporčić, PhD
ECTS	2	Study level and programme	MSc Forestry: Techniques, Technologies and Management in Forestry

Course content

1. Introduction, concept and definition of innovation, role and significance of innovations
2. Types of innovation, innovation processes, factors that encourage/inhibit innovation
3. Regional and sectoral innovation systems, the position of forestry
4. European innovation policy, the position of forestry
5. Innovation monitors and indicators, EIS, GEM
6. Innovation and creativity, evaluation and choice of ideas
7. Individual techniques of stimulating creativity
8. Group techniques of stimulating creativity
9. European initiatives, projects and actions on forestry innovations, COST E51, Innoforce
10. State of the innovations in European forestry
11. Innovation activities and innovation behavior of forest owners, managers and forest companies
12. Legal framework for innovations in Croatia, intellectual property, laws, regulations, the position of forestry

13. Examples of innovation from European forestry practice, case studies
14. Examples of innovation from Croatian forestry, case studies
15. State and level of innovations in Croatian forestry

Learning outcomes

- ✓ Depict the state of innovation and innovativeness in forestry (significance, role and division of innovations, stages of innovation process, innovation systems and monitors, company-level innovations, factors of innovation activity,conditions for innovation activity, innovation behavior, sources of impulses and information for innovation, support and innovation constraints).
- ✓ Explain creativity and inventiveness (features of creativity and inventiveness, process and stage of creative thinking, characteristics of creative people, techniques of encouraging creative thinking, evaluation and choice of ideas/solutions).
- ✓ Expose institutional support for innovation activities and examples of good practice.

Language

All teaching activities will be held in Croatian. However, foreign students will have the opportunity to attend additional office hours with the lecturer in English. Additionally, the lecturer will refer foreign students to the corresponding literature in English, as well as give them the possibility of taking the associated exams in English.

Literature

Required

- Rametsteiner, E., Weiss, G., Kubeczko, K., 2005: Innovation and entrepreneurship in forestry in central Europe. Brill Academic Publishers, Leiden-Boston.
- Srića V., 2003: Kako postati pun ideja. M.E.P. Consult, Zagreb.

Optional

- Šporčić, M., Landekić, M., Ćosić, M., Bakarić, M., 2017: Inovacijske nagrade u šumarstvu. Nova mehanizacija šumarstva 38: 79-90.
- Posavec, S., Šporčić, M., Antonić, D., Beljan, K., 2011: Poticanje inovacija - ključ razvoja u hrvatskom šumarstvu. Šumarski list 135 (5-6): 243-256..
- Šporčić, M., Landekić, M., Marjanović, M., 2012: Vodič za prikupljanje podataka i interpretaciju inovacija u šumarstvu. Nova mehanizacija šumarstva, vol. 33: 79-94.
- Martinić, I., Šporčić, M., Vondra, V., 2006: Inovacijski procesi kao ključ provedbe Hrvatske šumarske politike. Glasnik za šumske pokuse, pos. izdanje 5: 703-715.
- Srića, V., 2003: Inventivni menadžer u 100 lekcija. Znanje d.d. Zagreb.

Forms of teaching

Lectures, student presentations, solving of individual problem tasks (15 h).

Assessment methods

The evaluation of students` knowledge and achievements has been conducted during the classes and by written exams

METHODS OF PLANT TAXONOMY (code: 73820)

Original course title	Methods of Plant Taxonomy	Status	elective
Semester	winter	Course teacher	Assist. Prof. Martina Temunović, PhD
ECTS	2	Study level and programme	MSc Forestry; Programme: Silviculture and Forest Management with Wildlife Management

Course content

Lectures:
1. Taxonomy – definition, basic principles and terminology. Phylogeny. (1h)
2. Plant nomenclature. Taxon definition, understanding of the taxon concept, taxonomic ranks. (1h)
3. Evolution and Microevolutionary processes. (1h)
4. Species definitions. Speciation. (1h)
5. Developing and using plant identification keys, floristic handbooks. (1h)
6. Herbarium and herbarium collections. (1h)
7. Plant identification. (1h)
8. Methods of collecting and processing taxonomic data – morphology. (1h)
9. Methods of collecting and processing taxonomic data – anatomy, cytology and biochemistry. (1h)
10. Methods of collecting and processing taxonomic data – phytogeography and paleobotany. (1h)
11. Methods of collecting and processing taxonomic data – molecular taxonomy. (2h)
12. Methods of collecting and processing taxonomic data – molecular taxonomy. (1h)
13. Statistical analysis of taxonomic data. (1h)
14. Seminar presentations. (1h)

Learning outcomes

- ✓ To explain basic principles and terminology in plant taxonomy (phylogeny, plant nomenclature, understanding of the taxon concept, evolution, speciation)
- ✓ To use plant identification keys, floristic handbooks, herbarium collections and herbarium material for plant identification.
- ✓ To define taxonomic problems and to recommend appropriate methods of collecting and processing suitable types of taxonomic data (morphology, anatomy, cytology and biochemistry, phytogeography, paleobotany, molecular taxonomy).
- ✓ To analyse taxonomic data and to interpret the obtained results.

Language

All teaching activities will be held in English.

Literature

Required
1. Vidaković, M., J. Franjić, 2004: Golosjemenjače. Sveučilište u Zagrebu-Šumarski fakultet. Zagreb
2. Franjić, J., Ž. Škvorc, 2010: Šumsko drveće i grmlje Hrvatske. Sveučilište u Zagrebu – Šumarski fakultet, 432 str. Zagreb.
3. Franjić, J., Ž. Škvorc, 2014: Šumsko zeljasto bilje Hrvatske. Sveučilište u Zagrebu – Šumarski fakultet, 626 str. Zagreb.
4. Judd, W. S., C. S. Campbell, E. A. Kellogg, P. F. Stevens 2007: Plant Systematics. A Phylogenetic Approach. 3rd edition. Sinauer Associates. Sunderland.
5. Stuessy, T. F. 2009: Plant taxonomy: The systematic evaluation of comparative data. 2nd edition. Columbia University Press, New York.

Optional
6. Nikolić, T., 1996: Herbarijski priručnik, 1-167. Zagreb.

7. Nikolić, T., 2013: Sistematska botanika - Raznolikost i evolucija biljnog svijeta. Alfa d.d., 882 str. Zagreb.
8. Domac, R., 1994: Flora Hrvatske, priručnik za određivanje bilja. Školska knjiga, Zagreb.
9. Singh, G. 2016: Plant Systematics, 3rd edition: An Integrated Approach. CRC Press.
10. Besse, P. (ur.) 2014: Molecular plant taxonomy: methods and protocols. Humana Press.
11. Winston, J.E. 1999: Describing Species, Practical Taxonomic Procedure for Biologist. Columbia University Press, New York
12. Clive, S., 2005: Plant taxonomy and biosystematics-does DNA provide all the answers? Taxon 54: 999-1007.
9. Relevant scientific papers

Forms of teaching	Assessment methods
Lectures (15 h)	Written exam

UTILIZATION OF FOREST BIOMASS (code: 73832)

Original course title	Uporaba šumske biomase	Status	elective
Semester	winter	Course teacher	Assist. Prof. Dinko Vusić, PhD; Branko Ursić mag. ing. silv.
ECTS	2	Study level and programme	MSc Urban Forestry, Nature Conversation and Environmental Protection

Course content

Lectures
1. Wood biomass - potential and structure.
2. Standards of wood forest products by purpose (HRN).
3. Standards of wood forest products by quality (HRN EN).
4. Legal acts and bases in the field of production, trade and use of wood biomass.
5. Wood as an energy source. Ecological advantage of using energy wood.
6. Solid biofuels - normative framework.
7. Quality parameters of solid biofuels.
8. Energy harvesting systems.
9. Transport of energy wood.
10. Energy wood storage.
11. REgional logistics centers.
12. By-products and revocation of waste status.
13. Use of wood biomass in horticulture and compost production.
14. Use of wood biomass in energy facilities.
15. Trade and market of wood forest products.

Exercises
1. Methods for determining the amount and structure of aboveground wood biomass.
2. Wood defects - recognition and measurement.
3. Characteristics of wood - recognition and measurement.
4. Measurement, records and shipping of wood assortments.
5. Sampling of solid biofuels.
6. Determination of bulk density of wood chips.
7. Gravimetric analysis - determination of moisture content of wood chips.
8. Determination of the mass fraction of ash.
9. Granulometric analysis - determination of the mass of wood chips fractions.

10. Productivity of wood chips harvesting system.
11. Optimization of wood chips harvesting system.
12. Transport of wood chips. Cost break-even analysis.
13. Determining the optimal storage time of wood chips.
14. Procedure for revoking the status of waste for solid biofuels - preparation of documentation.
15. Statistical indicators of production and trade of wood products according to UNECE / FAO methodology; national product classification and customs tariffs.

Learning outcomes

- ✓ Establish a production system according to the potential of wood biomass of certain stands and biomass from urban areas by introducing new technologies
- ✓ Organize collection-logistic centres for storing and selling certain quantities of solid biofuels according to the basic features of the product declaration.
- ✓ Valorise solid biofuel based on physical and chemical properties and use.

Language

All teaching activities will be held in Croatian. However, foreign students will have the opportunity to attend additional office hours with the lecturer and teaching assistants in English to help master the course materials. Additionally, the lecturer will refer foreign students to the corresponding literature in English, as well as give them the possibility of taking the associated exams in English.

Literature

- Zečić, Ž., 2018: Uporaba šumske biomase (interna skripta), Šumarski fakultet. Zagreb
- Zečić, Ž., Vusić, D., 2020: Katalog drvnih šumskih proizvoda. Sveučilište u Zagrebu Šumarski fakultet, 1–217.
- United Nations, Economic Commission for Europe, 2018: Wood Energy in the ECE Region: Data, trends and outlook in Europe, the Commonwealth of Independent States and North America. Aguilar, Francisco X. (ur.)., Geneva, 1–93.

Optional
1. Hakkila, P., 1989: Utilization of Residual Forest Biomass. Springer-Verlag, Berlin, 1–568.
2. Aguilar, F. X., 2014: Wood Energy in Developed Economies: Resource Management, Economics and Policy. Routledge, London and New York, 1–338.

Forms of teaching

Lectures (15), exsercise (15 h)

Assesment methods

Oral exam

ZOOECOLOGY IN FOREST ECOSYSTEMS (code: 73826)

Original course title	Zooekologija u šumskim ekosustavima	**Status**	elective
Semester	winter	**Course teacher**	Assistant Prof. Marko Vucelja, Ph.D.
ECTS	2	**Study level and programme**	MSc Forestry: Silviculture and Forest Management with Wildlife Management

Course content

Lectures:
1. Zooecology as a science. Animal communities (zoocenoses). Types and dynamics of zoocenoses.
2. Abiotic factors
3. Wildlife feeding and nutrition, quantity and quality of food, foraging

4. Homotypic and heterotypic relationships
5. Stress and animal care
6. Communication and the evolution of signaling
7. Mimicry, deception and honesty
8. Selection
9. Periodicity of diet
10. Life in communities
11. Migratory movements
12. Territoriality
13. Survival
14. Behavioral changes
15. Human impact on animal populations

Learning outcomes

- Interpret homotypic and heterotypic relationships within animal populations.
- Describe primary, secondary and tertiary methods for monitoring the number of animal populations.
- Break down the spatial (microdistribution and macrodistribution) distribution of animal populations in managed forests
- Give examples from the animal world for accidental, accessory and constant species.
- Connect the birth rate and mortality, age structure and reproductive potential with the population size of a certain animal species.
- List, draw and interpret the main elements of the animal population curve
- Analyze the spatial (horizontal and vertical) aspect of population dynamics.
- Link the impact of animal species on the ecological succession of managed forests.
- Break down the periodicity (change of weather, daily, lunar, seasonal, annual) and it's influence on the stability of animal populations in managed forest ecosystems.
- Present and critically judge the anthropogenic impact on animal ecosystems.

Language

All teaching activities will be held in Croatian. Foreign students will have the opportunity to attend additional office hours with the lecturers and be provided with teaching materials and literature in English.

Literature

1. Androić, M. 1970. Osnovi zooekologije s osobitim osvrtom na entomofaunu. Izdavačko-tiskarsko poduzeće 'A.G. Matoš', Samobor. 152 str.
2. Elton, C. 1968. Animal Ecology, Metheun&Co. Ltd and Science Paperbacks, London, 207 pp.
3. Stoddart, D.M. 1979. Ecology of small mammals. Chapman and Hall Ltd., London. 279 pp.
4. Flowerdew, J.R., Gurnell, J., Gipps, J.H.W. 1985. The Ecology Woodland Rodents, Bank Voles and Wood Mice. The Zoological Society of London, Clarendon Press, Oxford. 409 pp.
5. Zabel, C.J., Anthonz, R.G., 2003. Mammal Community Dynamics, Cambridge University Press, 709 pp.

Forms of teaching

Lectures (15 h)

Methods of grading

Written exam. Term papers and student oral presentation

FOREST PRODUCTS (code: 33905)

Original course title	Šumski proizvodi	Status	compulsory
Semester	summer	Course teacher	Assist. Prof. Dinko Vusić, PhD; Assist. Prof. Andreja Đuka, PhD; Branko Ursić mag. ing. silv.
ECTS	4	Study level and programme	MSc Forestry: Techniques, Technologies and Management in Forestry

Course content

Lectures:

1. Division of forest products. Classification and presentation of quantities of wood forest products according to UNECE / FAO methodology.
2. Legal and bylaw basis of documentation for monitoring the production of wood assortments.
3. Balance of wood forest products.
4. Historical overview of product standardization; customs, standards and norms. European (CEN) and international (ISO) standardization of products and procedures; working bodies, the sequence of adoption of normative documents and their application.
5. Forms and usable properties of wood forest products throughout history - dynamics of change with reference to the degree of development of techniques and technologies.
6. Traditional and modern methods of product records. Measurement methods according to HRN and HRN-EN normative systems; reduction of bark, allowance and bonification. Measuring instruments. Measurement methods and presentation of results.
7. Wood defect according to HRN normative system.
8. Features of wood according to HRN EN normative system.
9. Classification of wood forest products according to the HRN normative system. Quality grades of deciduous roundwood; minimum dimensions and permissible defects.
10. Classification of wood forest products according to the HRN normative system. Quality classes of coniferous roundwood; minimum dimensions and permissible defects.
11. Classification of wood forest products according to the HRN normative system. Types and quality classes of cordwood; minimum dimensions and permissible defects.
12. Classification of wood forest products according to the HRN-EN normative system. Quality classes of roundwood; minimum dimensions and permissible defects.
13. Classification of wood forest products according to the HRN-EN normative system. Types and quality classes of energy wood.
14. Non-wood forest products. Fruits and seeds of forest trees, shrubs and ground vegetation. Aboveground commercial mushroom species . Underground commercial mushroom species. Healing herbs. Game. Eco certification.
15. Market and mods of forest products sale.

Exercises
1. Sequence of documentation for production monitoring and invoice preparation. Computerized production record systems; productivity calculation and invoice issuing.
2. Records of wood assortments using computer systems.
3. Preparation of documentation for the sale of wood assortments.
4. Shipping of wood assortments using computer systems.
5. Complaint and reclassification of wood assortments.
6. Measurement of wood assortments according to HRN and HRN-EN normative systems and determination of quantity.
7. Wood defects (HRN) - recognition.
8. Wood defects (HRN) - measurement.
9. Wood features (HRN EN) - recognition.
10. Wood features (HRN EN) - measurement.
11. Determination of total aboveground biomass and expansion factors.

12. Assessment of tree quality and assortment structure of stands.
13. Simulation of bucking (to standard lengths and to quality) and value of roundwood.
14. Processing and analysis of data from fieldwork.
15. Certification of forest products - preparation of documentation.

Field work:
Quality assessment of standing trees. Selection of the most suitable processing method. Bucking and records of wood assortments; the concept of maximum natural utilization and the concept of maximum financial utilization. Computer records of products. Total aboveground biomass. Assortment structure; assortment tables, assessment results and felling plan performance.

Learning outcomes

- ✓ Present the division of forest products and standardization of products and development of standardization (standards and norms, classification and reporting of primary forest products according to UNECE / FAO methodology, nomenclature of commercial tree species, classification of trees according to norms, primary and secondary forest products, legal and by-law acts, European (CEN) and International (ISO) product and Procedures standardization).
- ✓ Analyze methods of forest products records (traditional and current methods, methods of measurement according to HRN and HRN-EN normative systems, methods of measurement and expression of results).
- ✓ Classify primary forest products according to the HRN normative system - wood for technical use, wood for chemical use and firewood, and HRN-EN normative system - roundwood and solid biofuels (wood defects, quality grading, minimum dimensions and allowed defects, quality assurance system).
- ✓ Valorize other forest products (fruits and seeds of forest trees, shrubs and ground vegetation, aboveground commercial mushroom species, underground commercial mushroom species, medicinal plants, edible plants, game and wildlife, exploitation of mineral raw materials).

Language

All teaching activities will be held in Croatian. However, foreign students will have the opportunity to attend additional office hours with the lecturer and teaching assistants in English to help master the course materials. Additionally, the lecturer will refer foreign students to the corresponding literature in English, as well as give them the possibility of taking the associated exams in English.

Literature

Required:

- Zečić, Ž., Vusić, D., 2018: Šumski proizvodi - Predavanja i vježbe (interna skripta), Šumarski fakultet. Zagreb
- Zečić, Ž., Vusić, D., 2020: Katalog drvnih šumskih proizvoda. Sveučilište u Zagrebu Šumarski fakultet, 1–217.

Optional:
1. Prka, M., 2010: Bukove šume i bukovina bjelovarskog područja. Hrvatsko šumarsko društvo, Ogranak Bjelovar, 1–252.

Forms of teaching

Lectures (30h), exercises (15h), field classes (16h)

Assesment methods

Written exam + oral exam

HUNTING MANAGEMENT I (code: 235890)

Original course title	Lovno gospodarenje I	Status	compulsory
Semester	summer	Course teacher	Prof. Marijan Grubešić, PhD; Prof. Krešimir Krapinec, PhD; Assistant Prof. Kristijan Tomljanović, PhD
ECTS	4	Study level and programme	MSc Forestry: Silviculture and Forest Management with Wildlife Management

Course content

In addition to economic species of wildlife, students are also introduced to protected animal species, plans for their protection and revitalization of endangered species. The aim of this course is to educate students for future makers, implementers and supervisors of hunting management basics, breeding programs and game protection programs. To prepare students for future obligations of integrated habitat and fauna management, with the application of techniques and technology of optimal use of space and fauna with measures for protection and preservation of habitats and animal species. Through exercises and fieldwork, students will be directly acquainted with open hunting grounds, the implementation of management planning acts, as well as measures for the protection of habitats and animal species in open hunting grounds, based on the example of our national parks and nature parks.

Lectures:
1. Introduction. Course content. Literature. Legislative framework
2. Hunting ground. Division of hunting grounds
3. Criteria that hunting grounds must meet legally and for certain species of game.
4. Formation of hunting grounds
5. Establishment of hunting grounds and granting of hunting rights.
6. Analysis of hunting grounds in the Republic of Croatia. The content of the hunting economic base
7. Hunting cadastre
8. Calculation of hunting productive areas
9. Determining the creditworthiness and capacity of hunting grounds
10. Breeding, increment, excretion of game from the population
11. Development of large game fund, sex and age structure
12. Development of small game fund. Feeding and feeding of game
13. Technical arrangement of hunting grounds
14. Implementation of the hunting management basis
15. Administrative tasks in hunting ground management. Hunting economics and marketing

Exercises:
1. Introduction to exercises
2. Hunting management forms (LGO, PUD, PZD)
3. Calculation of surface structure - I
4. Calculation of surface structure - II
5. Calculation of hunting productive areas for large game
6. Calculation of hunting productive areas for small game
7. Determining creditworthiness
8. Calculation of the parent fund, increment and hunting management capacity - I
9. Calculation of the parent fund, increment and hunting management capacity - II
10. Calculation of supplementation and nutrition

11. Hunting management and hunting technical facilities
12. Hunting patterns, records
13. Implementation of hunting management studies
14. Revision of the hunting management plan
15. Laws, regulations, orders and directives

Learning outcomes

- ✓ Define wildlife habitat, hunting ground, and hunting grounds for certain game species (determining hunting productive areas, habitat quality for large and small game, determining the hunting capacity for each species of game).
- ✓ Presenting game management (optimum sex and age structure of game in the population, growth and recharge, dump, waste, development of large and small game stocks, planning the required amount of game food).
- ✓ Comply with the technical arrangement of hunting grounds (hunting grounds - feeding tanks, dormitories, eating areas, food storage, dummies, observatories and checkers, ...).
- ✓ Establish protected species (protection and revitalization plans of endangered species, wildlife conservation programs, action plans, management plans).

Language

All teaching activities will be held in Croatian. However, foreign students will have the opportunity to attend additional office hours with the lecturer in English. Additionally, the lecturer will refer foreign students to the corresponding literature in English, as well as give them the possibility of taking the associated exams in English.

Literature

Required:

- Mustapić, Z., i suradnici., 2004: LOVSTVO priručnik. Hrvatski lovački savez Zagreb, 597 str
- Andrašić, D., 1984: Zoologija divljači i lovna tehnologija. Skripta, Sveučilište u Zagrebu Šumarski fakultet, Zagreb, 294 str.
- Tucak, Z., Florijančić, T., Grubešić, M., Topić, J., Brna, J., Dragičević, P., Tušek, T., Vukušić, K., 2002: Lovstvo. Drugo prošireno izdanje. Uđbenik, Sveučilište Josipa Jurja Strossmayera u Osijeku, Poljoprivredni fakultet Osijek, 405 str.
- Durantel, P., 2007: Lovstvo
- Durantel, P. 2007: Praktična enciklopedija lovstva

Optional:

- Büchel, K., 2011: Lovstvo ilustrirana enciklopedija Grupa autora: 1967: Lovački priručnik, Lovačka knjiga Zagreb, 704 str.
- www.propisi.hr

Forms of teaching

Lectures (30 h), exercises (15 h), field work (16 h)

Methods of grading

Written exam. Term papers and student oral presentations

INTEGRATED FOREST PROTECTION IN PROTECTED AREAS (code: 98211)

Original course title	Integrirana zaštita šuma u zaštićenim područjima	Status	compulsory
Semester	summer	Course teacher	Prof. Danko Diminić, PhD; Prof. Boris Hrašovec, PhD; Assist. Prof. Marko Vucelja, PhD; Assist. Prof. Milivoj Franjević, PhD; Linda Bjedov, PhD
ECTS	4	Study level and programme	MSc Urban Forestry, Nature Conversation and Environmental Protection

Course content

Lectures:
1. Introduction, the harmful role of individual abiotic and biotic factors and their negative synergistic effect on the health status of individual trees and forest ecosystems.
2. Forest communities and protected natural objects of lowland flood ecosystems (in general). Integrated protection is focused on the main tree species and floodplain forest ecosystems. All current abiotic and biotic factors that, through their individual or joint (synergistic) action, affect or may affect the stability of floodplain forest ecosystems are analyzed. An integrated approach to measures to protect major tree species and floodplain forest ecosystems in order to prevent, reduce damage and repair the damage.
3. Forest communities and protected natural objects of lowland ecosystems (in general). Integrated protection is focused on the main tree species and lowland forest ecosystems. All current abiotic and biotic factors that, through their individual or joint (synergistic) action, affect or may affect the stability of lowland forest ecosystems are analyzed. An integrated approach to protection measures for the main tree species and lowland forest ecosystems in order to prevent, reduce the occurrence of damage and repair the damage.
4. Forest communities and protected natural objects of mountain and mountain ecosystems (in general). Integrated protection is focused on the main tree species and beech forest ecosystems. All current abiotic and biotic factors that, through their individual or joint (synergistic) action, affect or may affect the stability of beech forest ecosystems are analyzed. Integrated approach to measures for the protection of beech forest ecosystems in order to prevent, reduce the occurrence of damage and repair the damage.
5. Forest communities and protected natural objects of mountain and mountain ecosystems (in general). Integrated protection is focused on the main tree species and the forest fir ecosystems. All current abiotic and biotic factors that, through their individual or joint (synergistic) action, influence or may affect the stability of fir fir ecosystems are analyzed. An integrated approach to measures to protect forest fir ecosystems in order to prevent, reduce the occurrence of damage and repair the damage.
6. Forest communities and protected natural objects of the Croatian Mediterranean (in general). Integrated protection focuses on the main tree species and the forest ecosystems of the Mediterranean. All current abiotic and biotic factors that, through their individual or joint (synergistic) action, influence or may affect the stability of forest ecosystems in the Croatian Mediterranean are analyzed. An integrated approach to measures to protect the forest ecosystems of the Croatian Mediterranean in order to prevent, reduce the occurrence of damage and repair the damage.
7. Emphasis in the analysis of these forest ecosystems is given to problems with climate disturbances, forest fires; anthropogenic impact and roles of pathogens and harmful insect species with special reference to invasive indigenous and non-indigenous species.

Exercises in the partikum:
1. On the examples of current diseases, insect pest species, small rodents and wildlife, their individual impacts and indirect synergistic effects on the health status of major tree species and floodplain forest ecosystems are analyzed.
2. On the examples of current diseases, insect pest species, small rodents and wildlife, their individual impacts and indirect synergistic effects on the health status of major tree species and lowland forest ecosystems are analyzed.
3. On the examples of current diseases, insect pest species, small rodents and wildlife, their individual impacts and indirect synergistic effects on the health status of the main species of beech trees and beech forest ecosystems are analyzed.
4. On the examples of current diseases, insect pest species, small rodents and wildlife, their individual impacts and indirect synergistic effects on the health status of the main species of fir trees and forest fir ecosystems are analyzed.
5. On the examples of current diseases and insect pest species, their individual influences and indirect synergistic effects on the health status of the main tree species and forest ecosystems of the Croatian Mediterranean are analyzed.

Field work:
1. In forest beech ecosystems, the harmful effects of individual abiotic and biotic factors and their synergistic effect on the health status of individual trees and the stability of forest ecosystems are observed, analyzed and discussed.
2. In forest fir ecosystems, the harmful effects of individual abiotic and biotic factors and their synergistic effect on the health status of individual trees and the stability of forest ecosystems are observed, analyzed and discussed.
3. In the forest ecosystems of the Croatian Mediterranean, the harmful effects of individual abiotic and biotic factors and their synergistic effect on the health status of individual trees and the stability of forest ecosystems are observed, analyzed and discussed.

Learning outcomes

- ✓ Analyse integrated protection of lowland forest ecosystems (emphasis is on problems in water supply, including both underground and precipitation water, and increased temperatures (global warming), anthropogenic influence and roles of disease causative agents and pests, where aforementioned factors are analysed individually and in synergy and make the foundation for integrative approach to protective measures of main tree species and whole ecosystems).
- ✓ Present integrated protection of forest ecosystems of common beech (abiotic and biotic factors which individually or in synergy influence or can influence on stability of common beech ecosystems, climate disturbances, and anthropogenic influence).
- ✓ Analyse integrated protection of forest ecosystems of silver fir (forests and protected natural objects of hill and mountain ecosystems, abiotic and biotic factors which individually or in synergy influence or can influence on stability of silver fir ecosystems, emphasis is on problems with climate disturbances, anthropogenic influence and roles of diseases and pests).
- ✓ Present integrated forest protection of Mediterranean ecosystems (forests and protected natural objects of Croatian Mediterranean, important biotic and abiotic factors which individually or in synergy influence or could influence son stability of forest ecosystems, emphasis is on problems with climate disturbances with special overview of drought and forest fire, and anthropogenic influence and roles of diseases and pests

Language

All teaching activities will be held in Croatian. However, foreign students will have the opportunity to attend additional office hours with the lecturer and teaching assistants in English to help master the course materials. Additionally, the lecturer will refer foreign students to the corresponding literature in English, as well as give them the possibility of taking the associated exams in English.

Literature

Required:

- Grupa autora (J. Vukelić, ed.) 2005: Poplavne šume u Hrvatskoj. Akademija šumarskih znanosti, Zagreb, 455 str.
- Grupa autora (M. Oršanić, ed.) 2020: Ekologija, obnova i zaštita poplavnih šuma Posavine. Sveučilište u Zagrebu, Šumarski fakultet, Zagreb, 368 str.
- Grupa autora (D. Klepac, ed.) 1996: Hrast lužnjak (Quercus robur L.) u Hrvatskoj. Akademija šumarskih znanosti, Zagreb, 559 str
- Grupa autora (S. Matić, ed.) 2003: Obična bukva (Fagus sylvatica L.) u Hrvatskoj. Akademija šumarskih znanosti, Zagreb, 855 str.
- Grupa autora (B. Prpić, ed.) 2001: Obična jela (Abies alba Mill.) u Hrvatskoj. Akademija šumarskih znanosti, Zagreb, 895 str.
- Grupa autora (S. Matić, ed.) 2011: Šume hrvatskoga sredozemlja. Akademija šumarskih znanosti, Zagreb, 740 str.

Optional:

1. Altenkirsh, W., Majunke, C., Ohnesorge, B., 2002: Waldschutz auf ökologischer Grundlage. Eugen Ulmer Verlag, Stuttgart, Deutschland. ISBN 3-8001-3684-8, 434 str.
2. Berryman, A.A., 1988: Dynamics of Forest Insect Populations – Patterns, Causes, Implications. Plenum Press, New York and London, 603 str.
3. Professional and scientific articles relevant to the subject.

Forms of teaching

Lectures (30h), exercises (15h), field classes (16h)

Assesment methods

seminar + final oral exam

EUROPEAN FORESTRY (code: 225931)

Original course title	European Forestry	Status	elective
Semester	summer	Course teacher	prof. Igor Anić, Ph.D.; Assist. prof. Stjepan Mikac, Ph.D.
ECTS	2	Study level and programme	MSc Forestry; Programme: Silviculture and Forest Management with Wildlife Management

Course content

The objectives of the course are to introduce students to:

1) silvigeographic, structural, ecological and silvicultural characteristics of European forests;
2) historical aspects of forestry development in Europe with regard to the use of forest land;
3) trends and adjustments of silviculture in the conditions of climate change, natural disasters and nature protection requirements;
4) different methods of forest management on the examples of European countries.

Lectures (15 hours):
1. Silvigeography of Europe, part one: overview and general characteristics of forest areas.
2. Silvigeography of Europe, second part: structure of European forests (area, growing stock and increment by ownership, tree species, management methods, in general and on the examples of some countries).
3. Silvigeography of Europe, third part: forest habitats, forest types and silvicultural characteristics of the main tree species.
4. History of European forestry: the impact of land use on the development of forests and forestry.
5. Forestry in different areas of Europe: history, legislation, organization.
6. Characteristic methods of silviculture, case studies (2 hours).
7. Influence of different forest management methods on forest dynamics, sustainability and forest products.
8. Forest management and climate change: trends and adaptations.
9. Forest management and natural disasters: silvicultural procedures, case studies.
10. Forest management and nature protection requirements: trends, principles of multifunctional silviculture.
11. The concept of close to nature silviculture. Pro Silva Europa, principles, application.
12. Presentation of student seminar papers, discussion (3 hours).

Fieldwork (40 hours): Forest management of Central European countries

Learning outcomes

Present the silvigeographic features of European forests. Present the main methods of forest management in Europe. Link the history of land use with forest management methods. Valorize adaptations of silviculture in the conditions of climate change and natural disasters. Valorize the role of close to nature forestry and nature protection requirements. Evaluate the economic and public interest of European forests.

Language

All teaching activities will be held in Croatian. However, foreign students will have the opportunity to attend additional office hours with the lecturer and teaching assistants in English to help master the course materials. Additionally, the lecturer will refer foreign students to the corresponding literature in English, as well as give them the possibility of taking the associated exams in English.

Literature

1. Anić, I., S. Mikac, 2021: European forestry. PP presentations, University of Zagreb, Faculty of Forestry, Zagreb.
2. Ellenberg, H., 2009: Vegetation Ecology of Central Europe. Cambridge University Press, English translation, 4th edition, 731 p. FOREST EUROPE, UNECE and FAO 2011: State of Europe's Forests 2011. Status and Trends in

Sustainable Forest Management in Europe (https://www.unece.org/fileadmin/DAM/publications/timber/Forest_Europe_ report_2011_web.pdf).
3. McGrath, M. J., S. Luyssaert, P. Meyfroidt, J. O. Kaplan, M. Bürgi, Y. Chen, K. Erb, U. Gimmi, D. McInerney, K. Naudts, J. Otto, F. Pasztor, J. Ryder, M.-J. Schelhaas, A. Valade, 2015: Reconstructing management from 1600 to 2010. Biogeosciences, 12: 4291–4316 (www.biogeosciences.net/12/4291/2015/).
4. Nature-based forestry in Central Europe. University of Ljubljana, Biotechnical faculty, Ljubljana, 167 p.
5. Pro Silva, 2012: Pro Silva principles. 67 p. (https://www.prosilva.org/fileadmin/prosilva/3_Close_to_Nature_Forestry/01_ProSilva_Principles/Pro_Silva_Principles_2012.pdf)
6. Turbé, A., U. Jana, A. de Toni, S. Woodward, A. Schopf, S. Netherer, P. Angelstam, S. Mudgal, P. Sonigo, 2012: Disturbances of EU forests caused by biotic agents. European Commission (https://ec.europa.eu/environment/forests/pdf/FBD_report_2012.pdf)European forest

Forms of teaching

Lectures (15), Fieldwork (40 hours)

Assesment methods

seminar paper and oral exam

WILDLIFE FEEDING (code: 33924)

Original course title	Ishrana divljači	Status	elective
Semester	summer	Course teacher	Prof. Krešimir Krapinec, PhD; Prof. Marijan Grubešić, PhD
ECTS	2	Study level and programme	MSc Forestry: Silviculture and Forest Management with Wildlife Management

Course content

Contemporary hunting ground management includes a whole series of activities for habitat preservation (various international conventions), so as to ensure protection of species, habitat, but also a relevant trophy and physical structure in the population of single animal species. Therefore, this course of lectures intends to direct the students towards such manners of habitat management, aiming at upgrading of nutritional and legal factors, which will ensure a lasting fauna management.

Learning outcomes

- ✓ Managing and autonomous making decision in wildlife/game management

Language

All teaching activities will be held in Croatian. Foreign students will have the opportunity to attend additional office hours with the lecturers and be provided with teaching materials and literature in English.

Literature

1. Weis, G. B., 1997: Anlage und Pflege von Wildäsungsflächen. Nimrod – Verlag, Suderburg., 320 pp.
2. Černe, L.,1990: Ureditev lovišč za malo divjad; Lovska zveza Slovenije; Ljubljana; 70 pp.
3. Randal, D., Burggren, W., French, K., 1998: Eckert animal physiology: mechanisms and adaptations; W.H. Freeman and Company; New York; 824 pp.
4. Schwartz, M.W., 1997: Conservation in higly fragmentet landscapes; Chapman & Hall; New York; 436 pp.

5. Bookhout, T.A.,1996: Research and management techniques for wildlife and habitats; The Wildlife Society Bethesda; Maryland; 740 pp.
6. ***, 1986: Lehrbuch Jägerprüfung, Bänden 1-5, Paul Parey, Berlin und Hamburg, 1017 pp.
2. Ian McCall, I., 1988: Woodlands for Pheasants. The Game Conservancy, Fordingbridge, 99 pp.
3. Robertson, P. A., 1992: Woodland Management for Pheasants. Forestry Commission Bulletin 106, London, 18 pp.
4. Anon., 1994: Game and shooting crops. The Game Conservancy, Fordingbridge, 97 pp.

Forms of teaching

Lectures (15 h)

Assessment methods

Oral exam. Obligatory class attendance.

Department of Wood Technology Courses - Undergraduate Study Programmes (BSc)

MATHEMATICS (code: 33556)

Original course title	Matematika	Status	compulsory
Semester	winter	Course teacher	Assoc. Prof. Maja Moro PhD
ECTS	7	Study level and programme	BSc Wood Technology

Course content

1. Sets of numbers and points. Real numbers. Infimum and supremum expensive.
2. Inequalities (linear, quadratic, exponential, trigonometric, etc.).
3. Functions (algebraic and transcendent).
4. Limes function. Continuity of a function.
5. The notion of derivation. Derivation of elementary functions.
6. Differential calculus.
7. Analysis of algebraic functions using differential calculus.
8. Analysis of transcendent functions using differential calculus.
9. Functions of two variables.
10. Indefinite integral. Some methods of integration.
11. Certain integral-surface problems.
12. Application of integral calculus (area, volumes, moments, centre of gravity).

Learning outcomes

- ✓ Define and implement the tasks terms of mathematical logic, sets, sets of numbers and mathematical induction.
- ✓ Define, analyze and relate the concepts and properties of real functions of a real variable, as well as terms related to a sequences (limit of a sequence, limit of a function)
- ✓ Define and apply the concepts tasks derivatives, indefinite and definite integrals
- ✓ Define, analyze and apply the tasks terms of functions of two variables
- ✓ Define the term and solve differential equations using method of separation of variables
- ✓ Define and apply in the tasks from basic elementary algebra (vectors and matrices)

Language

Individual tasks and lectures in English.

Literature

Obligatory

1. Bradić, T. I sur., 1998: Matematika za tehnološke fakultete, Element, Zagreb

Recommended

Moro, M.: Zbirka ispitnih zadataka (radni materijal)

Forms of teaching

Lectures (45 h), exercises (45 h)

Methods of grading

3 partial exams and final oral exam, or final written final exam and final oral exam

TRANSPORT EQUIPMENT IN WOOD INDUSTRY (code: 239685)

Original course title	Transportna tehnika u drvnoj industriji	Status	compulsory
Semester	winter	Course teacher	Prof. Ružica Beljo Lučić Assist. Prof. Matija Jug
ECTS	5	Study level and programme	BSc Wood Technology

Course content

Purpose and task of transport. Historical development of transport. Basic forms of transport and transport equipment. Maximum load and capacity of means of transport of periodical and continous supply. Measures of assessment of transport activities. Equivalent resistance coefficient. Characteristics of transported materials in wood industry. Types of loads of transport constructions. Components of transport equipment. Driving mechanism of the means of transport in wood industry. Means of transport in wood industry. Means of periodical supply. Winches. Lifts. Cranes. Industrial vehicles. Hand-operated industrial vehicles. Motor-operated industrial vehicles. Road vehicles. Manipulators, industrial robots. Means of continous supply. Conveyors. Mechanical conveyors with a hauling element (belt conveyors, track conveyors, chain conveyors, elevators). Mechanical conveyors without a hauling element (roller, vibrating, worm, and gravity conveyors). Air conveyors. Components of air conveyors. Control of a exhaust system. A mean of transport in the function of the production technological process. Transport systems in a sawmill, in production plants of particle boards, in production plants of veneer and plywood and in production plants of furniture. Characteristics of transport equipment important in terms of choice and efficient application. Storage facilities in wood industry.

Learning outcomes

- ✓ Calculate the basic characteristics of transported materials in the wood industry that are important for transport and storage: volume, mass, density, bulk density, bulk angle, granulation.
- ✓ Analyze influential factors on the basic characteristics of transported materials.
- ✓ Calculate the required capacity of transport equipment in the woodworking and processing industry: capacity of conveyors (belt conveyors, scraper conveyors, elevators, roller conveyors, chain conveyors), cranes and industrial vehicles depending on the parameters of the technological processing of wood.
- ✓ Evaluate the transport losses expressed in percentage relative to the transported weight. Calculate the required driving power of the transport equipment in the woodworking process.
- ✓ Calculate the dimensions (diameter, crosssectional area) and select the appropriate components of the steel rope and chain according to the appropriate standards depending on the load weight, rope and chain strength and load mode.
- ✓ Control the operation of the air conveyor system – determine static pressure drop in the system, dynamic pressure, air flow rate, and calculate the fan's utility and system utility.
- ✓ Select the ventilator for the air conveyor system depending on the system parameters.

Language

Individual tasks and lectures in English.

Literature

1. 1.Sever, S. 1988: Transport u drvnoj industriji, autorizirani rukopis, Zagreb, 1 - 26, 50 - 231.
2. Hamm, Đ. 1987: Transportni uređaji, Šumarska enciklopedija, svezak 3, JLZ "Miroslav Krleža", Zagreb, 521-529.
3. Oluić, Č. 1991: Transport u industriji, Rukovanje materijalom I. dio, Sveučilišna naklada, Zagreb, 1 - 278.
4. Beljo Lučić, R.: Transportna tehnika u drvnoj industriji, prezentacije u Power Pointu, 2020.
5. Biljan, M.: Dizalice, Šumarska enciklopedija, svezak 1, JLZ, Zagreb, 1980, str. 346-357.
6. Madjarević, B.: Rukovanje materijalom, Tehnička knjiga, Zagreb, 1972, str. 1-476.
7. Šćap, D.: Prenosila i dizala (Odabrana poglavlja), Uvodne osnove, Sveučilište u Zagrebu, Fakultet strojarstva i brodogradnje, Zagreb, 1993.: Physiological Plant Ecology. Springer. Berlin.

Forms of teaching

Lectures (30 h), exercises (45 h), field work (2 days)

Assessment methods

Written – calculations, oral – in case of a negative result or if students have not taken exams in the course of the lectures.

WOOD ANATOMY (code: 228983)

Original course title	Anatomija drva	Status	compulsory
Semester	Winter	Course teacher	Asst. Prof. Iva Ištok, PhD; Prof. Jelena Trajković, PhD Assoc. Prof. Bogoslav Šefc, PhD Assist. prof. Iva Ištok PhD
ECTS	8	Study level and programme	BSc Wood Technology

Course content

Introduction: The aims of wood anatomy. The origin of wood in plant kingdom. Commercial utilisation. Methods in wood anatomy. Coarse structure of wood. Structure of vascular plants: basic parts of a vascular plant, primary and secondary growth. The origin and development of wood cells. Tissues. Cambium. Cell and cell wall: dimensions, forms, parts, divisions, development of cell wall. Composition and distribution of cell wall components in wood cells. Submicroscopic structure and organisation of cell wall. Sculptures of the cell wall: pits, perforations of vessel members, spiral thickenings and dentations, warty structures and warty pits. Macroscopic and microscopic structure of conifer wood: types of cells and tissues, their distribution and shape, useful features in identification of conifer wood, comparative anatomy of different kinds of conifer woods. Macroscopic and microscopic structure of hardwoods: types of cells and tissues, their distribution and shape, useful features in identification of hardwoods. Comparative anatomy of different kinds of hardwoods, guide through the hand lens key for identification of selected wood species. Wood identification: methods, limiting conditions, wood identification keys. Wood structure variations inside the species and inside the tree. Physical nature of wood, moisture content, dimensional changes, specific weight and density, porosity, permeability. The influence of wood structure on shrinking, density, permeability and final utilisation of wood. Irregularities of wood structure.

Learning outcomes

- ✓ Explain main terms of macroscopic, microscopic and submicroscopic characteristics of wood structure useful for its identification and for technical wood properties.
- ✓ Differentiate native comercial wood species on the base of their microscopic and macroscopic characteristics with help of wood identification keys.
- ✓ Explain variations in wood anatomy structure within tree, between trees of each species and explain the influence of variations in wood structure on technical porperties of wood and its use.
- ✓ Explain the origin of natural wood „defects" and recognize them and explain their influence on selected technical properties.
- ✓ Explain the influence of wood anatomy structure on its technical properties

Language

Individual tasks and lectures in English.

Literature

1. Lectures (skripta, autori: Jelena Trajković i Bogoslav Šefc, pdf dokument oko 3 MB) i Atlas slika
1. Wood Anatomy e-course
2. Z. Špoljarić 1978: Anatomija drva, Šumarski fakultet, Zagreb.
3. Panshin, A. J.; Zeew, C. de, 1980: Textbook of wood technology, McGraw-Hill, Inc. 722 str.
2. Schweingruber, F.H., 1990: Anatomy of European woods, Paul Haupt Berne and Stuttgart Publishers, 800 str.

3. Špoljarić, Z.; Petrić, B.; Šćukanec, V., 1969: Višejezični rječnik stručnih izraza u anatomiji drva, Poslovno udruženje šumskoprivrednih organizacija, Zagreb, 85 str.
4. Šumarska enciklopedija, HLZ Miroslav Krleža, Zagreb
5. Pojmovnik hrvatskoga drvnotehnološkog nazivlja (2018)
6. 2019: Vrste drva s naslovnica časopisa Drvna industrija (2019), Šumarski fakultet Sveučilišta u Zagrebu, str. 212.

Forms of teaching

Lectures (30 h), exercises (45 h)

Methods of grading

Exercises, microscopic wood identification colloquia, macroscopic wood identification colloquia, exam

WOOD IN CONSTRUCTION (code: 33647)

Original course title	Drvo u graditeljstvu	Status	compulsory
Semester	winter	Course teacher	Prof. Hrvoje Turkulin; Assoc. Prof. Vjekoslav Živković, PhD
ECTS	4	Study level and programme	BSc Wood Technology

Course content

Significance of production of wood building components in Croatia and in Europe. Specific requirements for exterior application of wood: synergistic actions of light, climatic and biological degradative factors. Technical properties of importance for building applicatioins, availability of the species: wood properties and durability. Principles of technical design of wood products for their durability: physical protection, technical detailing, surfacing and finishing, renovation of weathered products. Dimensional limitations of wood and laminating technique: tecnical principles, technical design of components, materials used, basics of the manufacturing process. Basics of building physics and principles of acousitc and thermal insulation of windows, floors, doors, walls. Windows and doors: function and design, forms and types, general functional requirements: ventilation, lighting, passage, insulation, passage. Wooden floors – phisical conditions during completion and use for sports and residential floors, materials for gluing and sealing. Review ofother classes and types of wood building components and products: houses, laminated beams, wooden structures, bridges, noise barriers, cladding and facades etc.

Learning outcomes

- ✓ Identify the prominent families of wood construction products and connect their end-use requirements with design and construction types and material properties.
- ✓ To appoint and explain the ecological features of wood as a building material, the importance of maintaining its durability and the possibilities of wood recycling.
- ✓ To explain the dimensional and structural limitations of wood and propose and evaluate their improvement methods (laminating, structural and engineering connections).
- ✓ To distinguish, group, and argument the technical properties of wood essential for construction, explain and evaluate the aesthetic, economic and traditional values of wood for construction.
- ✓ To identify, explain and group factors of durability and risk classes to the durability of construction products and wood buildings and suggest and design the measures to overcome these risks.
- ✓ To adapt or design a set of details and measures of integral (physical, structural, surface and biological) protection of a simple wood building or wood construction product.
- ✓ Connect the type of window and door with basic functional requirements, connect the details into a functional unit, and design and illustrate the final product.
- ✓ To describe types of wood floor coverings and connect the product type with the basic technical properties and functional requirements.

Language & forms of teaching

Inidividual consultations and seminars in English, laboratory work in bilingual explanations by associate teachers for exercises.
Lectures (30 h), exercises (30 h), field work (1 day)

Literature

1. Turkulin i dr. 2002: Durability of wooden facades. Drvna ind. 53(1):33-48 i 53(3): 44-54.
2.*** 2005: Collection of offprints on the topic of durability and surface protection of wood in building. Faculty of Forestry, Zagreb University
3.*** 1993: Wood building technology. Otawa: Canadian Wood Coiuncil. 3.Tomašević, J. (1999): Wood in flooring structures. Zagreb: Author's edition
4. PROHOLZ: Wood as construction material. ProHolz Austria, Vienna 2013.

Assessment methods

Verbal examination. Preconditions: positive consultations and revision of written reports.

WOOD CHEMISTRY (code: 228982)

Original course title	Kemija drva	Status	compulsory
Semester	winter	Course teacher	Assoc. Prof. Alan Antonović, PhD
ECTS	7	Study level and programme	BSc Wood Technology

Course content

Wood structure, density of wood, water content, chemical composition of wood, analysis of elements in wood, analysis of wood age, inorganic substances in wood, content and role of inorganic substances, wood ash, chemical reaction of wood, fundamentals of carbohydrate chemistry, monosaccharides, oligosaccharides, polysaccharydes, cellulose, molecular and supramolecular properties, nature and classification of polyoses, xylans, mannans, glucans, galactans, pectins, fundamentals of aromatic compounds, phenols, precursors of lignin, synthesys and role of lignin, structure and properties of lignin, instrumental and chemical methods analyses of cellulose and lignin, extractives, extractives of softwood, extractives of hardwood, extractives from foliage, buds and fruits, acidity of wood, measuring the pH of wood, chemical composition of bark, cellulose, polyoses, lignin, polyphenoles, suberin, extractives, combustion and pyrolysis of wood, degradation of wood.

Learning outcomes

- ✓ Use the knowledge acquired in different areas of wood technology, and to solve technological and qualitative tasks and problems in the wood industry.
- ✓ Explain the chemical composition and properties of wood and apply the same during the basic working and processing of wood
- ✓ Analyze and isolate all chemical components, whether analytically or instrumentally, related to determining different properties or for further working and processing of wood.

Language

Teaching will be conducted in English and forms of instruction are a combination of presentations and practical work in chemistry lab. Studying the student's knowledge is done by the tasks they need to do during the classes and they need to write a "Chemical log". The final evaluation of the knowledge is done by written and oral exam.

Literature

1. J. Baeza, J. Freer, Chemical Characterization of Wood and Its Components in Wood and Cellulosic Chemistry, ed: D. N.-S. Hon, N. Shiraishi, Marcel Dekker, Inc., New York,2001., pp. 275. - 384.
2. D. Fengel, G. Wegener, WOOD, Chemistry, Ultrastructure, Reactions, Walter de Gruyter, Berlin-New York, 1989.
3. D. N.-S. Hon, N. Shiraishi, Wood and Cellulosic Chemistry, Marcel Dekker, Inc. New York, 2001.

Forms of teaching

Lectures (45 h), exercises (45 h)

lectures, practical work in chemical lab, individual project tasks

Methods of grading

Partial exams, written exam, oral exam

WOOD DRYING TECHNOLOGY (code: 235955)

Original course title	Sušenje drva i drvnih materijala	Status	compulsory
Semester	Summer	Course teacher	Prof. Stjepan Pervan, PhD Assist. Prof. Miljenko Klarić, PhD
ECTS	5	Study level and programme	BSc Wood Technology

Course content

The theoretical basics of wood drying process, wood - moisture relations, hygroscopic properties of wood, shrinkage and swelling in drying process, wood moisture content measuring and controlling in wood drying process, air drying – basics, green and dry lumber stockyard, basics and means of technical drying of solid wood, types and use of kiln drying schedules, kiln dryers: types and equipment, drying control systems – basics usage, wood defects in drying process, diminishing of wood drying defects, Processes and schedules for chipped wood drying, Processes and schedules for veneer drying.

Learning outcomes

- ✓ Define the basics of wood chemistry and its impact on the drying process
- ✓ Define the basics of wood technology and the impact of technological properties on the drying process
- ✓ Define the anatomical basics of wood and their influence on the drying process
- ✓ Explain the theoretical basics of the drying process, the relationship between water and wood
- ✓ Describe the hygroscopicity of wood in relation to the surrounding climate, the negative phenomena of shape change (shrinkage and swelling) during drying the most commonly used commercial wood species in Croatia
- ✓ Identify the impact of process errors on wood and finished products quality
- ✓ Provide methods for measuring water content during the wood drying process and explain their industrial application
- ✓ Describe the natural drying - basics, storage yard of raw and dried material
- ✓ Describe ways of organizing the storage yard by the type of transport means
- ✓ Describe the basics of technical drying of massive wood
- ✓ Categorize the types of technical drying of the massive wood according to the technical criteria
- ✓ Categorize and apply types of wood drying regimes
- ✓ Distinguishing wood drying kilns according to the type of process and the level of equipment
- ✓ Describe and use of kiln control systems in industrial conditions
- ✓ Group and identify wood faults in the drying process to reduce the share of wood defects. Choose the most economical wood drying method without defects (natural drying, technical drying or combination of both types)
- ✓ Explain the processes and techniques of technical drying of chopped wood

- ✓ Explain the processes and techniques ofvveneer technical drying
- ✓ Group and identify veneer drying defects

Language

Individual tasks and lectures in English.

Literature

1. Pervan, S. (2000): Priručnik za tehničko sušenje drva. 272. str. SAND.
2. Simpson W.T. (1991): Dry kilns operator manual. 274 str. USDA, Madison, Wisconsin
3. Conners, T. (2010): Hardwood dry kiln operation: A manual for operators of small dry kilns. University of Kentucky, Kentucky USA. 114 str.
4. Simpson W.T. (1991): Dry kilns operator manual. 274 str. USDA, Madison, Wisconsin, 274 p.
5. Ross, R. J. (2010): Wood handbook-Wood as an engineering material. USDA, FPL, Madison, Wisconsin, 508 p.

Forms of teaching

Lectures (30 h), exercises (45 h), e-learning (8 h)

Methods of grading

Knowledge will be checked constantly by tracking students achivements, by evaluation of project tasks and/or seminars. Verbal examination (if necessary).

FURNITURE DESIGN (code: 236202)

Original course title	Oblikovanje namještaja	**Status**	elective
Semester	summer	**Course teacher**	Assoc. Prof. Danijela Domljan, PhD; Assoc. Prof. Zoran Vlaović, PhD
ECTS	3	**Study level and programme**	BSc Wood Technology

Course content

What is design. Historical overview of furniture design development. Characteristics of world and European styles in furniture manufacturing. The use and meaning of shapes, materials and constructions in certain historical styles. Contemporary trends in furniture design. Development of contemporary design. Basics of product design. Theory of form. Elements and principles of form. Aesthetic components of the product. Product perception. Expressive means of industrial design. Design elements of industrial design: Design principles. Functional principles. Aesthetic principles. Technical and technological principles. Human principles. Economic principles. Ecological principles. Product development. Which is a good design. The role and importance of good product design. The relationship between the designer and the company. Methods in the design process. Design and interdisciplinarity. Product quality. Design and standardization. Design and ergonomics. Anthropometry and ergonomics. Ergonomic methods. Design and marketing. Marketing information and market and user research. Design and visual communications. The importance of visual culture in communication with the product. Environmental design. Ecology and furniture design. Bionics. Biophilia. The role of information technology in product development. The relationship between furniture and dedicated space. The impact of sustainable development in product and space design.

Learning outcomes

- ✓ Recognize and apply the characteristics of historical styles and heritage in furniture design
- ✓ Compare and monitor contemporary trends and innovations in furniture design (internet, magazines, books) in the context of economic development, culture, heritage and social, developmental and historical factors of each nation and apply them in designing new furniture design solutions.

- ✓ Explain the importance of an interdisciplinary approach and the inclusion of knowledge of other professions in furniture design
- ✓ Recognize and explain the term good design using the parameters of good design
- ✓ Design and shape furniture and other wooden products using design elements (means of expression) and the principles of modern design (functional, aesthetic, technicaltechnological, human, economic, environmental principles, etc.) or according to given characteristics (input data)
- ✓ Use innovations and new materials and technologies in designing conceptual furniture solutions on a given topic
- ✓ Apply knowledge of aesthetics, ergonomics, anthropometry, ecology, standards, newmaterials, and technologies, marketing and visual identity in the design of furniture and other wood products
- ✓ Define design-functional, construction-technological and other characteristics of the executive design of furniture
- ✓ Apply knowledge of design drawing (spatial and / or, computer) and workshop work (professional practice) in the development of conceptual and implementation solutions for designed furniture.
- ✓ Present the solution of designed furniture in all stages of product development with the final model/prototype in the design of furniture and other wood products

Language

Teaching will be conducted in English. All forms of instruction are a combination of implementation of teoretical and practical skills in project tasks, gaining the knowledge of the teamwork, discussions, design methods (brainstorming, design analyses, etc.), presentations and exercises. The final evaluation of the knowledge is done by project presentation (oral presentation and final project map) of the student.

Literature

1. Domljan, D. (2015): Ekologija i ergonomija namještaja, (interna skripta), Šumarski fakultet. Zagreb
2. Domljan, D; Grbac, I; Jirouš Rajković, V; Vlaović, Z; Živković, V; Župčić, I. (2015): Kvaliteta i tehnički opisi proizvoda od drva. Svezak I. Opremanje zgrada za odgoj i obrazovanje, sveučilišni priručnik, Šumarski fakultet Sveučilišta u Zagrebu, Hrvatska gospodarska komora, Zagreb
3. Lapaine, B. (1994): Dizajn, Sveučilište u Zagrebu Šumarski fakultet, Zagreb
4. Noblet de, J. (1999): Dizajn, pokret i šestar, Golden marketing, Zagreb
5. Panero, J. i Zelnik, M. (1987): Antropološke mere i interijer, Zbirka preporuka za standarde u projektiranju, IRO ''Građevinska knjiga'', Beograd
6. Baxter, M. (2000): Product Design, CRC Press, London, Boca Raton, NY, Washington
7. IDSA (2001): Design secrets – products. 50 Real-Life Product Design Projects, Rockport, USA
8. Luchs M.G. Swan S.; Griffin, A (2015): Design Thinking: New Product Development Essentials from the PDMA. Willey, New Jersey
9. Bridger, R.S. (2018): Introduction to Human Factors and Ergonomics. Fourth Edition. CRC Press, Taylor & Francis Group, USA
10. Lidwell, W., Holden, K., Butler, J. (2006) : Univerzalna načela dizajna, Mate, Zagreb

Forms of teaching

Education is provided in forms of course attendance and practical seminar and project tasks which follow the program units. Student is obliged to solve individual seminars and teamwork project tasks (furniture design concepts), to do field research, consultations, learn and use design methods to solve problems in design process. - Project task; - Seminar works; - Field work (visit of exhibitions, fairs or event related to arts or to furniture manufacture or design).

Lectures (30 h), exercises (30 h), e-learning (16 h)

Methods of grading

Seminar presentation; Project presentation (map); Oral exam - Final presentation of the design concept in the project.

Department of Wood Technology Courses - Graduate Study Programmes (MSc)

CNC TECHNIQUES IN WOODWORKING (code: 235703)

Original course title	CNC tehnika u finalnoj obradi drva	Status	Compulsory
Semester	winter	Course teacher	Assoc. Prof. Goran Mihulja, PhD
ECTS	4	Study level and programme	MSc Wood Technology Processes

Course content

Application of CNC technique final wood processing. Possibilities and limitations of CNC machines and machining center production. Types, construction forms and divisions of CNC machines. Elements of safety for work with CNC machines. Methods of production preparation (programming) on CNC machines: on-machine programming, programming with NC software package, graphic programming, Programming with CAD system, with digitization, "Teach in" programming. Machining center tool database, tool changers, tool setting and adjustments. Selection of operations and execution plan for machining with CNC machines based on key issues of advanced wood processing (cutting, surface assessment, dynamic behaviour of tools and machines, vibration problems, material response and sawdust extraction). Positioning and fixing of workpieces. Creating templates for workpiece positioning. Possibilities of setting tool paths and regulating machining parameters. Advanced processing using "macros", components and block commands. Processing on arbitrary planes. Setting up processing by CAD. Pockets and engraving. Multi-element production systems "nesting", CAD/CAM systems in production.

Learning outcomes

- ✓ Explain the possibilities of application of NC and CNC machines in the final wood processing
- ✓ Distinguish and categorize the basic types of NC and CNC machines based on their capabilities (saws, planers, milling machines, machining centers,...)
- ✓ Propose the application of different CNC machines for the production of final products based on the production program
- ✓ Plan the optimal way of using the CNC machining center for the production of final products using: "macros", components, block commands, different processing planes, workpiece fastening systems and tools
- ✓ Design the sequences and parameters of the processing of the final product elements at the CNC machining center
- ✓ Organize the machining center tool database and tool changers
- ✓ Prepare machining with a CNC machine using different methods of creating programs and processing subroutines (graphic programming, CAD, CAD / CAM software, ...).
- ✓ Conduct the process of preparing CAM software based on the capabilities of the machining center or production system

Forms of teaching

Lectures (30 h), exercises (15 h), fieldwork (16 h)

Language

All teaching activities will be held in Croatian. However, foreign students will have the opportunity to attend additional office hours with the lecturer and teaching assistants in English to help master the course materials. Additionally, the lecturer will refer foreign students to the corresponding literature in English, as well as give them the possibility of taking the associated exams in English.

Literature

1. Alain Albert: Understanding CNC Routers, FPInovations - Forintek Division, 2010, str.10- 100.
2. Irons, I.: Learn CNC Secrets; Quickly Learn the Basic Concepts of CNC, FistFire Publishing Hobart, WA FistFire LLC, 2007, str.1-142.
3. Mihulja, G.: Računalom podržana proizvodnja drvom i drvnim materijalima I, Interni studenski priručnik.
4. Madison, J.: CNC MACHINING HANDBOOK, Ind. press INC. 1996.
5. Laika, A.: Programmieren von CNC Holzearbeitungmaschinen, Rosenheim, 1991.
6. Csanady, E., Magoss, E.: Mechanics of Wood Machining, Springer, Berlin, 2013.
7. Ljuljka, B.: Tehnologija proizvodnje namještaja, Zagreb, 1980, str. 1-257.
8. Tkalec, S., Prekrat, S.: Konstrukcije proizvoda od drva – osnove drvnih konstrukcija, Sveučilišni udžbenik Šumarski fakultet i Znanje, Zagreb, 2000.

Methods of grading

Exercises, project assigment, written exam, oral exam

THERMOHYDROMECHANICAL PROCESSING OF WOOD (code: 235703)

Original course title	Hidrotermička obrada drva	**Status**	Compulsory
Semester	winter	**Course teacher**	Prof. Stjepan Pervan, PhD Assist. Prof. Miljenko Klarić, PhD
ECTS	6	**Study level and programme**	MSc Wood Technology Processes

Course content

Physical, anatomical and chemical scientific basics of thermohydromechanical processing of wood and wood materials, hygroscopicity, anisotropy of shrinkage and swelling, elastoplastic properties of wood under different conditions, measurement of water content in wood by destructive and non-destructive methods, determination of macro and microclimatic conditions of raw and dried material storage, classic kiln dryier with and without air exchange - details of performance, wood drying schedules - analysis and modification, types of control and regulation systems - parameter control, computer control of wood drying process in situ and remotely, non-standard drying methods, implementation of drying quality standards, steaming of solid wood, steaming and boling of veneer logs, thermohydromechanical bending processes of solid wood, technical drying of wood particles, technical drying of veneer, energy of hydrothermal processes, wood defects in thermohydromechanical wood processing and prevention of their occurrence, technology selection and cost calculations of thermohydromechanical processes. Implementation of research and preparation of reports on the analysis of the process of thermohydromechanical wood processing.

Learning outcomes

- ✓ Knowledge of the thermohydromechanical wood processes.
- ✓ Conduct optimal procedures of thermohydromechanical wood processing.
- ✓ Optimize the procedures of thermohydromechanical wood processing.
- ✓ Know, evaluate and select the optimal technology of thermhydromechanical wood processing, in accordance with the requirements of production.

Forms of teaching

Lectures (30 h), exercises (30 h), e-learning (8 h)

Language

All teaching activities will be held in Croatian. However, foreign students will have the opportunity to attend additional office hours with the lecturer and teaching assistants in English to help master the course materials. Additionally, the lecturer will refer foreign students to the corresponding literature in English, as well as give them the possibility of taking the associated exams in English.

Literature

1. Pervan, S.(2019): Handbook for technical drying of wood. University handbook. Faculty of Forestry Zagreb University.
2. Simpson W.T. (1991): Dry kilns operator manual. 274 str. USDA, Madison, Wisconsin
3. Trübswetter, T. (2009): HolztrocknungVerfahren zur Trocknung von Schnittholz - Planung von Trocknungsanlagen. Hanser Fachbuch, 204 str.
4. Pervan, S. (2009): Techology of wood processing by steam. University book. Faculty of Forestry Zagreb University. 166 p.
5. Ross, R. J. (2010): Wood handbook-Wood as an engineering material. USDA, FPL, Madison, Wisconsin, 508 p.
6. Perre, P., Keey, R.B. (2014): Handbook of industrial drying: Drying of Wood: Principles and Practices. Taylor and Francis, str. 822-872.

Methods of grading

Taking exam, exercises

PANEL MATERIALS (code: 235552)

Original course title	Pločasti materijali	**Status**	Compulsory
Semester	winter	**Course teacher**	Prof. Vladimir Jambreković, PhD; Assist. Prof. Nikola Španić, PhD
ECTS	4	**Study level and programme**	MSc Wood Product Design

Course content

Development of standardization and technical regulations related to the application of board materials. Panel materials quality demands considering the construction and furniture design demands. Specific demands for panel materials in interior design. Wooden panels as construction materials for buildings. The influence of wooden raw material type on panel properties. The influence of chemical components on panel properties. The economic aspect of panels' applicability. The ecological aspects of panels' applicability for use in interior. The factors influencing on physical properties of panel materials. The influence of used raw material on panel's mechanical properties. The factors influencing the stability of panels in interior use. Panel durability factors in construction. Dependability of technical properties and formaldehyde emission.
Specifics of combustion of unprotected panel materials. The influence of fire retardants on technical properties of panels. The influence of panel structure on heat conductivity and acustic properties. Workability of panels considering the type of raw material and structure. Aesthetic, ecological and technical aspects of panel overlaying with natural and synthetic materials. Specifics of edge coating of panel materials. Novel panel materials.Wood-plastic composites.Comparable properties of panel materials. The direction of panels' properties development. The limitations of toxic chemical components share in panel structure.

Learning outcomes

- ✓ to identify, evaluate and compare the physico-mechanical, ecological, technical and aesthetic properties of panel materials
- ✓ explain the requirements for the quality of panel materials regarding the construction requirements and furniture design requirements

- ✓ to analyse and evaluate important factors influencing the properties of panel materials in indoor and outdoor use
- ✓ to determine the applicability of panels from the economic aspect
- ✓ to evaluate panels workabillity regarding the specific of their structure
- ✓ to recommend the appropriate type of panel, regarding the specific place of its use

Forms of teaching

Lectures (30 h), exercises (15 h), e-learning (16 h)

Language

All teaching activities will be held in Croatian. However, foreign students will have the opportunity to attend additional office hours with the lecturer and teaching assistants in English to help master the course materials. Additionally, the lecturer will refer foreign students to the corresponding literature in English, as well as give them the possibility of taking the associated exams in English.

Literature

1. Sandberg, D., Kitek Kuzman, M., Gaff, M.: Engineered Wood Products. Czech University of Life Sciences, Prague, 2018.
2. Jambreković, V., Španić, N.: Panel Materials, (Internal script), Faculty of Forestry, Zagreb, 2021 (in writing)
3. Moslemi, A. A. Particleboards - Volume 1: Materials. Southern Illinois University Press, 1974.
4. Ambrozy, H. G., Giertlová, Z.: Holzwerkstoffe: Technologie - Konstruktion - Anwendung. Springer-Verlag/Wien, 2005. [In German].

Methods of grading

Knowledge will be checked constantly by tracking students achivements, by evaluation of project tasks and/or seminars. Verbal examination (if necessary).

TECHNOLOGICAL PRODUCTION MANAGEMENT (code: 235551)

Original course title	Tehnološka priprema rada	Status	Compulsory
Semester	winter	Course teacher	Prof. Denis Jelačić, PhD
ECTS	6	Study level and programme	MSc Design of Wood Products

Learning outcomes

- ✓ To establish the position and activities of production management within the
- ✓ management system
- ✓ To create the work order as a main information carrier in production management
- ✓ To establish the standards and demands for material in the production
- ✓ To establish the standards and demands for working time in the production
- ✓ To establish the standards and demands for capacity in the production
- ✓ To create full technological documentation as a part of management-information system
- ✓ in a company
- ✓ To project the management-information system in the company

Course content

1. Goals and tasks of production management in wood processing and furniture manufacturing. Technological and operations production management and work allocation. Production management as a part of management subsystem.
2. Modern systems and concepts of production management.
3. Working order as a main information carrier in production management. Planning, launching, execution and control of working orders.
4. Creating of drat components. Types of draft components. Establishing of material standards and demands. Exercise: Establishing of material demands.
5. Establishing of time standards, working time and working order time. Exercise: Establishing of working order time.
6. Establishing of the flow coefficient. Creating time plans.
7. Establishing the working order priorities.
8. Material management. Methods for establishing stock quantities.
9. Methods for establishing capacity demands. Control of the production execution. Exercise: Establishing capacity demands.
10. Work allocation and working order caluculation. Multiplication, completing and launching of production documentation. Working order records and analysis of the plan execution. Exercise: Project of the production management and completing of technological documentation.
11. Production management documentation. Flow chart of production documentation as a part of information subsystem.
12. Creating a project of management-information system in wood processing and furniture manufacturing. Basics of management-information projects. Exercise: Creating a project of management-information system in a company.
13. Presentations of individual student projects.
14. Final class and quality of the classes inquiry.

Language

In agreement with the students enrolled in the course, the lecturer will provide as many teaching elements in English as possible, or in both English and Croatian for mixed groups (i.e., bilingual teaching materials and bilingual exams). Level 2 also includes additional individual consultations with foreign students (as in Level 1) for the teaching elements which will be held in Croatian.

Literature

- ✓ Jelačić, D. 1998.: Priprema proizvodnje I (Production Management I), Neodidacta, Zagreb
- ✓ Jelačić, D. 1998.: Priprema proizvodnje II (Production Management II), Neodidacta, Zagreb
- ✓ Grladinović, T. 1999: Upravljanje proizvodnim sustavima u preradi drva i proizvodnji namještaja, Šumarski fakultet, (Production management systems in wood processing and furniture manufacturing, Faculty of Forestry), Zagreb
- ✓ Figurić, M., et al., 1992.: Proizvodni sustavi u drvnoj industriji I, Šumarski fakultet
- ✓ (Production systems in wood industry I, Faculty of Forestry), Zagreb

Forms of teaching

Lectures (30 h), exercises (30 h), e-learning (16 h)

Methods of grading

Knowledge will be checked constantly by tracking students achivements, by evaluation of project tasks and seminars and by final written and oral exams (if necessary).

TECHNOLOGY OF WOOD BUILDING COMPONENTS (code: 235711)

Original course title	Tehnologija drvnih proizvoda za graditeljstvo	Status	Compulsory
Semester	winter	Course teacher	Prof. Hrvoje Turkulin, PhD; Assoc. Prof. Vjekoslav Živković, PhD
ECTS	6	Study level and programme	MSc Wood Technology Processes

Course content

Wooden windows and doors: function, general service requirements, types of products. Building physics – technical details in design of acoustic and thermal instulation of windows, doors, walls, floors. Principles of technical design and detailing of the most important types of windows and doors. Processes of small-scale manufactruing and large industrial production processes for windows and doors: choice of machines and equipment, material, accessories, analysis of specific machining operations. Technical design, detailing and specific production operations in manufacturing of entrance doors, panel doors, wooden floors, wooden laminated beams, bridges, wooden prefabricated houses. Stages in transportation, building, maintenance and restoration.

Learning outcomes

- ✓ Interpretation and evaluation of technological operations for full utilization of wood advantages and reduction of wood shortcomings when used as a construction material, relating wood properties to specific technical requirements for particular construction product (windows and french doors, panel and entrance doors, flooring elements, wood structures and buildings.
- ✓ Definitiion and interpretation of function and technical requirements (serving, lightenting, ventilation, mechanical requirements) as well as basics of building physics: descrtiption and interpretation of acoustic, thermal and hygrotechnical phenomena for wood building components.
- ✓ Comparison and evaluation of the function, economic feasibility and technical concept of wood building components.
- ✓ Interconnect and interpret the technical design and technology of production of wood building components, formulate and organize the technological process for particular product (production layout and definitiion of operational steps)
- ✓ Measure and evaluate technological parameters in the production line and evaluate the fitness of measured properties for particular wood building product (accuracy and smoothness of machined surfaces, wood material properties, glue application rate, pressure, temperature and curing time in gluing, application of coating and curing process of the finish in production of wood building components).
- ✓ Define, analyse and evaluate the physical conditions during production and installation of wooden floors, windows and french doors, glulam beams
- ✓ Select and interpret the measurement and testing methods for quality control of wood building components and control of production parameters.

Forms of teaching

Lectures (30 h), exercises (30 h), e-learning (24 h)

Language

Inidividual consultations and seminars in English, laboratory work in bilingual explanations by asssociate teachers for exercises.

Literature

1. Turkulin i dr. 2002: Durability of wooden facades. Drvna ind. 53(1):33-48 i 53(3): 44-54.
2.*** 2005: Collection of offprints on the topic of durability and surface protection of wood in building. Faculty of

Forestry, Zagreb University
3.*** 1993: Wood building technology. Otawa: Canadian Wood Coiuncil. 3.Tomašević, J. (1999): Wood in flooring structures. Zagreb: Author's edition
4. PROHOLZ: Wood as construction material. ProHolz Austria, Vienna 2013.

Methods of grading

Written and verbal examination. Preconditions: positive consultations and revision of written reports.

TECHNOLOGY OF WOOD PROTECTION (code: 235713)

Original course title	Tehnologija zaštite drva	Status	Compulsory
Semester	winter	Course teacher	Assoc. Prof. Marin Hasan, PhD
ECTS	5	Study level and programme	MSc Wood Technology Processes

Course content

The latest scientific knowledge on wood protection (new protection procedures and wood preservatives).
Traditional methods in the aim of the monitoring and controlling of wood health.
Methods of preventive protection of wood and wooden products during wood processing (storage, sawmills, wood drying processes, wood processing, wood finishing, the storage of final products). Application of novel environmentally friendly preservatives and methods in the wood preservation, especially regarding to soil, water and air protection.
Wood modifications (natural and artificial, fossilization, petrifying, active and passive, chemical, thermal and enzymatic modification, esterification, etherification, acetylation, wood heating processes without air, heating in oils, physical modification, ...).
Lectures and exercises at the Faculty and out of the Faculty (new and ancient wooden objects (constructions), museums, churches, restoration workshops, wood processing plants).
Learning on wood decontamination and repressive protection of wooden objects and objects of cultural heritage, 'anoxi' procedures.
Wood waste and recovered wood, possibility of reconstruction and reuse of old preservative treated wood, wood waste and residues from chemically protected wood (old poles and sleepers, thresholds, wooden elements of building constructions, old wooden buildings, old wooden joinery).
Classification, deponiing, recycling and reuse of products from chemically protected wood
which „life cycle" is formaly finished.
Phytosanitary sterilization (importance of sterilization of wooden packaging in international trade).

Learning outcomes

- ✓ Based on the results of laboratory tests, independently determine the biological resistance of wood to the applicable standards and to recommend hazard class in which such wood can be used.
- ✓ Assess the risk of using biodegraded wood in the production and / or use of wooden products.
- ✓ Explain the difference between decontamination and wood protection procedures and propose the required procedure in the given example.
- ✓ Differentiate and define wood preservatives according to the aggregation state, the origin of the active component and the nature of the solvent.
- ✓ Propose the appropriate wood preservative and procedure for the given product (in the given hazard class), respecting the ecological principles of wood protection and describe the advantages and disadvantages of the proposed.
- ✓ For the selected product and the conditions of use, in which the wood product is used, to recommend adequate physical, structural (and chemical) protection.
- ✓ Recommend steps of restoration, adequate preventive or repressive protection procedures and choose adequate protective agent(s) depending on the type of wood product(s), the place of use and the degree of destruction.
- ✓ Distinguish modified wood from natural and explain their advantages and disadvantages.

- ✓ When designing new products from wood to anticipate the conditions of its use and possible mechanisms of degradation and to choose wood with needed natural resistance and to the recommend needed protection.
- ✓ Independently or in a team develop a project (expert opinion) and present it in front of a group of people.

Forms of teaching

Lectures (30 h), exercises (15 h), fieldwork (8 h)

Language

All teaching activities will be held in Croatian. However, foreign students will have the opportunity to attend additional office hours with the lecturer and teaching assistants in English to help master the course materials. Additionally, the lecturer will refer foreign students to the corresponding literature in English, as well as give them the possibility of taking the associated exams in English.

Literature

1. Glavaš, M. 1999: GLJIVIČNE BOLESTI ŠUMSKOG DRVEĆA. Sveučilište u Zagrebu, Šumarski fakultet. Sveučilišni udžbenik, 1999.
2. Špoljarić, Z. 1973: ZAŠTITA DRVA (Impregnacija). Šumarski fakultet Zagreb, 1973.
3. Hasan, M., Despot, R. 2018: Zaštita drva I, Abiološki čimbenici, lignikolne bakterije i gljive, ksilofagni kukci i morski štetnici – skripta za studente drvne tehnologije iz predmeta Zaštita drva I i Patologija drva. Sveučilište u Zagrebu, Šumarski fakultet, Zagreb, 2018.
4. Reinprecht, L. 2001: PROCESY DEGRADACIE DREVA. Tehnicka Univerziteta vo Zvolene, Zvolen, 2001. (selected chapters).
5. Proceednigs from the international conferences WOOD IN THE CONSTRUCTION INDUSTRY. (DESPOT, r., Jambreković, V. Editors). Faculty of Forestry Zagreb. (editions from 2000 to 2004).

Methods of grading

https://www.sumfak.unizg.hr/site/assets/files/5238/assesment_methods_and_criteria_ds_dt_ddp_engl_2023.pdf

FURNITURE AND INTERIOR DECORATION (code: 235689)

Original course title	Namještaj i opremanje prostora	Status	elective
Semester	winter	Course teacher	Assoc. Prof. Danijela Domljan, PhD
ECTS	4	Study level and programme	MSc Design of Wood Products

Course content

What is space. Introduction to spatial design. Typology and tasks of space. Components of spatial expression (light, color, volume, texture, materials, depth, height, (). Aesthetic and functional components of space. Perception of space. Etiological examination of interior furnishing. Styles and trends. Introduction to architectural design. Organization and design of space. Types of drafts. Symbols in architectural design. Floor plan quotation. Space and furniture design parameters (aesthetic, functional, social, psychological and social, technical-technological, ecological and ethnological). Originality and tradition. The impact of heritage. Kitsch culture. Color and materials in space. Psychology of color. The role of materials. Feng shui. Vastu. Biophilia. Wood in the interior. Residential and public space. The relationship of furniture and functional space. Indoor and outdoor design criteria. Contemporary trends in the design of space and furniture. Characteristics of housing and furnishing of living space. Housing culture. Characteristics of modern housing. Functional units of a modern housing unit. Analysis of individual spatial units and their function. Man as a module of housing organization. Public spaces (administrative, educational, cateringtourist, cultural, sports facilities). Characteristics of the use and equipping of public spaces. Analysis of functional groups of furniture in public spaces. Typology and dimensions of furniture in public spaces. Urban equipment. Ecology and sustainable development in furnishing outdoor spaces.

Learning outcomes

- ✓ Distinguish the types, typology and tasks of residential and public space.
- ✓ Recognize and apply the components, principles and elements of space design (color, texture, light, materials, orientation, etc.) in certain historical stylistic periods, contemporary architecture and / or given task.
- ✓ To valorize and apply the features of Croatian heritage in the design of the content of the space and furnishing the interior with appropriate furniture.
- ✓ Apply the theory and criteria of spatial planning and architectural design in the furnishing of space.
- ✓ Apply human measures as a module of space organization.
- ✓ Evaluate and apply the principles of modern design of housing and public space and furniture (aesthetic, functional, social, psychological and social, technical-technological, ecological and ethnological) in relation to the needs and habits of users.
- ✓ Analyze, recommend and design functional groups of furniture in relation to a given spatial unit of residential or public use and user needs
- ✓ Analyze individual spatial units and their functions in residential and public space (common space, private (individual) space; space for work, socializing, communication, rest, etc.)
- ✓ Apply a designer freehand or computer drawing in the presentation of the executive solution of furniture and equipped space.
- ✓ Present the solution of equipped space and designed furniture in front of a group of people (potential clients, teachers, colleagues, etc.)

Language

Teaching will be conducted in English. All forms of instruction are a combination of implementation of teoretical and practical skills in project tasks (interior design field project), gaining the knowledge of the teamwork, discussions, design methods (brainstorming, design analyses, etc.), presentations and exercises. The final evaluation of the knowledge is done by project presentation (oral presentation and final project map) of the student.

Literature

1. Domljan, D; Grbac, I (2014): Interijer (interna skripta), Sveučilište u Zagrebu Šumarski fakultet
2. Grey, J. i sur. (2001): Dizajn stanovanja; Znanje, Zagreb, 2001.
3. Lawrence, M. (1997): Dekoriranje i uređenje doma; Dušević&Kršovnik, Rijeka
4. Neufert, E. (2000): Elementi arhitektonskog projektiranja, Golden marketing, Zagreb
5. Panero, J.; Zelnik, M. (1990): Antropološke mere i interijer, Zbirka preporuka za standarde u projektiranju, IRO ''Građevinska knjiga'', Beograd
6. Biondić, Lj. (2011): Uvod u projektiranje stambenih zgrada. Golden marketing-Tehnička knjiga, Sveučilište u Zagrebu Arhitektonski fakultet, Zagreb
7. Ching, F.D.K.; Binggeli, C. (1918): Interior design illustrated., 4th edition, Willey, USA
8. Cerver, F. A. (2000): Modernes wohndesign; Könemann, Köln
9. Gremley, C.; Love, M (2018): The Interior Design Reference & Specification Book, Rockport, USA
10. Neidhart, V. (1997): Čovjek u prostoru, Školska knjiga, Zagreb
11. Poore, J (1994): Interior Color by Design. A design tool for architects, interior designers and homeowners. Rockport, USA
12. Stulhofer, A.; Veršić, Z. (1998): Crtanje arhitektonskih nacrta. UPI-2M, Zagreb
13. Vrkljan, Z. (1986): Oprema građevnih nacrta. Udžbenici Sveučilišta u Zagrebu, Građevinski fakultet, Zagreb
14. *** (1999): Living spaces, Ecological Building and Design, Öko test, Könemann, English Edition, (Edit.: Schmitz-Gunther T.), Mladinska knjiga tiskarna d.d., Ljubljana

Forms of teaching

Education is provided in forms of course attendance and project tasks which follow the program units. Student is obliged to solve individual tasks (seminars) and teamwork project tasks, to do field research upon field project, consultations, learn and use design methods to solve problems in interior design process. - Project tasks; - Seminar works;- Field work (interior design field project; visit of exhibitions, fairs or event and companies related to arts, design and furniture production).

Lectures (30 h), exercises (15 h), e-learning (16 h)

Assessment methods

Seminar presentation; Project presentation (map); Written exam; Oral exam - Final presentation of the design concept in the project.

PROJECT MANAGEMENT (code: 235697)

Original course title	Upravljanje projektima	Status	elective
Semester	winter	Course teacher	Prof. Denis Jelačić, PhD
ECTS	4	Study level and programme	MSc Design of Wood Products

Course content

1. Plan and project. Production project. Investment project.
2. Projects within production systems. Establishing the activities on the project, managing of the project, methods and techniques of project management.
3. Gantt charts forwards and backwards (ASAP, ALAP, SPAN). Exercise: project planning using Gantt chart
4. Network diagrams, types of network diagrams (CPM, PERT, Precedence) and their use. Exercise: project planning using network diagram
5. Business and investment projects. Information on investor
6. Analysis of the supply-demand market with examples from the wood processing branche,
technical-technological analysis of the organization in wood processing and furniture manufacturing, location analysis
7. Financial preparation of the project, efficiency and sensibility evaluation
8. Purpose of the business plan, enterpreneuer business plan structure. Exercise: individual project with a business plan
9. Enterpreneuer decision making process, important business and time components of the project and business plan
10. Company value. Restrictions in business activities in wood processing and furniture manufacturing
11. Basics of the economy calculation, interest calculation, business with banks, loans, loan payments. Exercise: economy calculation for a business plan
12. Economical evaluation of an investment project. Return period for investment, profit and profit rate
13. Presentations of indivitual student projects
14. Final class, inquiry on quality of the classes and the subject

Learning outcomes

- ✓ Establish the position and tasks on projects within the management system
- ✓ Establish the time components of the project using Gantt charst and Network diagrams
- ✓ Establish the resources for quality execution of the project
- ✓ Create the project and make the business plan for the project
- ✓ Create the technical-technological analysis and location analysis of the project
- ✓ Create the financial preparation of the project with main time milestones
- ✓ Create the management project in the company

Language

In agreement with the students enrolled in the course, the lecturer will provide as many teaching elements in English as possible, or in both English and Croatian for mixed groups (i.e., bilingual teaching materials and bilingual exams). Level 2 also includes additional individual consultations with foreign students (as in Level 1) for the teaching elements which will be held in Croatian.

Literature

1. Demeter, D., Stepič, D. 1990: Project management, Otvoreno sveučilište, Zagreb.
2. Omazić, M.A., Baljkas, A. 2005: Projektni menadžment (Project management), Zagreb: Sinergija nakladništvo d.o.o.
3. Maylor, H.: Project Management, Prentice Hall, 2010.

4. Meredith, J.R., Mantel, S.J.: Project Management; A Managerial Approach, Wiley, 2012.

Forms of teaching

Education is provided in forms of course attendance and practical exercises which follow the program units. Beside that, student is obliged to solve individual project tasks, to do field research, different aspects of consulting asking for help in solving problems in project management.

Lectures (30 h), exercises (15 h), e-learning (8 h)

Methods of grading

Knowledge will be checked constantly by tracking students achivements, by evaluation of project tasks and seminars and by final written and oral exams (if necessary).

INTEGRATED MANAGEMENT SYSTEMS IN WOOD INDUSTRY (code: 235696)

Original course title	Integrirani sustavi upravljanja u drvnoj industriji	Status	elective
Semester	winter	Course teacher	Assist. Prof. Kristina Klarić, PhD; Assist. Prof. Krešimir Greger, PhD
ECTS	4	Study level and programme	MSc Wood Product Design

Course content

Introduction. Basic concepts and theories of quality management. Historical development of quality management. Management systems in the wood industry. Development stages of quality. Quality control, quality assurance, quality management. Development of standards, norms, integrated systems and quality management systems. Application of standardization in management systems in the wood industry. Development of management system and related standards. Standardization of quality management systems in the wood industry. Standardization of environmental management systems in the wood industry. Standardization of occupational safety and health management systems. Standardization of wood product traceability systems. Sustainable management in the wood industry. An integrated approach to sustainable management. Other standardized systems in the wood industry. Certification, accreditation and supervision. Application of process approach in development an integrated system. Application of continuous improvement based on PDCA cycle. Application of a systematic management approach through the integration of management system documentation. Defining, harmonizing basic processes, goals and resources. Risk analysis. Organizing integrated management systems in the wood industry.

Learning outcomes

- ✓ Identify and understand the basic concepts and theories of quality management in the field of quality management.
- ✓ Interpret management system development, standards, and system integration.
- ✓ Understand the certification, accreditation and supervision of integrated systems.
- ✓ Distinguish and define management systems in the wood industry.
- ✓ Design the development of a quality management system and integration with other certification systems for the wood processing and furniture manufacturing company.

Language

All teaching activities will be held in Croatian. However, foreign students will have the opportunity to attend additional office hours with the lecturer and teaching assistants in English to help master the course materials. Additionally, the

lecturer will refer foreign students to the corresponding literature in English, as well as give them the possibility of taking the associated exams in English.

Literature

1. Figurić, M., (2000): Proizvodni i poslovni procesi u preradi drva i proizvodnji namještaja. Zagreb: Šumarski fakultet.
   Baković, T., Dužević, I. (2014), Integrirani sustavi upravljanja, Ekonomski fakultet – Zagreb.
2. The Integrated Use of Management System Standards (IUMSS), Second Edition, ISO Handbook, 2018, Ženeva, Švicarska.
3. Štajdohar-Pađen, O., Plivati s ISO-om i ostati živ, Zagreb : Grafički zavod Hrvatske. Zagreb: Kigen, 2009.
4. Lazibat, T.: Upravljanje kvalitetom, Znanstvena knjiga, Zagreb, 2009.
5. Šiško Kuliš, M., Grubišić D.: Upravljanje kvalitetom, Sveučilište u Splitu, Ekonomski fakultet, 2010.

Forms of teaching

Lectures (30 h), exercises (15 h), e-learning (8 h)

Assessment methods

Tests in practical work, written exam, completed project, report on fieldwork, oral exam.

MATERIAL HANDLING (code: 33674)

Original course title	Rukovanje materijalom	**Status**	compulsory
Semester	summer	**Course teacher**	Professor Ružica Beljo Lučić, PhD
ECTS	4	**Study level and programme**	MSc Wood Technology Processes

Course content

General theory of handling material. Basic principles of material handling. Methodological basics of analysis and solving material flows. Transport systems in automated production. Automated transportation in the storage facilities. Automated transport equipment and transport routes. Solving transport problems in the wood industry. Transport cost analysis. Minimize transport costs. Transport systems in the wood industry. Transport and storage of logs and sawn timber. Organization of log yards with regard to the used transport equipment. Choice of transport equipment. Transport and storage of semi-finished and finished products. Storage facilities of final products. Storage equipment. Storage conditions. Designing a storage facilities. Storage facilities transport equipment. Determining the size of the storage space. Usability of storage facilities space. Transport and storage of bulk wood material. Defining the properties of the material. Types and properties of particles of bulk wood material. Types of transport and transport equipment. Types of storage facilities and silo. Calculate the required silo capacity. Design of air conveyor systems. Energy analysis of transport systems. Efficiency of transport systems. Heat balance of plants with air conveyor. Comparison of air and mechanical conveyors from the energy aspect. Options for reduction of energy consumption of air conveyors. Packaging. Packaging material. Internal protection. Packaging for wood products. Basic types of transport packaging in the wood industry. Machines and tools for packaging wood products. Wooden packaging. Production and testing of wooden packaging.

Learning outcomes

- ✓ Collect and analyse relevant information and research results on the subject related to material handling in wood processing and furniture production.
- ✓ Present in a clear and concise way professional information related to handling materials in wood processing and furniture production.

- ✓ Investigate, measure or calculate the properties of bulk wood materials and analyze the influencing factors on properties of materials important for their transport, storage and packaging (bulk density, bulk angle, granulation).
- ✓ Plan and conduct research related to material handling (transport, storage, packaging) by surveying participants in wood processing industry and furniture production
- ✓ Self-study the task of material handling and suggest technical and organizational solutions in certain time and financial conditions.
- ✓ Calculate the required size of the storage facilities depending on the type, quantity, layout of the material, used transport equipment etc.
- ✓ Create and use simple Excel tables to keep track of the stock of material in the storage facilities.
- ✓ Produce self-conceptual design of dust and chips extraction and transportation system using the data of manufacturers of pipes, fans, electric motors and wood particle separators.

Forms of teaching

Lectures (30 h), exercises (15 h), fieldwork (16 h)

Language

All teaching activities will be held in Croatian. However, foreign students will have the opportunity to attend additional office hours with the lecturer and teaching assistants in English to help master the course materials. Additionally, the lecturer will refer foreign students to the corresponding literature in English, as well as give them the possibility of taking the associated exams in English.

Literature

- ✓ Sever, S. 1988: Transport u drvnoj industriji, autorizirani rukopis, Zagreb.
- ✓ Oluić, Č. 1991: Transport u industriji, Rukovanje materijalom I. dio. Sveučilišna naklada, Zagreb, 1 – 278.
- ✓ Rukovanje materijalom, Power Point prezentacije, 2020.

Methods of grading

Knowledge will be checked constantly by tracking students achivements, by evaluation of project tasks and/or seminars. Verbal examination (if necessary).

BASICS OF WOOD RESTORATION (code: 235722)

Original course title	Osnove restauracije drva	Status	elective
Semester	summer	Course teacher	Assoc. Prof. Marin Hasan, PhD
ECTS	4	Study level and programme	MSc Wood Product Design

Course content

Introduction to wood product styles and production dating methods; stages and procedures in the wood products restoration; restoration design and documentation; wood identification and visual, non-destructive or semi-destructive condition assessment methods; identification of abiological and biological factors that caused deterioration of the product; key factors in selecting the optimal decontamination procedure; application of some (available) decontamination procedures; basic principles of wood consolidation, alternative wood species selection and restoration preparation; selection and application of adequate long-term wood protection.

Learning outcomes

1. Based on the obtained wooden object, independently determine the production style and propose a method of dating the object's age.

2. Independently identify the wood species from which the product is made and, if necessary, determine alternative species.
3. Independently identify biological and abiological damage and the risk of the speed of further decomposition and spread of infection.
4. Independently propose the decontamination procedure.
5. Independently propose the appropriate protective agent and procedure for a given product (in a given hazard class), respecting the ecological principles of wood protection and describing the proposed advantages and disadvantages.
6. For the selected product and the conditions in which the wood product is used, recommend adequate physical, structural (and chemical) protection.
7. Recommend remediation steps (consolidation and restoration), adequate preventive or repressive protection procedure and select acceptable means for consolidation and protection depending on the type of wood, place of use and degree of destruction of the wood product.
8. Individually or in a team, do a project (expert opinion) and present it to a group of people.

Forms of teaching

Lectures (30 h), exercises (15 h), field work (16 h)

Language

All teaching activities will be held in Croatian. However, foreign students will have the opportunity to attend additional office hours with the lecturer and teaching assistants in English to help master the course materials. Additionally, the lecturer will refer foreign students to the corresponding literature in English, as well as give them the possibility of taking the associated exams in English.

Literature

1. Unger, A., Schniewind, A.P., Unger, W. 2001: CONSERVATION OF WOOD ARTIFACTS, Springer, 2001.
Hasan, M., Despot, R. 2018: Wood protection I, Abiological factors, lignocol bacteria and fungi, xylophagous insects and marine pests - a script for students of wood technology in the subject Wood protection I, and Wood pathology. University of Zagreb, Faculty of Forestry, Zagreb, 2018
2. Reinprecht, L. 2000: REKONŠTRUKCIA OBJEKTOV Z DREVA, Monografia, Technicka Univerziteta vo Zvolene, Zvolen, 2000.
3. Reinprecht, L. 2001: PROCESY DEGRADACIE DREVA. Tehnicka Univerziteta vo Zvolene, Zvolen, 2001. (odabrana poglavlja). Library of the Institute of Wood Science
4. Salminen, E., Valo, R., Korhonen, M., Jernlås, R. 2014: Wood preservation with chemicals Best Available Techniques (BAT). TemaNord 2014:550 ISSN 0908-6692. Nordic Council of Ministers 2014. ISBN: 978-92-893-2828-9, ISBN 978-92-893-2829-6 (EPUB).
5. Timar, M.C.;Gurau, L.; Porojan, M.; Beldean, E. (2013): Microscopic identification of wood species. An important step in furniture conservation, European Journal of Science and Theology, August 2013, Vol.9, No.4, 243-252
6. Brian K. Brashaw, Voichita Bucur, Ferenc Divos, Raquel Gonçalves, 2009: Nondestructive Testing and Evaluation of Wood: A Worldwide Research Update, Forest Products Journal 59(3):7-14
7. Richardson, B.A. 1993: WOOD PRESERVATION second edition, E & FN SPON, London, 1993.
8. Eaton, R.A., Hale, M.D.C.1994: WOOD, DECAY, PESTS AND PROTECTION, Chapman & Hall, 1994. United Kingdom.
9. Bravery, A.F., Berry, R.W., Carey, J.K., Cooper, D.E. 1992: RECOGNISING WOOD ROT AND INSECT DAMAGE IN BUILDINGS, BRE Bookshop, Seconfd edition, 1992. Garston, Watford, United Kingdom.
10. Proceedings of international IRG-WP conferences: International Research Group on Wood Protection, IRG-WP Stockholm, Sweeden. (editions from 1990. to 2020.)

Assessment methods

https://www.sumfak.unizg.hr/site/assets/files/5240/diplomski_studij_oblikovanje_proizvoda_od_drva_-_eng.pdf

BIOREFINERY WOOD TECHNOLOGIES (code: 235731)

Original course title	Biorafinerijske tehnologije drva	Status	elective
Semester	summer	Course teacher	Prof. Alan Antonović, PhD
ECTS	4	Study level and programme	MSc Wood Technology Processes

Course content

LECTURES:
1. Bioeconomy and circular economy; Introduction to biorefinery technologies; Environmental, logistical, energy, economic and socio-social aspects of biorefinery technologies; Mapping biorefinery technologies in the World;
2. Wood as a raw material for the production of organic products, characterization and evaluation; Reactions of wood chemical compounds; Introduction to protocols and research techniques of wood chemical composition,
3. Processes of wood conversion into biorefinery platforms; Mechanical and physical processes - pressing, grinding, separation, fiber separation, fractionation, extraction, upgrading; Biochemical processes - anaerobic digestion, aerobic / anaerobic fermentation, enzymatic conversion, transesterification; Chemical processes - hydrolysis, oxidation, branching; Thermochemical processes - combustion, gasification, pyrolysis, hydrothermal upgrading, torefication, liquefaction, hydrogenation;
4. Wood pretreatments 1; Pre-treatments of cellulose polysaccharides and wood polyoses / hemicelluloses (hydrolysis, fermentation, chemical treatments); Introduction to chemical and biotechnological methods used for pretreatment and enzymatic hydrolysis of wood; Fermentation of sugars into chemicals to produce bioethanol;
5. Wood pretreatments 2; Lignin pretreatments (radical and chemical pretreatments) in the process of obtaining phenolic bioproducts; Lignin regeneration processes; Valorization of lignin and its derivatives into organic products;
6. Introduction to biorefinery bioproducts; Bioenergy; Biofuels; Biogas; Biomaterials - biopolymers and biochemicals;
7. Biorefinery technologies; Classification of biorefinery technologies; Introduction to different types and concepts of biorefinery technologies; Operating flow and material flow;
8. Biorefinery technologies for bioenergy and biofuel production 1; Liquid wood fuels; Enzymatic conversion of wood for the production of various organic products; Basic concepts of enzymatic biocatalysis for the conversion of wood into biofuels and biochemicals; Enzyme classification; Bioethanol; Bio-ETBE; Biodiesel; Bioethers MTBE and TAME; Cellulose ethanol; Advanced biodiesel; BTL; BIO-SNG; HEFA; BioDME; Biohydrogen; Biobutanol; Biomethanol; Bio oils; Ground oil;
9. Biorefinery technologies for the production of bioenergy and biofuels 2; Biochar, biogas and biooils; Chemical processes (catalytic and thermochemical processes) for the conversion of wood into biofuels and biochemicals; Biotechnologies for the production of biochemicals and biofuels from extractives of wood (use of triacylglycerols, fatty acids and glycerols); Fermentation of sugar into chemicals for biodiesel production;
10. Biorefinery technologies for biogas production; Anaerobic digestion; Degradation mechanisms; Bioreactors and process parameters; Biogas purification; Biogas valorization; Environmental regulation and biogas safety;
11. Biorefinery technologies for biomaterial production 1; Building blocks and biochemicals; Methane; Carbon monoxide; Methanol; Monoethylene glycol; Milk acid; Succinic acid; Ethyl lactate; Propylene glycol; 1,3-Propanediol (PDO); Epilochidrin; Propylene; Acrylic acid; Acrylonitrile; Acrylamide; Butanol; Adipic acid; Isoprene;
12. Biorefinery technologies for biomaterial production 2; Building blocks and biochemicals; Furani; Farnes; Teraphthalic acid; 3-hydroxypropionic acid; Aspartic acid; Glutamic acid; Levulinic acid; Polyhydroxyalkanoates;
13. Biorefinery technologies for biopolymer production 1; Bio-polyethylene (Bio-PE); Biopolypropylene (Bio-PP); Bio-polyethylene phthalate (Bio-PET); Bio-polytrimethylene terephthalate (Bio-PTT);
14. Biorefinery technologies for biopolymer production 2; Thermoplastic copolyester elastomer (TCP); Polylactic acid (PLA); Polyhydroxyalkanoates (PHA); Polybutylene adipateco- terephthalate (PBAT);
15. Biorefinery technologies for biopolymer production; Lignocellulosic biomass liquefaction mechanisms; Liquefaction with phenols; Liquefaction with polyhydric alcohols; Application of liquefied lignocellulosic biomass in biopolymers; Bioformaldehyde polymers;
PRACTICAL WORK:
1. Preparation of wood samples for chemical analysis,
2. Determination of the elemental composition of wood by flame atomic absorption spectrometry (FAAS) and CHNSO analysis,
3. Determining the group chemical composition of wood in order to determine the parameters of biorefinery analyzes,

4. Identification and characterization of group chemical composition of wood with instrumental hibernetic assembly,
5. Determination of the content and ratio of enzymes for dissolving wood polysaccharides,
6. Fermentation of wood polysaccharides in the production of bioethanol,
7. Determination of biochar, biogas and bio-oil content by pyrolytic decomposition of wood,
8. Determination of OH-number of liquefied wood,
9. Determination of the degree of liquefaction and solids content and dry matter content of wood,
10. Obtaining polylactic acid from wood hemicellulose and determining its properties and characteristics,
11. Obtaining succinic acid from wood hemicellulose and determining its properties and characteristics,
12. Synthesis of formaldehyde resins with liquefied wood and determination of properties of obtained bioproducts.

Learning outcomes

1. identify and explain different sources of lignocellulosic biomass suitable for biorefinery technologies in the production of various bioproducts,
2. critically evaluate different biorefinery technologies for the production of different bioproducts (bioenergy, biofuels, biogas and biochemicals) from lignocellulosic biomass and analyze potential future price reductions through technological development,
3. explain and present the basic technical-technological concepts of various biorefinery technologies and their practical applications related to engineering systems for the production of organic products,
4. identify and describe bio-products with higher added value obtained by biorefinery technologies from lignocellulosic biomass,
5. draw and construct simple schemes of biorefinery technologies and critically assess the potential of biorefinery processes

Forms of teaching

Lectures (30 h), exercises (15 h)

Language

All teaching activities will be held in Croatian. However, foreign students will have the opportunity to attend additional office hours with the lecturer and teaching assistants in English to help master the course materials. Additionally, the lecturer will refer foreign students to the corresponding literature in English, as well as give them the possibility of taking the associated exams in English.

Literature

- Antonović (2018): Kemija drva (interna skripta). Šumarski fakultet, Zagreb
- N. Quereshi, D. Hodge, A.A. Vertes (2014): Biorefineries: Integrated biochemical processes for liquid biofuels. Elsevier,
- C.A.C. Alzate, J.M. Botero, V.A. Marulanda (2018): Biorefineries – Design and Analysis. CRC Press,
- J.-L. Wertz, O. Bedue (2013): Lignocellulosic birefineries. EPFL Press,
- M. Rabacal, A.F. Ferreira, C.A.M. Silva, M. Costa (2017): Biorefineries – Targeting energy, high value products and waste valorisation. Springer International Publishing,
- J.-L. Wertz, M. Deleu, S. Coppee, A. Richel (2019): Hemicellulose nad lignin in biorefineries. CRC Press,
- K. Wageman, N. Tippkotter (2019): Biorefineries. Springer Interantional Publishing

Assessment methods

exercises, project task, exam

SELECTED METHODS IN WOOD ANATOMY (code: 235699)

Original course title	Odabrane metode rada u anatomiji drva	Status	elective
Semester	summer	Course teacher	Asst. Prof. Iva Ištok, PhD; Assoc. Prof. Bogoslav Šefc, PhD; Prof. Jelena Trajković, PhD
ECTS	4	Study level and programme	MSc Wood Product Design

Course content

1. Knowledge of different microscopy and preparation techniques for morphological, qualitative and quantitative analyses of wood, wood cells and wood materials.
2. Measuring instruments and methods in optical microscopy; microtomy and maceration of wood: preparation, staining and fitting of preparations; microphotography; electron microscopy; ultramicrotomy; wood surface replication methods; preparation methods; application of X-ray technique in wood anatomy.
3. Diagnostic features in wood identification.
4. Identification of wood using modern software (keys) for wood identification. Methods and boundary examples (reliability of identification).

Learning outcomes

- ✓ Explain and apply different microscopy techniques in identifying wood, wood cells, and wood materials, as well as evaluating wood quality.
- ✓ Know, explain and apply techniques of histological wood preparations for microscopy.
- ✓ Know the diagnostic features in wood identification.
- ✓ Identify wood types using modern software (keys) for wood identification.

Forms of teaching

Lectures (30 h), exercises (15 h)

Language

All teaching activities will be held in Croatian. However, foreign students will have the opportunity to attend additional office hours with the lecturer and teaching assistants in English to help master the course materials. Additionally, the lecturer will refer foreign students to the corresponding literature in English, as well as give them the possibility of taking the associated exams in English.

Literature

1. Wood anatomy: lectures in course Wood anatomy (script, authors: Jelena Trajković and Bogoslav Šefc, pdf document 3 MB) and Image atlas to use with lectures (illustrations to use with lectures, collected by: Jelena
2. Trajković and Bogoslav Šefc, pdf document 39 MB)
3. Wheeler, E,A.; Baas, P, Gasson, P.E. (1989): Iawa list of microscopic features for hardwood identification, IAWA Journal, Vol 10 (3):219-332.
4. Von Arx, G.; Crivellaro, A.; Čufar, K; Prendin, L.A.(2016): Quantitative Wood Anatomy— Practical Guidelines, Frontiers in Plant Science 7(56):781, doi: 10.3389/fpls.2016.00781
5. Wheeler, E,A.; Baas, P. (1998): WOOD IDENTIFICATION -A REVIEW; IAWA Journal, Vol 19 (3):241-264,
6. H. G. Richter and M. J. Dallwitz 2000: 'Commercial timbers: descriptions, illustrations, identification, and information retrieval.' In English, French, German, and Spanish. Version: 25th June 2009. https://www.deltaintkey. com/wood/index.htm
7. Tiago Ferreira, Wayne Rasband, 2012.: ImageJ Users Guide, 185 str. https://imagej.nih.gov/ij/docs/guide/user-guide.pd
8. Timar, M.C.;Gurau, L.; Porojan, M.; Beldean, E. (2013): Microscopic identification of wood species. An important step in furniture conservation, European Journal of Science and Theology, August 2013, Vol.9, No.4, 243-252

9. Brian K. Brashaw, Voichita Bucur, Ferenc Divos, Raquel Gonçalves, 2009: Nondestructive Testing and Evaluation of Wood: A Worldwide Research Update, Forest Products Journal 59(3):7-14
10. InsideWood. 2004-onwards. Published on the Internet. http://insidewood.lib.ncsu.edu/search [date of accession].
11. Gasson, P.E. Baas, Wheeler, E,A. (2011): WOOD ANATOMY OF CITES-LISTED TREE SPECIES, IAWA Journal, Vol 32 (2):155-198,
12. Abramowitz Mortimer, 2003: Microscope basics and beyond. Revised edition. For Olympus America http://microscopy.
13. Geoffrey Daniel, 2016: Microscope Techniques for Understanding Wood Cell Structure and Biodegradation, u knjizi: Secondary Xylem Biology; Origins, Functions, and Applications, Chapter: 15, Publisher: Academic Press, Editors: Yoon Soo Kim, Ryo Funada, Adya P. Singh, pp.310-345

Methods of grading

exercises/seminars, oral exam

SPECIAL TECHNOLOGY OF WOOD DRYING (code: 235722)

Original course title	Specijalne metode sušenja drva	Status	elective
Semester	summer	Course teacher	Professor Stjepan Pervan, PhD; Assist. Prof. Miljenko Klarić, PhD
ECTS	4	Study level and programme	MSc Wood Technology Processes

Course content

Physical basics of special methods of wood drying - drying by EM waves, convection drying, drying at reduced air pressure, vacuum drying - technological versions, condensing drying - technological versions, vacuum-pressure process - technological versions, HF and RF drying - technological versions, microwave drying - technological designs, IR radiation drying, drying in liquids, drying with directly heated gases, drying of lamellas, measurement of drying parameters in special drying methods, drying schedules of special wood drying methods, modification of special wood drying schedules, wood drying defects in special drying methods, advantages and disadvantages of special drying methods, selection of technology, calculations and costs of special drying methods.

Learning outcomes

1. Knowledge of the unconventional special technologies for drying of wood.
2. Apply and conduct unconventional wood drying procedures.
3. Evaluate and select the appropriate level of special drying technology according to production requirements.

Forms of teaching

Lectures (30 h), exercises (15 h), e-learning (8 h)

Language

All teaching activities will be held in Croatian. However, foreign students will have the opportunity to attend additional office hours with the lecturer and teaching assistants in English to help master the course materials. Additionally, the lecturer will refer foreign students to the corresponding literature in English, as well as give them the possibility of taking the associated exams in English.

Literature

1. Pervan, S. (2000): Priručnik za tehničko sušenje drva. 272 p. SAND 2000.

2. Pervan, S. (2009): Tehnologija obrade drva vodenom parom. 166 p. SAND 2009.
3. Krpan, J. (1965): Sušenje i parenje drva. Šumarski fakultet Zagreb, 363 p.

Methods of grading

Knowledge will be checked constantly by tracking students achivements, by evaluation of project tasks and/or seminars. Verbal examination (if necessary).

WOOD MODIFICATIONS (code: 33666)

Original course title	Modifikacije drva	Status	elective
Semester	winter	Course teacher	Prof. Hrvoje Turkulin, PhD; Prof. Vlatka Jirouš-Rajković, PhD, Assoc. ; Assoc. Prof. Vjekoslav Živković, PhD; Assoc. Prof. Marin Hasan, PhD; Assoc. Prof. Bogoslav Šefc, PhD
ECTS	4	Study level and programme	MSc Wood Technology Processes

Course content

Analysis of the grounds for wood modification (natural shortcommings-hygroscopicity, liability to weathering and biological deterioration), and improvement of tehcnical properties – mechanical, thermal, acoustic properties, adhesion and permeability. Review of the modification technologies: surface modifications (physical – roughness and plasma treatments, application of chemical treatments, irradiations, finishing). Bulk wood modifications (heat treatments, acetylation, densification, infiltration, cell wall modifications, enzymatic modifications). Theoretical and practical aspects of wood modification by laboratory heat treatment, acetylation, surface treatments (NaOH, cytric acid, DMDHEU, HALS and UV primers), by impregnation (oil and PEG): measurements of the changes in dimensional stability, hygrophobicity (contact angle), colour fastness, surface integrity, strength changes, biological resistance. Review of the potential commercial applications of modified wood.

Learning outcomes

- ✓ Differentiate unmodified wood from modified as well as modified from chemically protected and explain their advantages and disadvantages.
- ✓ Differentiate the different types of wood modification (thermal, chemical, ...) and the essential parameters of the modification regime.
- ✓ Select those properties of modified wood that are important for a particular product (eg, durability in external floors, dimensional stability in flooring in the interior).
- ✓ Recommend the type of wood and type of modification for a given product according to the hazard classes (HRN EN).
- ✓ Recommend the tests and independently test the selected properties of modified wood (test for loss of mass modification, examine biological resistance, hygroscopic properties, ...), interpret the obtained results and determine the durability class according to HRN EN norms.
- ✓ Compare the examined properties of modified wood and select the optimum for the desired product (eg loss of mass, dimensional stability, hardness, bending strength or tension, modulus of elasticity, loss of mass due to the action of fungi).
- ✓ Review the most important parameters and compare the effect of some modification parameters to suggest correction of modification regime to achieve the required properties (eg, correction of the temperature or treatment time required to achieve a certain degree of durability or color change level in thermal modification in the water vapor).
- ✓ Individually or in a team, make a durability insurance project for a new product from modified wood in terms of its use, to recommend the optimum modification procedure while respecting the ecological principles (eg,

application of additional chemicals) and economic requirements (eg energy needs) and present it to a group of people.

Language

All teaching activities will be held in Croatian. However, foreign students will have the opportunity to attend additional office hours with the lecturer and teaching assistants in English to help master the course materials. Additionally, the lecturer will refer foreign students to the corresponding literature in English, as well as give them the possibility of taking the associated exams in English.

Literature

1. Zbirka članaka o modifikacijama drva (European conference on wood modification 2014., 2015., 2017., 2018.)
2. Živković, V. i dr. Influence of natural surface ageing on bonding quality of thermally modified oak and beech wood // Drvna industrija, 70 (2019), 3; 273-278
3. Živković, V. i dr. Surface properties of thermally modified wood floorings // Proceedings of the Eighth European Conference on Wood Modification / Helsinki: Aalto University, 2015. str. 115- 118

Formsof teaching

Lecturing: obligatory lectures, practica and completion of written reports. One day of field studies and completion of a written review. Examination: consultations and revision of written reports and reviews. Verbal examination.

Lectures (30 h), exercises (15 h)

Assessment methods

Verbal examination. Preconditions: positive consultations and revision of written reports.

INVESTIGATION OF PHYSICAL AND MECHANICAL PROPERTIES OF WOOD (code: 235554)

Original course title	Istraživanje fizikalnih i mehaničkih svojstava drva	Status	obligatory
Semester	summer	Course teacher	prof.Tomislav Sinković PhD; assist. prof. Tomislav Sedlar; PhD; Branimir Jambreković, PhD
ECTS	5	Study level and programme	MSc Wood Product Design

Course content

Knowledge about physical and mechanical properties of wood. Preparation for investigation of physical and mechanical properties of wood. Methods for the selective sampling of wood and general requirements for physical and mechanical tests on small clear test pieces. Instruments and devices for determination of physical and mechanical properties of wood. Macroscopic properties of wood. Optical methods, thomographi, ray x, b, g. Physical properties of wood. Methods for determination of dimensions and mass. Methods for determination of volume (regular dimensions, immersion). Methods for determination of density (according to standards, floatation. immersion, ray x, b, g). Methods for determination of moisture content (ove-drying, distillation, titration, electrical moisture meters, ray x, b, g). Methods for determination of fiber saturation point (sorption, shrinkage, mechanical properties, electrical properties, and thermal conductivity). Methods for determination of thermal, electrical and acoustical properties of wood. Destructive and nondestructive methods for determination of mechanical properties of wood. Comparing and determination of macroscopic, physical and mechanical properties of domestic and foreign commercial wood species.

Learning outcomes

- ✓ Determination of the necessary parameters of trees for the selection of modal trees for the exploration of physical and mechanical properties of wood
- ✓ Selection and felling of trees for the exploration of physical and mechanical properties of wood
- ✓ Preparation of samples for research of physical and mechanical properties of wood
- ✓ Testing of physical and mechanical properties of wood
- ✓ Statistical treatment and evaluation of the results of the research of physical and mechanical properties of wood
- ✓ Collection of relevant data to display the results of research on physical and mechanical properties of wood for the purpose of displaying as scientific or professional work

Language

Teaching will be conducted in English and forms of instruction are a combination of presentations and exercises. Studying the students' knowledge is done by the tasks they need to do during the classes. The final evaluation of the knowledge is done by interviewing the student.

Literature

1. Horvat i drugi: Osnove nauke o drvu, Zagreb, 1985
2. Karahasanović, A.: Nauka o drvetu, Sarajevo, 1988
3. Ugrenović, A.: Tehnologija drveta, Zagreb, 1950
4. Govorčin, S.; Sinković, T.: Ispitivanje fizikalnih i mehaničkih svojstava drva, 2004, Zagreb, Interna skripta
5. Giordano, G.: Tecnologia del legno, Volume I, Torino, 1971, str. 1-1086.
6. Giordano, G.: Tecnologia del legno, Volume 111, Torino, 1976, str. 1-1351.
7. Lincoln, W., A. Walker, et al. 1989. The Encyclopedia of Wood. Facts on File Books. Quarto Publishing plc, London.
8. Tsoumis, G.: Science and Technology of Wood, New York,1991, str. 1-233.

Forms of teaching

Lectures (30 h), exercises (30 h), e-learning (8 h)

Assessment methods

Oral exams

TECHNOLOGY OF PANELS MADE FROM FRAGMENTED WOOD (code: 235709)

Original course title	Tehnologija ploča od usitnjenog drva	Status	obligatory
Semester	summer	Course teacher	Prof. Vladimir Jambreković, PhD; Assist. Prof. Nikola Španić, PhD
ECTS	5	Study level and programme	MSc Wood Technology Processes

Course content

Development stages in technolgy of panels from fragmented wood. Production technologies. Management of technological processes. Definition of properties of panels made from fragmented wood. Panel characteristics planning. Raw material preparation. Particles and fibres characteristics planning. Factors affecting the characteristics of bonding materials and chemical additives. Planning of characteristics of chemical components. The raw material characteristics influence on panel properties. Specifics of recycled wood composites technology. The elaboration of technological parameters in production processes. The significance of size separation and particles dosage. Specifics of dosage of fibres

and chemical components. Structure and quality of „mats" from fragmented wood. Technological processes at hot and cold pressing. Factors influencing on pressing and quality of panels. Specifics of continuous pressing processes. Technological processes in the production of wood-plastic composites (WPC). Influence of chemical additives on WPC properties. Technology of wood cellulose based biocomposite and nanocomposite materials. Final processing of composite materials. Conditioning and moisture content equalisation. Panel classification. Technological conditions of panel overlaying with veneers and synthetic materials. Technologcal conditions of overlaying panels edges. Stability of panels overlaid with synthetic materials. The influential factors of overlaying quality. The influence of overlaying materials on panels properties. Monitoring , analysis and presentation of technological parameters. Control and management of technological phases of panel production. Optimisation of panel properties with correction of technological parameters. Quality assurance. The development of new technologies in production of panels from fragmented wood.

Learning outcomes

- ✓ to identify and evaluate production technologies and process equipment for the production of panels from fragmented and defibrated wood
- ✓ to design the characteristics of basic and auxiliary raw materials depending of the production process and the type of product made from fragmented and/or defibrated wood
- ✓ to manage the technological processes in the production of boards and shaped products(moldings) made from fragmented and defibrated wood
- ✓ to optimize the panel properties by correcting the technological parameters
- ✓ to recommend the methods and technical conditions for the panel overlaying
- ✓ apply the technical regulations for wooden panels
- ✓ to design and implement new technologies in the production of boards and shaped products from fragmented and defibrated wood

Language

Teaching will be conducted in English and forms of instruction are a combination of presentations and exercises. Studying the students' knowledge is done by the tasks they need to do during the classes. The final evaluation of the knowledge is done by interviewing the student.

Literature

- ✓ Španić, N., Jambreković, V.: Particleboard and Fiberboard Production Technology, (Internal script), Faculty of Forestry, Zagreb, 2021. (in writing).
- ✓ Thoemen, H., Irle, M., Šernek, M. (eds.): Wood-Based Panels: An Introduction for Specialists. Brunel University Press, 2010.
- ✓ Moslemi, A. A. Particleboards - Volume 2: Technology. Southern Illinois University Press, 1974.

Forms of teaching

Lectures (30 h), exercises (30 h), e-learning (8)

Assessment methods

Oral exams

INTERNATIONAL MARKET OF WOOD PRODUCTS (code: 33721)

Original course title	International Market of Wood Products	Status	elective
Semester	summer	Course teacher	Assoc. Prof. Andreja Pirc Barčić, PhD; prof.Darko Motik, PhD
ECTS	4	Study level and programme	MSc Wood Product Design

Course content

Wood economy. The basic facts of wood processing, furniture manufacture and paper manufacture and recycling. The basic facts of international market of wood products. The strategies of development and growth of wood economy on the international market. An aggregate demand and a multiplier model. International market research of furniture and other wood products. Different methods of collecting, systematizing and data processing of European and world wood products market. Measuring economic success of wood economy on the international market. The methods of calculating consumption, export, import and production on the international market of furniture and other wood products. Different techniques of presenting the processed data of international market research. The influence of macroeconomic policy of certain countries on the growth and development of wood economy. The criteria for evaluating the wood economy share in the complete economy. The share in industry and gross domestic product. Following the sale trends of certain wood products on the world market. The information about the employment record, the employees' structure, payments, the enterprise income and investments on the international market of wood and wood products.

Learning outcomes

- ✓ To analyze the impact of the macroeconomic policies of individual countries on growth and development of the timber economy.
- ✓ To review the economic success of the wood industry in international wood products market with a view to achieving competitive advantages within the wood sector.
- ✓ To analyze production, export and import of furniture and other wood products on the international market.
- ✓ To calculate the consumption of furniture and other wood products on the international market using apparent consumption method
- ✓ To analyze information on employment trends, salaries, income and investments on the international furniture and wood products market.
- ✓ To analyze criteria for monitoring the share of the wood economy in the entire economy.
- ✓ To analyze the trade statistics regarding wood based European and world markets.
- ✓ To investigate possible activities to increase the share of wood products in the international market.

Language

All teaching activities will be held in English.

Literature

1. Hansen, E., Ranwar, R., Vlosky, R. (2014): The Global Forest Sector. CRC Press.
2. FAO Yearbook of Forest Products – godišnja izdanja.
3. Sertić Basarac, M., Pirc Barčić, A.; Klarić, K. (2018): Economic Determinants and Analysis of the European Union Wood Industry SMEs Employment. Bioresources. 13 (1): 522-534.
4. Forest Products Annual Market Review, 2019-2020
5. Previšić, Ozretić Došen, Krupka: Osnove međunarodnog marketinga, Školska knjiga, Zagreb, 2012

Forms of teaching

Except regular practice, students have to collect all the available data and information for an assigned practical work, they have to systematize the data and present all the received facts in a form of a project work.
Lectures (30 h), exercises (15 h)

Assessment methods

The evaluation of students` knowledge and achievements is going to be conducted during the classes and by written and oral exams.

SPECIAL PRODUCTS OF WOOD (code: 235690)

Original course title	Special Products of Wood	Status	elective
Semester	summer	Course teacher	Prof. Tomislav Sinković, PhD; assist. prof. Tomislav Sedlar; PhD; Branimir Jambreković, PhD
ECTS	4	Study level and programme	MSc Design of Wood Products

Course content

Knowledge about pencils, history of pencils and wood species for pencils. Matches and wood species for its productions. Models and wood species for its productions. Heel and wood species for its productions. Barrels and wood species for its productions. Barrels for strongdrink and softdrink. Light barrels. Barrels manufactured from plywood. . Pacage and wood species for its productions. Parts of wooden pacages. Standards for wooden pacages. Wood densifying by commpresion (lignostone). Manufacturion of beech lignostone. Structure, density, variation of moisture content, swelling and shrinkage, straingth, impact bending strength. Birch lignostone. Use of lignostone. Wooden briquttes, wood species for its productions and productions. Houses made of wood, square timber, sawn timber, particleboard, plywood and sandwich composites. Musical instruments. Acoustical properties of wood. Compering of acoustical properties of wood species witch are used for musical instruments. Toys and wood species for its productions. Fancy wood articles. Clasification over use of fancy wood articles. Wood species for productions of fancy wood articles. Wood in shipbuilding. Forms of forest cultivated for shipbuilding. Wood species for shipbuilding. Ships and boats made of wood. Parts of ships and boats. Request of shipbuilding technique and construction. Properties of wood for shipbuilding. Select the wood species for shipbuilding. Carving and inlaid work. Wood species and its properties inportante for carving and inlaid work. Wood for sport equipments and props.

Learning outcomes

- ✓ Determining the characteristics of special products of wood in use that affect the choice of wood species for the production of special products of wood
- ✓ Determination of the required parameters of trees and sawmill for making special wood products
- ✓ Determining the most characteristic properties of wood material for the production of special wood products
- ✓ Determination of timber properties relevant for the production of special wood products
- ✓ Defining the basic technological characteristics for the production of special wood products
- ✓ Valuation of technological characteristics for production of special wood products
- ✓ Collection of relevant data to display the basic technological characteristics for the production of special wood products for the purpose of displaying as scientific or professional work

Language

The course is going to be taught in English. All forms of teaching are a combination of presentations and exercises. Students gain the knowledge by performing assigned tasks during the course. Final evaluation of the knowledge is done in the form of interview.

Literature

1. Panshin, A.J.; deZeeuw. C., 1980: Textbook of wood technology, 4th edition. McGraw-Hill series in forest resources. McGraw-Hill book company, New York.
2. Forest Products Laboratory. 1999: Wood Handbook - Wood as an engineering material. Gen. tech. rep. FPL-GTR-113. U.S. Department of Agriculture, Forest Service, Forest Products Laboratory, Madison, WI.
WOOD Magazine. 1993: Classic woodworking; Woods and how to use them. better; Homes and gardens. Meredith Books, Des Moines, IA.
4. Jackson, A; Day, D., 1991: Good wood handbook - The woodworker's guide to identifying, selecting and using the right wood. Harper Collins publishers Ltd, London.

Forms of teaching

Lectures (30 h), exercises (15 h), e-learning (8 h)

Assessment methods

Oral exam

WOOD FIBERS AND PAPER TECHNOLOGY (code: 235719)

Original course title	Wood Fibers and Paper Technology	Status	elective
Semester	summer	Course teacher	Prof. Vladimir Jambreković, PhD; Assist. Prof. Nikola Španić, PhD; Assoc. Prof. Alan Antonović, PhD
ECTS	4	Study level and programme	MSc Wood Technology Processes

Course content

Development of wood fibres and paper technology. The quality of wood fibres depending on the wood species. Technological processes of wood delignification. Impact of basic and modified methods of delignification on the quality of wood fibres. Thermo-mechanical and chemi-thermo-mechanical pulping. Defibration procedures and their impact on the quality of ground wood. Technological processes of producing semi-cellulose. Neutral sulphite pulping. Cold alkaline pulping. Technological processes of sulphite cellulose. Comparison of sulphite and natrone procedures. Comparison of discontinuous and continuous methods of cooking chips. Influence of white liquor composition and technological parameters on defibration efficiency. Methods and procedures of fibres bleaching. Wood fibres quality insurance. Influential efficiency factors of black liquor regeneration. Technological processes for production of recycled fibers. Nano-cellulose production technologies. Wet-end and dry-end parts of paper manufacturing technology. Paper surface protection and pigment coating methods. Paperboard and cardboard technologies. Paperboard and cardboard surface treatment, dispersion and extrusion protection and lamination methods. Mechanical and electronic printing methods. Technological processes control and paper

Learning outcomes

- ✓ to analyse and evaluate the processes of mechanical defibration of wood, and of producing semi- cellulose and technical cellulose
- ✓ to recommend appropriate methods and to manage technological processes of wood delignification and regeneration of chemicals

- ✓ to identify and recommend the methods, and to manage and evaluate processes of subsequent chemical treatment of produced wood fibres and regenerated cellulose
- ✓ to identify and evaluate the procedures of nano cellulose production
- ✓ to evaluate, recommend and manage technological processes of producing paper, cardboard and corrugated cardboard
- ✓ to improve the properties of paper and of wood fibres and nano cellulose based products

Language

All teaching activities including the exam will be held in English. All of the teaching materials (lectures, laboratory worksheets and instructions, etc.) will be written in English.

Literature

1 Holik, H. (Ed.): Handbook of Paper and Bord. WILEY-VCH, Weinheim, 2006.
2. Ćorlukić, F.: Technology of Paper. Školska knjiga, Zagreb, 1987. [In Croatian].
3. Španić, N., Jambreković, V., Antonović, A.: Technology of Wood Fibres, (Internal script), Faculty of Forestry, Zagreb, 2021. (in writing)
4. Kljajić, F.: Chemical Pulping. Školska knjiga, Zagreb, 2000. [In Croatian].
5. Sjöström, E., Alén, R. (Eds.): Analytical methods in Wood Chemistry, Pulping, and Papermaking. Springer, Berlin Heilderberg, 1999.

Forms of teaching

Lectures (30 h), exercises (15), e-learning (8)

Assessment methods

Written exam. Oral exam.

WOOD MACHINING OPTIMISATION (code: 235734)

Original course title	Optimizacija mehaničke obrade drva	**Status**	elective
Semester	summer	**Course teacher**	Prof. Ružica Beljo Lučić, PhD; Assoc. Prof. Igor Đukić, PhD
ECTS	4	**Study level and programme**	MSc Wood Technology Processes

Course content

Defining the wood machining process parameters: performance, cutting power, energy consumption, specific cutting energy, machining accuracy, machined surface quality, tool wear, tool blade heating, noise and dust emissions, vibration and properties of chips obtained from machining.
Economic, energy, ergonomic and ecological requirements in the modern technological process of wood machining.
Analysis of the influence of different machining parameters (machine types, rotational
frequency, cutting speed, feed speed, main motor power) on the output values of the machining process.
Analysis and influence of tool parameters (different materials and tool design, geometry, vibration damping system).
Analysis of the influence of workpiece parameters (types of wood and wood materials, structural, physical and mechanical properties, cutting directions, moisture content,
workpiece dimensions, machining allowance) on the output values of the machining process.
Analysis of human influence (knowledge, skills, psychophysical condition) on the output values of the machining process.
Analysis and determination of dimensions and shapes of wood chips that occur during a certain wood machining process and design of the required amount of air flow for suction
of wood particles.

Defining machining objectives, optimality criterion functions, and constraining factors: possible constraints imposed by machine, tool, workpiece and human operator. Possibilities of application of optimization methods for determination of optimal parameters in wood machining with regard to processing requirements and limitations. Methods for solving the optimization problems in wood machining using computers.

Learning outcomes

- ✓ investigate and explain the relationships between the most influental factors in wood machining
- ✓ recognize, analyze and apply economic, energy, ergonomic and environmental requirements in modern wood machining
- ✓ calculate the maximum feed speed obtainable with the given parameters of the workpiece material, tools and machine, with a constrain related to the required machined surface quality
- ✓ calculate the required amount of air for extraction of wood chips in a unit of time depending on the wood machining parameters and the type of machine
- ✓ state the goals of wood machining process, define the function to be optimized and determine the parameters that limit the space of possible solutions of the function
- ✓ apply simpler optimization methods for choosing optimal wood machining parameters

Language

All teaching activities will be held in Croatian. However, foreign students will have the opportunity to attend additional office hours with the lecturer and teaching assistants in English to help master the course materials. Additionally, the lecturer will refer foreign students to the corresponding literature in English, as well as give them the possibility of taking the associated exams in English.

Literature

1. Goglia, V., 1994: Strojevi i alati za obradu drva: 1. dio. Šumarski fakultet Sveučilišta u Zagrebu, Zagreb.
2. Csanády, E., Magoss, E., 2011: Mechanics of Wood Machining. Department of Wood Engineering, University of West Hungary, Sopron.
3. Šavar, Š., 1990: Obrada metala odvajanjem čestica. Školska knjiga Zagreb.
4. Gottlöber, C., 2014: Zerspanung von Holz und Holzwerkstoffen. Fachbuchverlag Leipzig, Carl Hanser Verlag.
5. Parkinson, R., Balling, R. J., Hedengren, J. D., 2013: Optimization Methods for Engineering Design – Applications and Theory. Brigham Young University.
6. Martins, J. R. R. A., Ning, A., 2020: Engineering Design Optimization.

Forms of teaching

Lectures (30 h), exercises (15)

Methods of grading

partial exams